Draft Final
Feasibility Study Report
Port Uplands Area, MJB North Area, and Marine Area
Former Scott Paper Company Mill Site
Anacortes, Washington

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Prepared for

Port of Anacortes
MJB Properties
Kimberly-Clark Corporation

Submitted by

GEOENGINEERS, INC.
600 Stewart Street, Suite 1700
Seattle, WA 98101
(206) 728-2674

AMEC GEOMATRIX, INC.
600 University Street, Suite 1020
Seattle, WA 98101-4107
(206) 342-1760

ANCHOR ENVIRONMENTAL, L.L.C.
1423 3rd Avenue, Suite 300
Seattle, WA 98101
(206) 287-9130

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List of Acronyms

BGS	Below ground surface
BSAFs	Biota-sediment accumulation factors
CAO	Cleanup action objectives
CAP	Cleanup action plan
CHE	Coast and Harbor Engineering
cm	centimeters
CM1	Commercial Marine (1)
cPAH	Carcinogenic polycyclic aromatic hydrocarbons
CQAP	Construction quality assurance project plan
CSL	Cleanup screening level
CWA	Clean Water Act
DMMP	Dredge Material Management Program
EPA	United States Environmental Protection Agency
FS	Feasibility study
ft	Feet
HAZWOPER	Hazardous Waste Operation and Emergency Response
HPA	Hydraulic Project Approval
K-C	Kimberly-Clark Corporation
mg/L	Milligrams per liter
mg-N/L	Milligrams nitrogen per liter
MHHL	Mean higher-high water
MJB	MJB Properties
MLLW	Mean lower low water
MSL	Mean sea level
MTCA	Model Toxics Control Act
NFA	No further action
NWCAA	Northwest Clean Air Agency
NWP	Nationwide Permit
OC	Organic carbon
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
PQL	Practical quantitation limit
PSDDA	Puget Sound Dredged Disposal Analysis
RI	Remedial investigation
SEPA	State Environmental Policy Act
SHS	Sun Healthcare Systems, Inc.
SMS	Sediment Management Standards
SQS	Sediment Quality Standard
SVOCs	Semivolatile organic compounds
TCLP	Toxicity characteristic leaching procedure
TPH	Total petroleum hydrocarbons
TVS	Total volatile solids
UTS	Universal Treatment Standards
WAC	Washington Administrative Code
WDNR	Washington Department of Natural Resources

DRAFT FINAL
FEASIBILITY STUDY REPORT
PORT UPLANDS AREA, MJB NORTH AREA, AND MARINE AREA
FORMER SCOTT PAPER COMPANY MILL SITE
ANACORTES, WASHINGTON
FOR
PORT OF ANACORTES
MJB PROPERTIES
KIMBERLY-CLARK CORPORATION

1.0 INTRODUCTION

This report presents the feasibility study (FS) conducted for upland properties and aquatic lands at the former Scott Paper Company ("Scott Paper") Mill site (the "Site") located in Anacortes, Washington (Figure 1). At the request of the Washington State Department of Ecology (Ecology), this FS was prepared by the entities responsible for cleanup of the various portions of the Site: Port of Anacortes ("Port"), Kimberly-Clark Corporation ("K-C"), and MJB Properties ("MJB"). Once approved, this FS fulfills the requirements of the Consent Decree for the Port properties and the Agreed Order for the MJB upland property and the marine area adjacent to the Site uplands. The FS was completed to develop and evaluate cleanup action alternatives for addressing contamination identified at the Site, and to select a preferred alternative for cleanup.

The FS utilizes information about the history and environmental conditions of the Site gathered during prior investigations. The results of these investigations are summarized in the remedial investigation (RI) report (GeoEngineers et al. 2008), a companion document to this report. The RI and FS were completed in accordance with the requirements of the Model Toxics Control Act (MTCA) Cleanup Regulation, Chapter 173-340 Washington Administrative Code (WAC), and the Sediment Management Standards (SMS), Chapter 173-204 WAC.

The Site layout is shown in Figure 2. Because of different ownership and use, the various portions of the Site are referred to by distinct names. The northern portion of the Site, referred to as the "Port Property," is currently owned by the Port, with the exception of the area known as Parcel 2, which was previously owned by the Port but is currently owned by several other entities. The Port has indemnified purchasers of former Port-owned property at the Site from past environmental liability. The Port Property includes an uplands area (the "Port Uplands Area"), which consists of three parcels (Port Parcels 1, 2, and 3), and the adjacent aquatic lands delineated by the federal channel to the north, the inner harbor line to the east, and the Port/MJB property line to the south. The southern portion of the Site is owned by MJB, and consists of an uplands area (referred to as the "MJB North Area") and the adjacent aquatic lands delineated by the Port/MJB property line to the north, the inner harbor line to the east, and the MJB property line to the south. For the purpose of the RI/FS, the aquatic lands adjacent to the Port Uplands Area and the MJB North Area are collectively referred to as the "Marine Area."

This document addresses contamination identified at the Site. Information regarding contamination is presented by area: the Port Uplands Area, the MJB North Area, and the Marine Area. The aquatic lands are addressed in this report as one contiguous area (the Marine Area) due to the existence of impacted sediment extending across the boundary between the northern and southern portions of the Site and common sediment transport pathways.

1.1 SITE BACKGROUND

This section provides a summary of Site background information. Additional background information about the Site, including descriptions of historical Site operations and land use, current and likely future land use, and the uplands and marine area environmental setting, is provided in the RI report.

The former Scott Paper Mill was located in Anacortes, Washington on the west shore of Fidalgo Bay. The development of the shoreline as an industrial area began in approximately 1890 with the construction of a lumber mill on the Port Uplands Area. Prior to development, the area was largely a shallow tideland. The lumber mill extended from the upland fill on pilings into Fidalgo Bay to approximately the inner harbor line. In 1925, a pulp mill was constructed on the MJB North Area. The pulp mill produced pulp using waste from the lumber mill. Materials utilized at the pulp mill included petroleum, sulfur, anhydrous ammonia, ammonium hydroxide, and chlorine. Bunker C and diesel fuels were used to generate power and operate equipment. Effluent from mill operations was discharged directly to Fidalgo Bay from 1925 to 1951.

In 1940, Scott Paper purchased the lumber and pulp mills; they operated the lumber mill until 1955 and the pulp mill until 1978. The Scott Paper Mill operations were bounded by Cap Sante Boat Haven to the north, Fidalgo Bay to the east, and Q Avenue to the west. To the south, the approximate extent of Scott Paper Mill operations was 20th Street. Site boundaries are depicted in Figure 2. During its operation, the Scott Paper Mill constructed a waste stream outfall that discharged to the Guemes Channel at the current location of the Port-owned Dakota Creek Shipyard. The pulp mill closed in 1978.

In 1978 and 1979, the Port purchased the northern portion of the Site. The southern portion of the Site was purchased by Snelson-Anvil in 1979, and has been owned by MJB since 1990. In 2008, the Port acquired a narrow strip of the southernmost portion of the northern Marine Area offshore of the Port Uplands Area (Figure 2) from Mr. and Mrs. Lorren Levorsen and Mrs. Delores Snelson. The Site has been redeveloped since mill operations ceased. Initial redevelopment activities included demolition of mill buildings and wharves and removal of tailings pond waste. Site redevelopment is discussed further below.

1.1.1 Port Uplands Area Redevelopment and Previous Cleanup Actions

After closure of the mill, little activity occurred on the Port Uplands Area until 1990 when the Port constructed and operated a log storage facility on Parcels 1 and 2. The log storage yard was in operation through 1993. Since closure of the log storage yard, Port Parcel 1 has remained undeveloped. Development of Parcel 1 is planned following Ecology approval of the current RI/FS investigations and any necessary cleanup.

Parts of Parcel 2 have been developed since the closure of the log storage yard. In 1998, an RI of Port Parcel 2 was performed by Sun Healthcare Systems, Inc. (SHS), a prospective buyer of Parcel 2. The Parcel 2 RI consisted of collecting and analyzing soil samples from test pits throughout Parcel 2; collecting and analyzing groundwater samples from monitoring wells; and monitoring groundwater levels to evaluate potential tidal influences. SHS prepared an RI/FS report and cleanup action plan (CAP) for upland soil at Parcel 2 following completion of the RI (ThermoRetec 1999a, 1999b).

SHS purchased Parcel 2 from the Port in 1999. In 2000, SHS completed a soil cleanup action at Parcel 2 under the MTCA Voluntary Cleanup Program. The cleanup action included removal and off-site disposal of 3,469 tons of petroleum-contaminated soil, soil capping, and institutional controls to prevent future exposure to subsurface soil and restrict the use of groundwater as drinking water. The Parcel 2 soil cleanup also included the installation of a sheet pile wall along the shoreline for containment of residual contaminated soil, concurrently providing structural foundation support for the building constructed by SHS (see below; ThermoRetec 2000). Ecology subsequently issued a No Further Action (NFA) letter for petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins/furans, wood debris, and metals in Parcel 2 soil (Ecology 2000). The NFA letter was conditional on groundwater monitoring being conducted at Parcel 2.

SHS built an office park on Port Parcel 2 in 2000. SHS subsequently subdivided Parcel 2 into four sub-lots and sold these lots to four entities. Since then, additional buildings have been constructed on Parcel 2. Ecology modified the type of written opinions it provides under the Voluntary Cleanup Program in 2005 and no longer provides NFA letters for a single medium such as soil (Ecology 2005b). In 2006, Ecology notified the Port that it planned to rescind the NFA letter it had issued for Parcel 2 soil because the cleanup action had not fully addressed contamination on the property.

Construction of Seafarers' Memorial Park on Port Parcel 3 began in 1995. The park includes grass, landscaped areas, and a community building, as well as asphalt-paved roads and parking areas. Parcel 3 and the adjacent Marine Area are part of Seafarers' Memorial Park. At present, there are no plans to modify the site use of Parcel 3.

1.1.2 MJB Property Redevelopment

The MJB North Area comprises the southern portion of the former Scott Mill operations area (Figure 2). Approximately 18.5 acres of upland and 13.5 acres of intertidal and subtidal lands comprise the MJB North Area north of 20th Street (according to the Skagit County Geographic Information System website). The MJB North Area (the term used in previous deliverables under the Agreed Order) refers to the area between 17th and 20th Streets, east of R Street. The MJB North Yard (the term used in communications relating to zoning and redevelopment) refers to the area between 17th and 22nd Street, east of R Street. This document addresses the MJB North Area (north of 20th Street).

Snelson-Anvil purchased the property in 1979 for the assembly of portable buildings to be shipped to Alaska. Redevelopment of the property involved the demolition of buildings. According to a previous site assessment (AGI 1987), Snelson-Anvil's policy for developing the property in the early 1980s was to remove wood waste and soft or deleterious soils and replace them with granular fill. A review of borings logs and historical aerial photographs performed during the RI (GeoEngineers et al. 2008) indicated that wood waste and unsuitable soil may have been selectively excavated in areas where heavy loads were planned (e.g., construction of a heavy portable). The aerial photograph review also indicated that many of the former Scott Mill buildings and an associated surge pond were still intact on the property in 1981, but were removed and replaced by the construction of portable buildings by 1983.

Some portions of the MJB North Area, such as the northwest office building and parking lot, the northeast triangular portion, and the central area around the electrical building, have not been significantly excavated since the time of the former Scott Mill operations. Other than these discrete areas, excavation of structurally unsuitable fill, and replacement with better quality, compactable fill, occurred across much of the MJB North Area in about 1982. Since 1982, the MJB North Area has been used for light industrial activities.

Currently, the MJB North Area is mostly undeveloped, with one large building in the southwest corner and three smaller buildings. Undeveloped portions of the MJB North Area are largely unvegetated with the exception of non-native, invasive brush in the northeast corner. No foundations remain of the former structures associated with the Scott Paper Mill.

MJB has considered a marina as one development option for the MJB North Area. The conceptual plan for the marina includes slips for pleasure boats and float planes, docks, and, potentially, a floating breakwater. A 12-ft wide (approximate) promenade, adjacent to a 25-ft wide landscaped set-back along the top of the bank, is planned as the transition from the offshore to the upland areas. The marina would also include support facilities (e.g., parking). MJB has also made a preliminary determination that a water and waterview-dependent mixed-use development, with a residential component, is a viable future development option for the property. As part of the City's Comprehensive Plan update, MJB has requested that the Anacortes City Council consider incorporating limited residential uses into a mixed-use development at the MJB North Area, even though residential uses are not currently allowed. On May 31, 2006, the City Council met to deliberate on the Comprehensive Plan policies for Commercial Marine areas. The Council agreed on draft language that would allow limited residential uses in the CM1 zone as a component of a mixed-use development.

A mixed-use uplands development might include a hotel, retail shops, offices, restaurants, residences and parking structures. Residence styles would likely consist of townhouses, townhouses over flats, and/or stacked flats. These residences would primarily be situated above the lower non-residential levels or above an in-ground or above-ground parking structure. The uplands development area would be surfaced with concrete, asphalt, or structures, with localized and controlled landscaped areas.

1.2 REGULATORY FRAMEWORK

In 2003, the Port entered into a Consent Decree (Consent Decree No. 03 2 00492 1) with Ecology. The Consent Decree requires the Port to complete the following work to address potential Site contamination from historical operations at the former Scott Mill: an RI/FS for soil at Port Parcel 1; an RI/FS for soil at Port Parcel 3 and groundwater at the Port Uplands Area; and a Marine Area RI/FS for nearshore sediments that are part of Port Property. The Port completed the RI studies for soil at Port Parcels 1 and 3 and groundwater at the Port Uplands Area in 2006. An earlier RI/FS for soil at Port Parcel 2 was completed in 1999 (ThermoRetec, 1999a). The results of the Port Uplands Area RI studies, including the Parcel 2 RI results, are presented in the RI report.

In 2004, K-C entered into an Agreed Order (Order No. DE 1783) with Ecology to prepare an RI/FS for the southern portion of the Site, including soil and groundwater at the MJB North Area and associated marine sediments. Pursuant to the Agreed Order and agreements with the Port and MJB, K-C conducted an RI for the entire Marine Area, while MJB (pursuant to agreements with K-C) conducted an RI for the

MJB North Area. The results of the MJB North Area and Marine Area RI studies are presented in the RI report.

In addition to the work described above, the Port Consent Decree and the K-C Agreed Order require the Port and K-C, respectively, to identify whether any sitewide issues have not been addressed after submittal of the required RI/FS reports. If unresolved sitewide issues are identified, the Port and K-C are required to address them. The Port, K-C, and MJB ("the cooperating parties") agreed to combine the required RI/FS reports into a single, integrated RI/FS document to facilitate Ecology review and ensure that sitewide issues are addressed. The cooperating parties have jointly prepared this FS report for the entire Site based on the information presented in the RI report.

1.3 STATEMENT OF PURPOSE

The purpose of the FS is to develop and evaluate cleanup action alternatives to enable a cleanup action to be selected for the uplands areas (Port Uplands Area and MJB North Area) and the adjacent aquatic lands (Marine Area) of the Site. In accordance with the MTCA Cleanup Regulation (WAC 173-340), if concentrations of hazardous substances do not exceed the cleanup level at a standard point of compliance, no further action is necessary.

1.4 REPORT ORGANIZATION

This report is organized as follows:

- Section 1.0 summarizes the Site background and regulatory framework pertinent to the FS, and states the FS purpose;
- Section 2.0 summarizes the results of the RI studies completed at the Site, including a summary of the Site environmental conditions (nature and extent of contamination) and the conceptual site model;
- Section 3.0 describes the basis for the cleanup action, including a summary of cleanup standards and the locations and media requiring cleanup action evaluation;
- Section 4.0 describes the framework for the development and evaluation of cleanup action alternatives, including the objectives of the cleanup action, the applicable regulatory requirements, the screening of remediation technologies, and integration of the alternatives with habitat restoration and site development;
- Section 5.0 describes the criteria used to evaluate the cleanup action alternatives;
- Section 6.0 presents the development and evaluation of cleanup action alternatives for the Port Uplands Area and the MJB North Area;
- Section 7.0 presents the development and evaluation of cleanup action alternatives for the Marine Area;
- Section 8.0 presents a summary of the recommended cleanup actions for the Site;
- Section 9.0 describes the limitations on the use of this report; and
- Section 10.0 presents the references used in preparing this report.

2.0 SUMMARY OF REMEDIAL INVESTIGATION RESULTS

Various RI and cleanup activities have been conducted at the Site since approximately 1990. The scope and results of these activities are described in detail in the RI report (GeoEngineers et al. 2008). This section summarizes the pertinent results of the RI regarding the environmental conditions at the Site (i.e., nature and extent of contamination) and presents the conceptual site model. The information presented in this section is excerpted from the RI report.

2.1 Environmental Conditions

This section summarizes the chemical testing results for soil, soil vapor, groundwater, and sediment samples collected during the various RI studies conducted at the Site. Habitat features and aquatic resources of the Marine Area also are summarized. Further details and sources of the information presented in this section are provided in the RI report.

2.1.1 Soil

This section summarizes the comparison of chemical concentrations detected in soil at the Port Uplands Area and the MJB North Area with the preliminary soil cleanup levels developed in the RI. The locations within the Port Uplands Area and the MJB North Area where chemical concentrations exceed the preliminary soil cleanup levels are shown in Figures 3 through 9. Site-specific soil cleanup standards used in the development and evaluation of cleanup action alternatives in the FS are discussed in Section 3.0.

2.1.1.1 Port Uplands Area

At Port Parcel 1, the only constituent detected in soil at a concentration above the preliminary cleanup levels was arsenic. Arsenic was detected at a concentration above the preliminary cleanup level at one location [ET-TP03; 6-10 feet below ground surface (ft BGS) depth interval] near the northeastern corner of Parcel 1 (Figure 5).

Multiple constituents were detected in soil remaining at Port Parcel 2 at concentrations above the preliminary cleanup levels, including metals (antimony, arsenic, chromium, copper, lead, mercury, nickel, and zinc), diesel- and motor oil-range petroleum hydrocarbons, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), polychlorinated biphenyls (PCBs), and dioxins/furans. These exceedances were concentrated in two areas: the rectangular parking lot near the center of Parcel 2 and the area of the subsurface containment wall in the southeastern portion of Parcel 2 (Figures 4 through 6).

The nature and extent of soil contamination at Port Parcel 3 can be summarized as follows:

- **Arsenic in Shallow Soil (0 to 2 ft BGS)**. The only constituent detected in shallow soil at Parcel 3 at a concentration above the preliminary cleanup levels was arsenic. Arsenic was detected at concentrations above the preliminary cleanup level at one location (LAI-S-4) in Seafarers' Memorial Park (Figure 3).
- **Arsenic, Lead, Copper, Diesel- and Motor Oil-Range Petroleum Hydrocarbons, cPAHs, and Dioxins/Furans in Deeper Soil (2 to 15 ft BGS).** These constituents were detected at concentrations above the preliminary cleanup levels at Seafarers' Memorial Park and near the present southern end of "R" Avenue (Figures 4 through 6).

2.1.1.2 MJB North Area

There are two categories of soil at the MJB North Area that have concentrations of metals and cPAHs that exceed preliminary cleanup levels:

- **Arsenic, Copper, Zinc, Chromium, Lead, Nickel, and cPAHs in Shallow Soil (0 to 2 ft BGS).** Arsenic, copper, and zinc occur at concentrations exceeding preliminary cleanup levels at a number of sample locations across the MJB North Area in the uppermost grayish-brown gravelly fill layer from 0 to 2 ft BGS (Figure 7). Chromium, lead, and cPAHs were each detected in one sample of surface soil in the nearshore area, and nickel was detected in two samples, at concentrations above preliminary cleanup levels.
- **Antimony, arsenic, copper, lead, thallium, zinc, and cPAHs in Deeper Soil (2 to 15 ft BGS).** These constituents occur at concentrations exceeding preliminary cleanup levels in deeper soil in the northeast and/or southeast portion of the MJB North Area, and appear to be limited to the wood layer and woody fill layers in the subsurface from 4 to 11.5 ft BGS (Figures 8 and 9).

2.1.2 Soil Vapor

Soil vapors were monitored using a Gasport® multimeter during the Port Parcel 3 RI conducted in 2004 and 2005. Air around each borehole was monitored for hydrogen sulfide and methane gas during drilling of the borehole. No detectable concentrations of either of these gases were measured. Previous soil vapor and air sampling performed at Port Parcel 3 includes the following:

- 1993. Ambient air samples were collected by the Northwest Air Pollution Authority and analyzed for hydrogen sulfide. Measured concentrations ranged from 0 to 1 part per million.
- 1994. Air samples from shallow post holes were collected by Prezant Associates. Hydrogen sulfide was not detected at a detection limit of 0.1 parts per million.
- 1995. Soil vapor monitoring wells (VM-1 through VM-6) were installed by Hart Crowser Inc. prior to construction of Seafarers' Memorial Park at six locations across the Park. The wells were screened from 4 ft BGS to the top of the groundwater table (typically 8 to 10 ft BGS). Soil vapor samples collected from the wells were analyzed in the field using Sensidyne tubes and an MSA 361 gas monitoring instrument. Hydrogen sulfide was not detected in any of the soil vapor samples.
- 1998. Hydrogen sulfide monitoring was performed by Earth Tech during the excavation of test pits at Parcel 3. No detections of hydrogen sulfide were reported.

2.1.3 Groundwater

This section summarizes the comparison of chemical concentrations detected in groundwater at the Port Uplands Area and the MJB North Area with the preliminary groundwater cleanup levels developed in the RI. Site-specific groundwater cleanup standards used in the development and evaluation of cleanup action alternatives in the FS are discussed in Section 3.0.

2.1.3.1 Port Uplands Area

The nature and extent of groundwater contamination at the Port Uplands Area can be summarized as follows:

- **Shoreline Monitoring Wells.** Groundwater at the shoreline wells (MW-101, MW-105, MW-106, MW-107, and MW-108) located landward from the proposed conditional point of compliance (i.e., the groundwater/surface water interface in the porewater discharge zone; see Section 3.1.2.2) complies with the preliminary groundwater cleanup levels. Although there were a few sporadic exceedances of preliminary cleanup levels or screening levels at shoreline wells (ammonia and sulfide at well MW-101; bis(2-ethylhexyl)phthalate at wells MW-101, MW-105, MW-107, and MW-108), these were isolated occurrences and are not representative of groundwater conditions.

- **Interior Monitoring Wells.** Groundwater at interior wells MW-103, MW-104, MW-109, and MW-111 complies with the preliminary groundwater cleanup levels, although there was one marginal exceedance of dissolved arsenic at well MW-111. This exceedance was isolated and is not representative of groundwater conditions. Total and/or dissolved arsenic were detected at concentrations above the preliminary cleanup level during four monitoring events at well MW-102. Diesel-range and motor oil-range petroleum hydrocarbons were detected at concentrations above the preliminary cleanup levels during one monitoring event at well MW-110, and free product was observed during two monitoring events at MW-110, at measured thicknesses of 0.03 ft and 0.6 ft.

2.1.3.2 MJB North Area

The nature and extent of groundwater contamination at the MJB North Area can be summarized as follows:

- **Shoreline Monitoring Wells.** Groundwater at the shoreline wells (located landward from the proposed conditional point of compliance at the groundwater/surface water interface in the porewater discharge zone; see Section 3.1.2.2) complies with the preliminary groundwater cleanup levels.

- **Interior Monitoring Wells.** Groundwater at interior well MW-7 appears to comply with the preliminary groundwater cleanup levels. At interior well MW-4, dissolved arsenic was detected in groundwater at concentrations exceeding the preliminary cleanup level.

2.1.4 Marine Sediments

Two navigation channels continue to be routinely dredged in the northern portion of Fidalgo Bay to allow medium and shallow draft ship navigation to marinas and industrial properties. Limited areas of the upper intertidal zone adjacent to the Site containing a mix of sand and gravel may provide suitable spawning habitat for sandlance (*Ammodytes hexapterus*) or surf smelt (*Hypomesus pretiosus*) (Antrim et al. 2000). Offshore areas consist primarily of eelgrass (*Zostera spp.*) beds of varying densities. These beds provide a number of ecological functions including support of prey species, substrate for spawning of Pacific herring (*Clupea pallasi*), and rearing for juvenile salmon and crab (Huckell/Weinman 1996; City of Anacortes 1999; Antrim et al. 2000). As discussed in the RI report, detailed eelgrass surveys of the areas offshore of the MJB North Area and Port Uplands Area were performed during August 2004 and August 2007, respectively.

Sediment impacts at the Site can be attributed to direct deposition of hazardous substances in the Marine Area, transport of contaminants in groundwater, and/or erosion of contaminated soil from the Port Uplands Area and the MJB North Area to Fidalgo Bay. Site sediments can also be impacted by the decay of wood debris present below the surface sediment. The nature and extent of sediment contamination at the Site can be summarized as follows:

- Several metals (copper, lead, mercury, and zinc) and organics [PCBs and wood debris/total volatile solids (TVS)] have been detected above preliminary cleanup levels in sediments collected from the intertidal beach area immediately offshore of the Site.
- Intertidal and shallow subtidal surface sediments offshore of the Port Uplands Area typically consist of exposed wood and other debris or cobbles. A relatively thin layer of silt and sand is found at lower elevations where wave energy is lower. Shallow subtidal surface sediments typically consist of a relatively thin layer of silt and sand sediments overlying the wood debris deposits.

2.2 CONCEPTUAL SITE MODEL

This section summarizes the conceptual model for the Site based on the results of the RI. The conceptual site model includes a discussion of the contaminant exposure pathways identified for the Site and the potential risks posed to human health and the environment by hazardous substances in soil, groundwater, and/or sediment.

Soil impacts at the Site likely resulted from past releases of hazardous substances to the soil; Site soil can also be impacted by the decay of buried wood debris. Possible sources of groundwater impacts include hazardous substances that migrate from soil to groundwater or that are released or produced in the saturated zone. Contaminants present in groundwater can migrate to marine surface water. Sediment impacts likely resulted from direct deposition of hazardous substances in the Marine Area, transport of contaminants in groundwater, erosion of contaminated soil from the Port Uplands Area and the MJB North Area to Fidalgo Bay, and/or decay of wood debris present below the surface sediment. The conceptual site model illustrating potential contaminant transport mechanisms is shown in Figure 10.

2.2.1 Soil

Site soil consists of multiple layers of fill overlying native marine sediment and glacial deposits. Surface soil is predominantly recent gravel and sand fill material with mixed wood debris. Metals and cPAHs were the only constituents detected in shallow soil (upper 2 ft) at concentrations above preliminary cleanup levels: arsenic was detected at one location at Port Parcel 3, and arsenic, copper, zinc, chromium, lead, nickel, and cPAHs were detected at one or more locations at the MJB North Area. The deeper soil contains a heterogeneous mixture of soil and wood debris. Constituents detected in the deeper soil at concentrations above preliminary cleanup levels include metals (antimony, arsenic, chromium, copper, lead, mercury, nickel, and zinc), diesel-range and motor oil-range petroleum hydrocarbons, cPAHs, PCBs, and dioxins/furans at the Port Uplands Area, and metals (antimony, arsenic, copper, lead, thallium, and zinc) and cPAHs at the MJB North Area.

2.2.1.1 Contaminants in Site

- Contact (dermal, incidental ingestion, or inhalation) by visitors, workers (including excavation workers), and potential future residents or other Site users with hazardous substances in soil;
- Contact (dermal, incidental ingestion, or inhalation) by terrestrial wildlife with hazardous substances in soil; and

- Contact by terrestrial plants and soil biota and/or food-web exposure to hazardous substances in soil.

Constituents detected in the upper 15 ft of soil were evaluated to assess the potential risk to humans, plants, and animals posed by contaminated soil.

The soil sampling locations at the Port Uplands Area where constituents were detected at concentrations above preliminary cleanup levels protective of human health and terrestrial ecological receptors are shown in Figures 3 through 6. The majority of the soil exceedances occur between 6 and 10 ft BGS at Seafarers' Memorial Park, the central parking lot at Parcel 2, and the area of the subsurface containment wall in the southeastern portion of Parcel 2. There are also several exceedances at sampling locations along "R" Avenue.

The RI results for the MJB North Area indicate that metals and cPAHs are present in soil (0 to 15 ft BGS) at a number of discrete areas at concentrations exceeding preliminary cleanup levels (Figures 7 through 9). The majority of these metal and cPAH exceedances occur in a wood layer and woody fill layers between 4 and 11.5 ft BGS at the northeast corner of the MJB North Area.

2.2.2 Groundwater

Two hydrogeologic units have been identified at the Site: a shallow water-bearing unit and a confining unit. The shallow water-bearing unit occurs in the fill material and ranges from 7 to 15 ft in thickness across the Site. The thinnest portion of the water-bearing unit was encountered in the western portion of Port Parcel 1. The confining unit underlying the shallow water-bearing unit consists of native marine silts and clays. The thickness of the confining unit has not been determined, but appears to be greater than 2 ft throughout the Site. Some RI soil borings were advanced as much as 5 to 10 ft into the confining unit.

The depth to groundwater (based on measurements collected within 2 hours of low tide) ranges from 3 to 12 ft BGS. Groundwater elevation data suggest that groundwater flows to the north toward Cap Sante Waterway in the northern portion of the Port Uplands Area, and to the east and southeast toward Fidalgo Bay in the remaining portion of the Site. An evaluation of groundwater levels at low tide, mid tide, and high tide indicates that the tides do not significantly effect groundwater flow direction, except in limited areas close to the shoreline at high tide, when it appears the groundwater flow direction may be reversed (i.e., toward the uplands).

Although some constituents were detected at interior monitoring wells at concentrations above preliminary cleanup levels protective of marine surface water, groundwater at or near the proposed conditional point of compliance (i.e., the groundwater/surface water interface in the porewater discharge zone; see Section 3.1.2.2) generally appears to comply with preliminary cleanup levels. Even at interior wells, relatively few constituents were found at concentrations above preliminary cleanup levels.

The following potential exposure routes and receptors exist for contaminants in Site groundwater:

- Exposure by aquatic organisms to impacted groundwater that may discharge to Fidalgo Bay or Cap Sante Waterway, resulting in acute or chronic effects; and
- Ingestion by Site visitors of aquatic organisms affected by the discharge of impacted groundwater to Fidalgo Bay or Cap Sante Waterway.

Human ingestion of hazardous substances in groundwater is not a potential exposure pathway because groundwater at the Site or potentially affected by Site soil is not a current or reasonable future source of drinking water. The MTCA regulation, Washington Administrative Code (WAC) 173-340-720(2)(d), states that even if groundwater is classified as a potential future source of drinking water because it is present in sufficient quantity, contains less than 10,000 milligrams per liter (mg/L) total dissolved solids, and is not too deep to recover, the groundwater may still be classified as nonpotable due to its proximity to marine surface water. To be classified as nonpotable on the basis of its proximity to marine surface water, the following conditions must also be met:

- The groundwater does not serve as a current source of drinking water;
- Contaminated groundwater will not migrate to groundwater that is a current or potential future source of drinking water;
- There are known points of entry of the groundwater into surface water;
- The surface water is not classified as a suitable domestic water supply source; and
- The groundwater is sufficiently hydraulically connected the surface water that the groundwater is not practicable to use as a drinking water source.

The shallow groundwater at the Site meets at least four, and likely all five of these conditions. First, groundwater at the Site is not a current source of drinking water. Second, the groundwater migrates toward marine surface water and discharges at seeps in the intertidal and/or subtidal zone as discussed in later sections of this report. Third, the marine surface water offshore of the Site is not classified as a suitable domestic water supply. Fourth, the Site groundwater is hydraulically connected to marine surface water, as evidenced by the apparent tidal influence on groundwater levels in wells near the shoreline. Finally, migration of shallow groundwater to a lower aquifer that is a current or potential future source of drinking water is unlikely, due to the presence of a confining native silt/clay unit at the base of the shallow water-bearing unit at the Site (see the RI report [GeoEngineers et al. 2008] for further information regarding Site hydrogeology). Consequently, the Site groundwater qualifies as a nonpotable water source.

The preliminary groundwater cleanup levels developed in the RI are based on protection of marine surface water. The RI identified the following constituent exceedances, which could pose a risk to marine surface water (and consequently aquatic organisms or Site visitors) if the constituents were to migrate to surface water via Site groundwater:

- At interior well MW-102, total and dissolved arsenic have been detected above preliminary cleanup levels.
- well MW-110, diesel-range and motor oil-range petroleum hydrocarbons have been detected above MTCA Method A cleanup levels. In addition, free product has been observed during two monitoring events at MW-110, at measured thicknesses of 0.03 ft and 0.6 ft.
- At interior wells MW-4 and MW-111, dissolved arsenic has been detected above the preliminary cleanup level.

Constituent concentrations exceeding preliminary groundwater cleanup levels at the interior wells do not appear to be migrating to Fidalgo Bay and/or Cap Sante Waterway, as indicated by the following:

- **Shoreline Monitoring Wells.** Groundwater at shoreline monitoring wells complies with preliminary cleanup levels, although there was one exceedance each of bis(2-ethylhexyl)phthalate and ammonia at well MW-101. Sulfide also was detected during one monitoring event at well MW-101 at a concentration greater than the screening level defined in the RI. These exceedances, as well as sporadic exceedances of bis(2-ethylhexyl)phthalate at wells MW-105, MW-107, and MW-108, were isolated and are not representative of groundwater conditions.
- **Wellpoints.** Groundwater at wellpoints located downgradient of the interior wells and landward from the proposed conditional point of compliance complies with the preliminary cleanup levels. Sulfide concentrations detected in groundwater at the wellpoints occasionally exceeded the screening level defined in the RI.
- **Porewater.** Porewater (0 to 10 cm) in intertidal sediment deposits complies with the preliminary cleanup levels. Ammonia and sulfide concentrations measured at the proposed conditional point of compliance were rarely detected, and were well below the preliminary cleanup level for ammonia and the screening level for sulfide. These data are consistent with tidal mixing and associated oxidation of sediment porewater that occurs near the sediment/water interface. In the presence of dissolved oxygen, ammonia and sulfide both rapidly undergo chemical and biological oxidation to nitrate and sulfate, respectively. Thus, tidal mixing and associated oxidation processes attenuate potential ammonia and sulfide risks to benthic infauna at the Site.

2.2.3 Sediments

The wave action in the Site area, which is predominantly from the southeast and northeast, is strong enough to maintain a mixed sand/gravel/cobble intertidal substrate (Antrim et al. 2000). Wave and current modeling of the Site has shown that storm-generated wave and current action has resulted in significant erosion at the shoreline since at least 1962. The shoreline along parts of the Port and MJB properties has been temporarily reinforced to minimize this erosion, and protection of the shoreline has required routine maintenance by the Port and MJB. The erosion of the shoreline along the MJB property has been less than that observed at the Port property, likely due to its general orientation to the storm-generated waves. Net sediment transport along the western shore of Fidalgo Bay, in the vicinity of the Site, appears to be predominantly in a southerly direction (City of Anacortes 1999). In February 2005, the Port completed a Bank Stabilization Interim Action along the Seafarers' Memorial Park shoreline under the Port's Consent Decree (Landau Associates 2005a). Monitoring suggests that shoreline erosion has now ceased in the Interim Action area, and that stable and desirable beach substrate (i.e., pea gravel) is being maintained (Landau Associates 2006). However, the northeastern shoreline of the MJB property has experienced continued erosion during MJB's time of ownership (since 1990), with an apparent increased rate of erosion within the past four years.

Sediment impacts at the Site can be attributed to direct deposition of hazardous substances in the Marine Area and/or erosion of contaminated soil from the Port Uplands Area and the MJB North Area to Fidalgo Bay. Site sediments can also be impacted by the decay of wood debris present below the surface sediment. The nature and extent of sediment contamination at the Site can be summarized as follows:

- Several metals (copper, lead, mercury, and zinc) and organics (PCBs and wood debris/TVS) have been detected above preliminary cleanup levels in sediments collected from the intertidal beach area immediately offshore of the Site. The sampling data define a localized area of PCB exceedance within the intertidal and shallow subtidal zone (Figures 11 and 12).

- A potential source of these localized metal and PCB contaminated sediment deposits is erosion of upland fill material containing similarly elevated metal and PCB concentrations. Potential nearshore chemical source areas exceeding sediment cleanup screening levels (CSLs) are generally depicted in Figure 12, and include soil in parts of the Port Uplands Area (Port Parcel 3) and a portion of the MJB North Area that contain elevated concentrations of metals and/or PCBs. Erosion of soil from these areas is the likely source of down-drift sediment contamination observed just to the south. These areas of the shoreline are currently armored with riprap.
- Historical sources of woody debris at the Site include former log rafting operations, over-water storage of milled wood, placement of woody debris-containing fill materials (including sawdust, bark, and wood chips), and lumber/pilings remaining from the former pier structure. A range of surficial debris is present in the beach area, including dimensional lumber, bricks, and other construction materials. Debris accumulations are most evident within the intertidal and shallow subtidal zones extending from south of the Cap Sante Boat Haven breakwater to south of the existing kayak dock.
- Based on the available Site characterization data (generally summarized in Figures 13 through 17), relatively extensive wood debris deposits are present throughout much of the upland areas of the Site, extending 10 to 30 ft BGS, and continuing into the nearshore (intertidal and shallow subtidal) area of Fidalgo Bay.
- Intertidal and shallow subtidal surface sediments offshore of the MJB North Area typically consist of a relatively thin layer of silt and sand sediments overlying the wood debris deposits. The thickness of the naturally developed sediment “cap” in this area of the Site is typically 0.5 to 1 ft at upper intertidal elevations, increasing in thickness at lower tidal elevations.
- Intertidal and shallow subtidal surface sediments offshore of the Port Uplands Area typically consist of exposed wood and other debris or cobbles. A relatively thin layer of silt and sand is found at lower elevations where wave energy is lower.
- As part of initial evaluations, sediment areas potentially impacted by wood debris were screened using conventional parameters such as wood debris content (based on visual observation) and TVS, comparing surface sediment levels to preliminary cleanup levels developed by Ecology based on Site-specific biological analyses. A debris field consisting of dimensional lumber, wood fragments, and other debris exceeding one or both of these screening criteria is present on the sediment surface, most extensively across the intertidal area of the North Marine Area (Figure 12).
- Validated tissue chemistry data for potentially bioaccumulative chemicals such as mercury, PCBs, and dioxins/furans are available for Dungeness crab samples collected in Fidalgo Bay. Significantly, the home range of crabs collected from Fidalgo Bay sampling stations overlaps the area where, based on general review of fate and transport processes, potential releases from the Site may have been deposited. Since crabs live in contact with sediments, and since benthic infauna are a primary food source of crabs, these organisms may be particularly appropriate in evaluations of the nature and extent of chemical releases. The maximum detected concentrations of mercury, PCBs, and dioxins/furans in Fidalgo Bay crab tissue are below risk screening criteria and/or are generally equivalent to regional background levels.
- Sediment core samples were collected from the Dakota Creek Industries/Pier 1 area, adjacent to the Guemes Channel outfall of the former Scott Paper Mill. Samples were taken from proposed

dredging areas. The sediment samples were analyzed for dioxins/furans and compared to Puget Sound Dredged Disposal Analysis (PSDDA) (2000) screening levels and surface sediment reference samples from Fidalgo Bay. Results indicated that the detected dioxins/furans were below PSDDA screening levels and that the proposed sediment for dredging was suitable for open water disposal.

3.0 BASIS FOR CLEANUP ACTION

This section presents the basis for the sitewide cleanup action. There are two distinct elements that form the basis for the cleanup action: 1) the site-specific cleanup standards, and 2) the locations and media requiring cleanup action evaluation. The information presented in this section is largely excerpted from the RI report.

3.1 CLEANUP STANDARDS

Cleanup standards consist of: 1) cleanup levels that are protective of human health and the environment, and 2) the point of compliance at which the cleanup levels must be met. Preliminary Site-specific cleanup standards were developed in the RI. These preliminary cleanup standards are adopted in this FS for the purpose of developing cleanup action objectives (CAOs) for the Site. CAOs are presented in Section 4.1. The proposed media-specific cleanup levels and points of compliance are summarized below. Detailed information regarding the derivation of cleanup levels can be found in the RI report.

3.1.1 Cleanup Levels

Site-specific cleanup levels for soil that are protective of human health and terrestrial ecological receptors, and cleanup levels for groundwater that are protective of marine surface water, were developed in accordance with MTCA requirements. Further testing of soil in selected portions of the Port and MJB North Uplands Areas will evaluate the risk to terrestrial ecological receptors through soil bioassay and/or focused bioaccumulation testing. The soil bioassay and bioaccumulation results will be integrated into the forthcoming Cleanup Action Plan (CAP). Because Site groundwater is not a current or reasonably likely future source of drinking water, cleanup levels for Site soil need not be protective of groundwater as drinking water. Additionally, an empirical demonstration was used in the RI to show that existing chemical concentrations in Site soil are protective of groundwater as marine surface water at the proposed conditional point of compliance for groundwater.

Figures 4 and 5 of the RI report present flow charts that illustrate the process used for developing cleanup levels for soil and groundwater. Cleanup levels for sediments protective of benthic infauna were developed in accordance with MTCA and SMS requirements and direction provided by Ecology. These cleanup levels are also considered for upland areas of the Site where erosion of soils could lead to deposition of contaminants in the Marine Area.

3.1.1.1 Soil

Soil cleanup levels for unrestricted land use were developed in accordance with WAC 173-340-740 using the exposure pathways outlined in Section 2.2.1. The Port Uplands and MJB North Areas are currently zoned Commercial Marine (1) (CM1), which provides for a mix of commercial, industrial, and recreational uses. However, to be consistent with MTCA requirements, the RI developed preliminary soil cleanup levels based on unrestricted land use, including the more stringent MTCA Method B cleanup levels that assume ground floor residential land use [WAC 173-340-740(3)].

Under MTCA Method B, soil cleanup levels must be as stringent as:

- Concentrations established under applicable state and federal laws;
- Concentrations protective of terrestrial ecological receptors;
- Concentrations protective of direct human contact with soil; and
- Concentrations protective of groundwater.

Each of these criteria was considered during the development of soil cleanup levels, as detailed in the RI report. The proposed cleanup levels used in this FS for constituents detected in Site soil are presented in Table 1.

In accordance with the MTCA regulation, WAC 173-340-7493(3)(b), the cooperating parties are currently planning to conduct a more detailed terrestrial ecological evaluation of the Site using soil bioassays and/or focused bioaccumulation testing. Potential risks to plant life and soil biota in target areas of the Site (i.e., where human health criteria are not exceeded and where the only soil exceedances are based on screening values listed in WAC 173-340-900, Table 749-2) will be addressed directly using tests described in *Early Seedling Growth Protocol for Soil Toxicity Screening* (Ecology Publication No. 96-324) and *Earthworm Bioassay Protocol for Soil Toxicity Screening* (Ecology Publication No. 96-327), respectively. The soil bioassay and bioaccumulation results will be integrated into the CAP.

3.1.1.2 Groundwater

Groundwater elevation data suggest that the predominant groundwater migration direction at the Site is toward Cap Sante Waterway and Fidalgo Bay. Consequently, groundwater cleanup levels protective of marine surface water were developed for the Site. MTCA Method B cleanup levels protective of marine surface water were developed in accordance with WAC 173-340-730(3) for those constituents detected in groundwater. If necessary, preliminary groundwater cleanup levels were adjusted to be no less than the practical quantitation limit (PQL) or natural background concentration, in accordance with WAC 173-340-730(5)(c). The proposed cleanup levels used in this FS for constituents detected in Site groundwater are presented in Table 2.

At Ecology's request, groundwater concentrations protective of hypothetical groundwater use as drinking water were considered for potential use as cleanup levels in the RI. However, because direct human ingestion of constituents in groundwater is not a potential exposure pathway at the Site (as discussed in the RI report), groundwater concentrations protective of hypothetical groundwater use as drinking water are not used as cleanup levels for the Site.

The ambient water quality criterion for ammonia listed in Chapter 173-201A WAC is for un-ionized ammonia. Concentrations measured during the RI were reported by the laboratories as total ammonia. The criterion for un-ionized ammonia may be expressed as total ammonia based on salinity, temperature, and pH, using Ecology's *Spreadsheets for Water Quality-Based NPDES Permit Calculations* (Ecology 2004c). Using the measured temperature and pH in Port Uplands Area shoreline wells, and salinity calculated from measured chloride concentrations in shoreline wells, the ammonia cleanup level expressed as total ammonia ranges between 3.2 and 74.4 milligrams nitrogen per liter (mg-N/L).

For some detected constituents, adequate regulatory information to develop groundwater cleanup levels protective of marine surface water is not available. Other water quality information for some of these constituents is included in Table 2. These values are not cleanup levels, but provide context for evaluating detected concentrations and were used for screening purposes during the RI.

3.1.1.3 Sediment

Sediment cleanup levels were developed according to MTCA and SMS requirements and direction provided by Ecology. Two SMS criteria are promulgated by Ecology (WAC 173-204-320). These include the Sediment Quality Standard (SQS), the concentration below which effects to benthos are unlikely, and the cleanup screening level (CSL), the concentration above which more than minor adverse biological effects may be expected. The SQS and CSL values have been developed for a suite of chemicals that includes metals, PAHs and other semivolatile organic compounds (SVOCs), PCBs, and ionizable organic compounds. The SQS are the most stringent SMS criteria and are used in this FS as sediment cleanup levels for the SMS constituents detected in sediment at the Site.

There is no promulgated SMS criterion for wood debris in sediment. In Fall 2007, a supplemental sediment investigation was performed in the Marine Area. The scope and results of the 2007 supplemental sediment investigation are described in the RI report. The primary objective of this supplemental investigation was to conduct a suite of confirmatory biological tests on synoptic surface sediment samples collected from locations representing the range of wood debris content at the Site with the potential for deleterious effects. These data were then used to develop sediment cleanup levels for wood debris at the Site. Based on Ecology's interpretations of the Fall 2007 biological data, surface sediment TVS levels greater than 9.7 percent (dry weight basis) and/or wood debris levels greater than 25 percent (by volume) were identified as having the potential for site-specific deleterious effects exceeding SQS biological criteria. Surface sediment TVS levels greater than 15 percent and/or wood debris levels greater than 50 percent were identified as having the potential for deleterious effects exceeding CSL biological criteria.

There are no promulgated SMS criteria or screening levels for dioxins, and cleanup levels for this group of compounds are under further evaluation by Ecology and other regulatory agencies. In the RI, sediment results were compared to the 2000 Dredge Material Management Program (DMMP) risk-based screening criterion for 2,3,7,8-TCDD of 5 nanograms per kilogram (ng/kg), and the calculated DMMP toxicity equivalent quotient concentration (all dioxin congeners combined) of 15 ng/kg (PSDDA 2000).

To ensure protection of human health, the cleanup action alternatives evaluated for the Marine Area in this FS (Section 7.0) considered potential bioaccumulation risks associated with residual mercury and PCB exposure that may remain in the Marine Area following completion of the cleanup action. The potential bioaccumulation risks were assessed consistent with MTCA human health risk assessment procedures (WAC 173-340-708). The residual risk assessment is described further in Section 7.0.

A summary of the proposed sediment cleanup levels used in this FS for constituents detected in sediment at the Site is provided in Table 3. These cleanup levels were used in the RI to identify contaminants of potential concern and indicator hazardous substances for the offshore portions of the Site.

3.1.2 Points of Compliance

Under MTCA, the point of compliance is the point or location on a site where the cleanup levels must be attained. The points of compliance for affected media will be approved by Ecology and presented in the sitewide CAP. However, it is necessary to identify proposed points of compliance in order to develop and evaluate cleanup action alternatives in the FS. This section describes the proposed points of compliance for soil, groundwater, and sediment.

3.1.2.1 Soil

The standard point of compliance for the soil cleanup levels shown in Table 1 will be throughout the soil column from the ground surface to 15 ft BGS, in accordance with WAC 173-340-740(6)(d) and WAC 173-340-7490(4)(b). For potential terrestrial ecological exposures, MTCA regulations allow a conditional point of compliance to be established from the ground surface to 6 ft BGS (the biologically active zone according to MTCA default assumptions), provided institutional controls are used to prevent excavation of deeper soil [WAC 173-340-7490(4)(a)]. Accordingly, in areas of the Site where potential ecological exposures are a concern, and where appropriate institutional controls can be implemented, a conditional point of compliance for soil concentrations protective of terrestrial ecological receptors may be proposed throughout the soil column from the ground surface to 6 ft BGS.

3.1.2.2 Groundwater

Because the groundwater cleanup levels (Table 2) are based on protection of marine surface water and not protection of groundwater as drinking water, the proposed conditional point of compliance for the groundwater cleanup levels is the point of groundwater discharge to the Cap Sante Waterway and Fidalgo Bay. This corresponds to the groundwater/surface water interface at the Port Uplands Area and the MJB North Area. At the Port Uplands Area, existing shoreline wells (MW-101, MW 105, MW-106, MW-107, and MW-108) may be used to evaluate compliance. Monitoring well MW-112 is located near the Fidalgo Bay shoreline; however, this well is installed upgradient of a subsurface containment wall intended to retard migration of potentially contaminated groundwater to Fidalgo Bay; therefore, monitoring well MW-112 will not be used to evaluate compliance. At the MJB North Area, existing shoreline wells (MW-1, MW-2, MW-3, MW-5, and MW-6) may be used to evaluate compliance. Monitoring wells MW-4 and MW-7 are located farther west, away from the shoreline; therefore, they will not be used to evaluate compliance.

3.1.2.3 Sediment

For marine sediments potentially affected by hazardous substances, the point of compliance for protection of the environment is surface sediments within the biologically active surface water habitat zone, represented by samples collected across the top 10 centimeters (cm) (i.e., 0 to 0.3 ft) below the mudline.

3.2 LOCATIONS AND MEDIA REQUIRING CLEANUP ACTION EVALUATION

This section identifies the locations and environmental media (soil, groundwater, sediment) at the Site that require cleanup action evaluation.

3.2.1 Port Uplands Area

Based on the information presented in the RI report, soil at Port Parcels 1 and 3 requires evaluation of cleanup action alternatives due to the presence of some constituents at concentrations exceeding cleanup levels protective of human health and terrestrial ecological receptors. Potential erosional sources of localized contaminated sediment deposits have also been identified in Port upland shoreline areas (see Figure 12). Cleanup actions have been previously evaluated and implemented for soil at Port Parcel 2. However, because soil containing constituents at concentrations exceeding cleanup levels and source criteria remain at Port Parcel 2, the cleanup action alternatives evaluated in this FS include actions to address residual soil contamination at Parcel 2.

Groundwater in the shoreline monitoring wells, landward of the proposed conditional point of compliance, appears to comply with cleanup levels protective of marine surface water. Sporadic exceedances of bis(2-ethylhexyl)phthalate and ammonia at shoreline wells are not considered representative of groundwater conditions.

Despite the apparent compliance of groundwater in the shoreline wells, arsenic and petroleum hydrocarbons, respectively, were detected at concentrations above cleanup levels at interior monitoring wells MW-102 and MW-110. In addition, free product was observed in well MW-110 during two groundwater monitoring events, at measured thicknesses of 0.03 ft and 0.6 ft. Consequently, remedial options for groundwater at the Port Uplands Area are evaluated in this FS.

3.2.2 MJB North Area

Based on the information presented in the RI report, shallow soil in discrete areas throughout much of the MJB North Area, and deeper soil within the northeast and southeast corners of the MJB North Area, requires evaluation of cleanup action alternatives due to the presence of some constituents at concentrations exceeding cleanup levels protective of human health and terrestrial ecological receptors. Potential erosional sources of localized contaminated sediment deposits have also been identified in MJB North upland shoreline areas (see Figure 12).

Groundwater in the shoreline monitoring wells, landward of the proposed conditional point of compliance, complies with cleanup levels protective of marine surface water. Consequently, this FS does not evaluate remedial options for groundwater at the MJB North Area.

3.2.3 North Marine Area and Adjacent Shoreline Areas

Based on the information presented in the RI report, surface sediments in upper intertidal portions of the North Marine Area immediately adjacent to Port Parcel 3 require evaluation of cleanup action alternatives due to the presence of chemical constituents at concentrations exceeding sediment cleanup levels. A potential source of these localized contaminated sediment deposits is erosion of adjacent upland fill material containing similarly elevated metal and organic chemical concentrations (see Figure 12).

Relatively extensive wood debris deposits are present throughout much of the upland areas of the Site, extending 10 to 30 ft BGS, and continuing into the nearshore (intertidal and shallow subtidal) area of Fidalgo Bay at the Port Parcel 3 shoreline. Near-surface woody debris deposits in this area require evaluation of cleanup action alternatives due to the presence of woody debris and TVS at concentrations exceeding cleanup levels protective of aquatic ecological receptors and degraded habitat conditions. Cleanup actions in the shoreline area considered in this FS are based on designs that would allow continued attenuation of woody debris degradation compounds such as ammonia and sulfide, as well as improved habitat conditions.

3.2.4 South Marine Area and Adjacent Shoreline Areas

Based on the information presented in the RI report, surface sediments in upper intertidal portions of the South Marine Area immediately adjacent to the MJB North Area require evaluation of cleanup action alternatives due to the presence of some constituents (especially PCBs) at concentrations exceeding sediment cleanup levels. A potential source of these localized contaminated sediment deposits is erosion of upland fill materials within the North Marine Area containing similarly elevated metal and organic chemical concentrations (see Figure 12). Shoreline stabilization performed by the Port in this area appears to have reduced PCB transport to the South Marine Area. Cleanup actions in the shoreline area considered in this FS are based on designs that would allow continued attenuation of woody debris degradation compounds such as ammonia and sulfide.

4.0 FRAMEWORK FOR CLEANUP ACTION ALTERNATIVE DEVELOPMENT AND EVALUATION

This section presents CAOs, applicable regulatory requirements for the cleanup action, and a screening evaluation of general response actions and remediation technologies that are potentially applicable to the Site.

4.1 CLEANUP ACTION OBJECTIVES

CAOs consist of chemical- and medium-specific goals for protecting human health and the environment. The CAOs specify the media and contaminants of interest, potential exposure routes and receptors, and proposed cleanup goals. Because of the substantial differences between the uplands and marine area physical environments, resources/uses, and cleanup standards, as well as anticipated differences in cleanup-related construction logistics, separate cleanup action alternatives are developed in this FS for the uplands and marine areas. The CAOs for these areas are presented below.

4.1.1 Uplands Areas

The objective of the uplands cleanup action is to eliminate, reduce, or otherwise control to the extent feasible and practicable, unacceptable risks to human health and the environment posed by hazardous substances in soil and groundwater in accordance with the MTCA Cleanup Regulation (WAC 173-340) and other applicable regulatory requirements. Specifically, the objective of the uplands cleanup is to mitigate risks associated with the following potential exposure routes and receptors:

- Contact (dermal, incidental ingestion, or inhalation) by visitors, workers (including excavation workers), and potential future residents or other Site users with hazardous substances in soil;
- Contact (dermal, incidental ingestion, or inhalation) by terrestrial wildlife with hazardous substances in soil;
- Contact by terrestrial plants and soil biota and/or food-web exposure to hazardous substances in soil;
- Exposure by aquatic organisms to hazardous substances in soil that erodes, or groundwater that migrates, to Fidalgo Bay or Cap Sante Waterway; and
- Ingestion by Site users of marine organisms contaminated by erosion of impacted soil or migration of impacted groundwater to Fidalgo Bay or Cap Sante Waterway.

The cleanup goal for the uplands areas is to mitigate these risks by meeting the soil and groundwater cleanup standards identified in Section 3.1.

4.1.2 Marine Area

The objective of the Marine Area cleanup action is to eliminate, reduce, or otherwise control to the extent feasible and practicable, unacceptable risks to human health and the environment posed by hazardous substances in marine sediment in accordance with the MTCA Cleanup Regulation (WAC 173-340) and other applicable regulatory requirements. Specifically, the objective of the Marine Area cleanup is to mitigate risks associated with the following potential exposure routes and receptors:

- Exposure of benthic organisms to hazardous substances in the biologically active zone of sediment (the upper 10 cm below the mudline);
- Ingestion by aquatic organisms of benthic organisms contaminated by hazardous substances in sediment; and
- Ingestion by Site visitors of marine organisms contaminated by hazardous substances in sediment.

The cleanup goal for the Marine Area is to mitigate these risks by meeting the sediment cleanup standards identified in Section 3.1.

4.2 APPLICABLE REGULATORY REQUIREMENTS

In addition to the cleanup standards developed through the MTCA process and presented in Section 3.1, other regulatory requirements must be considered in the selection and implementation of the cleanup action. MTCA requires the cleanup standards to be "at least as stringent as all applicable state and federal laws" [WAC 173-340-700(6)(a)]. Besides establishing minimum requirements for cleanup standards, applicable state and federal laws may also impose certain technical and procedural requirements for performing cleanup actions. These requirements are described in WAC 173-340-710. Applicable state and federal laws are discussed below.

The cleanup action at the Site will be performed pursuant to MTCA under the terms of a Consent Decree between Ecology and one or more implementing parties, including the Port. Accordingly, the anticipated cleanup action meets the permit exemption provisions of MTCA, obviating the need to follow procedural requirements of the various local and state regulations that would otherwise apply to the action. Similarly, the anticipated cleanup action also qualifies for a U.S. Army Corps of Engineers (Corps) Nationwide Permit 38 (NWP 38). Nevertheless, federal consultation under the Endangered Species Act, Section 401 Water Quality Certification, and other substantive requirements must still be met by the cleanup action. Ecology will be responsible for issuing the final approval for the cleanup action, following consultation with other state and local regulators. The Corps will separately be responsible for issuing approval of the project under NWP 38, following Endangered Species Act consultation with the federal Natural Resource Trustees, and also incorporating Ecology's 401 Water Quality Certification.

4.2.1 MTCA and SMS Requirements

The main law that governs the cleanup of contaminated sites in the state of Washington is MTCA. The MTCA Cleanup Regulation (WAC 173-340) specifies criteria for the evaluation and conduct of a cleanup action, including criteria for developing cleanup standards for soil and groundwater. When contaminated sediments are involved, the cleanup levels and other procedures are also regulated by the SMS (WAC 173-204). The SMS were developed to establish cleanup standards for marine, low salinity, and freshwater environments for the purpose of reducing and/or eliminating adverse effects on biological resources and significant health threats to humans from surface sediment contamination. The SMS cleanup standards govern the cleanup of contaminated sediment sites. Both MTCA and SMS regulations require that cleanup actions must protect human health and the environment, meet environmental standards in other applicable laws, and provide for monitoring to confirm compliance with cleanup levels.

MTCA places certain requirements on cleanup actions involving containment of hazardous substances that must be met for the cleanup action to be considered in compliance with soil cleanup standards. These requirements include implementing a compliance monitoring program that is designed to ensure the long-term integrity of the containment system and applying institutional controls to the affected area (WAC 173-340-440).

The key MTCA decision-making document for cleanup actions is the RI/FS. In the RI/FS, the nature and extent of contamination and the associated risks at a site are evaluated, and potential alternatives for conducting a site cleanup action are identified. The cleanup action alternatives are then evaluated against MTCA remedy selection criteria, and one or more preferred alternatives are selected. After reviewing the RI/FS, and after consideration of public comment, Ecology then selects a cleanup action for the site and documents the selection in a CAP. Following public review of the CAP, the site cleanup process typically moves forward into design, permitting, construction, and long-term monitoring.

This FS report and the companion RI report (GeoEngineers et al. 2008) were prepared consistent with the requirements of MTCA and the SMS.

4.2.2 Solid and Hazardous Waste Management

The Washington Hazardous Waste Management Act and the implementing regulations, the Dangerous Waste Regulations (Chapter 173-303 WAC), would apply if dangerous wastes are generated during the cleanup action. There is no indication of listed wastes being generated or disposed of at the Site. Based on the analytical data generated during the RI, only limited volumes of soil and/or sediment at the Site may be characterized as dangerous waste if excavated or dredged. The Dangerous Waste Regulations would be applicable only if pre- or post-removal sampling of excavated/dredged material [e.g., toxicity characteristic leaching procedure (TCLP) sampling, if required by the receiving landfill] or confirmation soil sampling indicated contaminant concentrations exceeding levels associated with dangerous waste characteristics or criteria. Related regulations include state and federal requirements for solid waste handling and disposal facilities (40 CFR 241, 257; Chapter 173-350 and -351 WAC) and land disposal restrictions (40 CFR 268; WAC 173-303-340).

4.2.3 Puget Sound Dredged Material Management Program

In Puget Sound, the open water disposal of sediments is managed under the Dredged Material Management Program (DMMP). This program is administered jointly by the Corps, the U.S. Environmental Protection Agency (EPA), the Washington Department of Natural Resources (WDNR), and Ecology. The DMMP developed the Puget Sound Dredge Disposal Analysis (PSDDA) protocols which include testing requirements to determine whether dredged sediments are appropriate for open water disposal. The DMMP has also designated disposal sites throughout Puget Sound. While some initial characterization work has been performed at the Site, if a cleanup action alternative is ultimately selected by Ecology that includes PSDDA disposal of sediments, additional characterization work may be required to complete the suitability determination. Use of PSDDA facilities would need to comply with other DMMP requirements including material approval, disposal requirements, and payment of disposal site fees.

4.2.4 State Environmental Policy Act

The State Environmental Policy Act (SEPA) (RCW 43.21C; WAC 197-11) and the SEPA procedures (WAC 173-802) are intended to ensure that state and local government officials consider environmental values when making decisions. The SEPA process begins when an application for a permit is submitted to an agency, or an agency proposes to take some official action such as implementing a MTCA CAP. Prior to taking any action on a proposal, agencies must follow specific procedures to ensure that appropriate consideration has been given to the environment. The severity of potential environmental impacts associated with a project determines whether an Environmental Impact Statement is required. A SEPA checklist would be required prior to initiating remedial construction activities. Because the Site cleanup action will be performed under a Consent Decree, SEPA and MTCA requirements will be coordinated, if possible.

4.2.5 Shoreline Management Act

The Shoreline Management Act (RCW 90.58) and its implementing regulations establish requirements for substantial developments occurring within water areas of the state or within 200 feet of the shoreline. The City of Anacortes has set forth requirements based on local considerations such as shoreline use, economic development, public access, circulation, recreation, conservation, and historical and cultural features. Local shoreline management plans are adopted under state regulations, creating an enforceable state law. Because the Site cleanup action will be performed under a Consent Decree, compliance with substantive requirements would be necessary, but a shoreline permit would not be required.

4.2.6 Washington Hydraulics Code

The Washington hydraulics code establishes regulations for the construction of any hydraulic project or the performance of any work that will use, divert, obstruct, or change the natural flow or bed of any of the salt or fresh water of the state. The code also creates a program requiring Hydraulic Project Approval (HPA) permits for any activities that could adversely affect fisheries and water resources. Timing restrictions and technical requirements under the hydraulics code are applicable to dredging and placement of cover sediments if necessary.

The FS has been prepared using costs and durations that recognize potential fish closure periods, during which time dredging and any in-water work will not be permitted. Exact closure periods will be determined through agency consultation.

4.2.7 Water Management

4.2.7.1 Clean Water Act

The Clean Water Act (CWA) is the primary federal law for protecting water quality from pollution. The CWA regulations provide requirements for the discharge of dredged or fill material to waters of the United States and are applicable to any in-water work. The CWA regulations also prescribe permitting requirements for point source and non-point source discharges. Acute Marine Criteria are relevant and appropriate requirements for discharges to marine surface water during sediment dredging, as well as for return flows (if necessary) to surface waters from dewatering operations.

Section 404 of the CWA requires permits from the Corps for discharges of dredged or fill material into waters of the United States, including wetlands. Section 404 permits depend on suitability determinations according to DMMP guidelines.

Section 404(b)(1) requires an alternatives analysis as part of the permitting process. Requirements for all known, available, and reasonable technologies for treating wastewater prior to discharge to state waters are applicable to any dewatering of marine sediment prior to upland disposal. Section 401 of the CWA requires the state to certify that federal permits are consistent with water quality standards. The substantive requirements of a certification determination are applicable.

Ecology has promulgated statewide water quality standards under the Washington Water Pollution Control Act (Chapter 90.48 RCW). Under these standards, all surface waters of the state are divided into classes (AA, A, B, C, and Lake) based on the beneficial uses of the water bodies. Water quality criteria are defined for different types of pollutants and the characteristic uses for each class of surface water. The standards for marine waters will be applicable to discharges to surface water during sediment dredging, and return flows (if necessary) to surface waters from dewatering operations.

SMS acknowledges the Washington Water Pollution Control Act as the primary authorizing legislation for establishing sediment source control standards.

4.2.7.2 Construction Stormwater General Permit

Construction activities that disturb 1 or more acres of land need to comply with the provisions of construction stormwater regulations. Because the Site cleanup action will be performed under a Consent Decree, a permit will not be needed, but Ecology will require substantive compliance with these provisions. A substantive requirement would be to prepare a stormwater pollution prevention plan or equivalent MTCA construction quality assurance project plan (CQAP) prior to activities that would disturb 1 or more acres of soil. The CQAP would document planned procedures designed to prevent stormwater pollution by controlling erosion of exposed soil and by containing soil stockpiles and other materials that could contribute pollutants to stormwater. It is anticipated that a CQAP would be prepared as part of the remedial design process, and supplemented as appropriate by the remedial contractor.

4.2.8 Other Potentially Applicable Regulatory Requirements

The following is a list of other potentially applicable regulations for the cleanup action:

- **Air Emissions** – Applicable for site grading or excavation work that could generate dust. Controls would need to be in place during construction (e.g., wetting or covering exposed soils and stockpiles), as necessary, to meet the substantive restrictions on off-site transport of airborne particulates by the local agency, the Northwest Clean Air Agency (NWCAA).
- **Archeological and Historical Preservation** – The Archeological and Historical Preservation Act (16 USCA 496a-1) would be applicable if any subject materials are discovered during site grading and excavation activities.

- **Health and Safety** – Site cleanup-related construction activities would need to be performed in accordance with the requirements of the Washington Industrial Safety and Health Act (RCW 49.17) and the federal Occupational Safety and Health Act (29 CFR 1910, 1926). These applicable regulations include requirements that workers are to be protected from exposure to contaminants and that excavations are to be properly shored.

These requirements are not specifically addressed in the detailed analysis of cleanup action alternatives because they could be met by each of the alternatives.

4.3 SCREENING OF GENERAL RESPONSE ACTIONS AND REMEDIATION TECHNOLOGIES

This section presents a screening evaluation of potentially applicable general response actions and remediation technologies for the cleanup action. The screening evaluation is carried out for each of the environmental media (soil, groundwater, sediment) requiring cleanup action evaluation. Based on the screening evaluation, selected response actions and technologies are carried forward for use in the development of cleanup action alternatives for the uplands and marine areas (Sections 6.0 and 7.0 of this report).

4.3.1 Soil

A range of potential response actions and remediation technologies was evaluated for soil at the Port Uplands Area and the MJB North Area so that an appropriate range of cleanup action alternatives could be considered. The response actions considered in the screening evaluation include no action, institutional controls, soil containment, soil removal, off-site management, ex situ treatment, and in situ treatment (Table 4).

The response actions related to institutional controls are restrictive covenants (e.g., deed restrictions, posted notifications) and access restrictions (e.g., fencing). Long-term groundwater monitoring also is considered as a potential response action. The specific technologies related to engineered controls consist of physical barriers to human and ecological contact with impacted soil, including a surface cover (e.g., asphalt or concrete pavement or a shallow reinforced geotextile barrier layer) or a multi-layer, low permeability cap. Either a surface cover or multi-layer cap would provide physical isolation between human and ecological receptors and contaminated soil, but the cap would also provide a low permeability layer to reduce or eliminate the infiltration of water into the contaminated soil. The removal technology considered for impacted soil is excavation with off-site disposal. Excavation followed by ex situ treatment is considered as a possible remediation technology, with the specific process options of physical stabilization/solidification with Portland cement and blending of soil to reduce low levels of contamination to below cleanup levels. In situ treatment using natural attenuation is also screened as a potential remediation technology.

These potential response actions and remediation technologies for soil were screened on the basis of effectiveness, implementability, and cost. A summary of the screening evaluation is shown in Table 4. On the basis of the screening, it was determined whether the response actions and technologies warrant further evaluation.

Some response actions and technologies were screened out from further evaluation due to low effectiveness or implementability, or due to another technology being similarly effective and implementable and having a significantly lower cost. For example, containment through a multi-layer, low permeability cap would be an effective means of preventing human and ecological exposure to contaminated soil. However, a multi-layer cap is considered to be unnecessary for the Site because infiltration of precipitation and mobilization of soil contaminants into groundwater was demonstrated in the RI to not be a concern. A surface cover such as asphalt pavement would provide a similar level of effectiveness in preventing exposure to contaminated soil, with a greater degree of implementability and lower cost.

In situ treatment technologies are not further considered for soil because effective and well-demonstrated technologies have not been developed for treatment of the metals detected in soil at the Port Property. Natural degradation and dispersion of arsenic and other metals in Site soil is expected to be limited and is not considered an effective treatment technology for these contaminants.

One treatment technology considered to have the potential to be moderately effective and implementable is ex situ physical stabilization/solidification with Portland cement with subsequent placement of soil back into the excavation following treatment. Stabilization of soil has not been well demonstrated over the long term for the specific combination of contaminants in Site soil, but the technology is considered to be reliable enough to retain for potential further evaluation.

Ex-situ blending of soil with low levels of metals to reduce the potential exposure point concentration is considered a viable remediation approach for limited portions of the MJB North Area. This approach has been retained for inclusion in the cleanup action alternatives considered for that area.

Potentially effective and implementable response actions and remediation technologies are evaluated further below.

4.3.1.1 Institutional Controls

A restrictive covenant (e.g., deed restrictions, posted notification of Site conditions) would not be an acceptable cleanup action alternative on its own because it would not achieve the CAOs for the uplands areas. However, restrictive covenants can in certain instances be effective and implementable in combination with engineered and other institutional controls where the covenant requires maintenance of the protective barriers that keep humans and ecological receptors from contacting contaminated soil.

If contaminated soil is to be left in place at a depth less than 15 ft BGS, then a restrictive covenant could be employed to require special procedures for future subgrade work (e.g., worker protection and soil management plans). Use of restrictive covenants could, however, restrict the future land use at the Site and adversely impact property values. Therefore restrictive covenants may not be acceptable in certain areas of the Site, including the Port Uplands Area.

Access controls such as fencing would not be implementable because they would not be compatible with continued use of Port Parcel 3 as open space park or potential future development of other areas of the Site consistent with unrestricted land uses.

Institutional controls would require long-term monitoring to ensure that the Site conditions remain as required to achieve CAOs.

4.3.1.2 Engineered Controls

Applicable engineered controls that could be employed for uplands soil include establishing and maintaining a barrier layer between impacted soil and potential human and ecological receptors. One type of barrier layer that could be used is a reinforced (to prevent animal burrowing) geotextile liner installed over areas of contaminated soil that are currently unpaved and not covered by buildings. Clean fill and/or a lawn would be placed over the top of the geotextile to keep it anchored in place and protected from degradation by sunlight. The geotextile would not need to be an impermeable liner because, as documented in the RI report, leaching of soil contaminants to groundwater is not an exposure pathway of concern at the Site. Using a permeable geotextile reduces the need to add drainage features or be overly concerned about establishing proper grading for drainage. If the geotextile is specified to the proper thickness and strength it would be effective in preventing children and animals from digging through it. Surface pavement using asphalt and/or concrete would also provide an effective barrier that would prevent human or ecological exposure and also limit erosion of contaminated soil. This approach has been used successfully for remediation of other sites.

Although a geotextile liner may provide an effective barrier to exposure, it would require long-term monitoring to identify any areas where the liner becomes exposed or damaged, and maintenance to repair the liner. Similar monitoring and maintenance would be required to ensure the long-term integrity of alternate types of surface cover such as asphalt or concrete pavement. Use of surface pavement or a geotextile liner would not result in a permanent reduction in contaminant mass, mobility, or toxicity. However, surface pavement has a long history of use at contaminated sites. This technology has been retained for inclusion in the cleanup action alternatives considered for the MJB North Area. A cleanup action alternative employing engineered controls will not be developed for the Port Uplands Area because of the constraints such controls would place on land use.

4.3.1.3 Excavation and Off-Site Disposal

Soil removal by excavation is considered to be an effective technology to permanently eliminate the risk of exposure to contaminants at the Site. Excavation is generally implementable over undeveloped portions of the Site. Excavation adjacent to or underneath existing buildings or other structures or utilities may require protective measures such as shoring or temporary removal of structures. It is anticipated that the majority of excavated soil could be disposed of at a permitted solid waste (Resource Conservation and Recovery Act Subtitle D) landfill rather than requiring disposal at a hazardous/dangerous waste (Subtitle C) disposal facility. Due to elevated levels of metals detected in some soil, it will be necessary to perform dangerous waste characterization of excavated soil, and it is likely that some soil may require treatment prior to disposal or disposal at a Subtitle C facility.

4.3.1.4 Solidification/Stabilization

Solidification of contaminated soil implies forming a solid mass such that the contaminants are physically isolated from potential receptors and the leachability of the contaminants is reduced due to limited infiltration of water into the solidified waste. Stabilization of contaminated soil typically involves chemically binding and immobilizing the contaminants on a molecular level. These two approaches are commonly combined. Treatment of soil by solidification/stabilization is most commonly employed by mixing contaminated soil with Portland cement or another pozzolanic material. With contaminants such as heavy metals, both solidification and stabilization have been reliably demonstrated. With organic contaminants, solidification can be achieved but the organics (e.g., petroleum hydrocarbons) are not typically stabilized on a molecular level. This technology is primarily effective for remediating soil that is releasing contaminants to groundwater.

Because soil volume expands when mixed with Portland cement, the use of solidification/stabilization as a stand-alone cleanup action alternative would require that the ground elevation of the Site be raised over the treated area. Alternatively, some soil would need to be disposed of off site if existing Site elevations must be maintained to support planned Site use. Addition of Portland cement would also be expected to raise the pH of groundwater.

Soil solidification/stabilization would be a treatment technology worthy of detailed evaluation as a component of a cleanup action alternative if the impacted soil was affecting groundwater and it could not be safely and cost-effectively excavated and disposed of at a waste treatment/disposal facility. However, this is not the case for most of the impacted soil at the uplands areas. Also, solidification/stabilization offers no significant benefits in terms of effectiveness or implementability, and may be difficult to implement in a manner that would not impede future Site grading and development, as such development would likely require special construction, handling, and/or disposal methods for the treated soil. Since uplands groundwater has not been significantly affected by leaching from Site soil, this technology is not considered appropriate for treatment of soils remaining on site, but may be appropriate for facilitating cost-effective disposal of highly contaminated soil.

4.3.2 Groundwater

Based on groundwater monitoring results for shoreline wells at the Port Uplands Area and MJB North Area, Site groundwater appears to comply with the groundwater cleanup levels at the proposed conditional point of compliance (the point of groundwater discharge to the Cap Sante Waterway and Fidalgo Bay). Additionally, sporadic detections of hazardous substances have been reported in only a few interior monitoring wells. Because apparent impacts to groundwater appear to be limited to a few isolated areas of the Site interior, and marine surface water does not appear to have been adversely affected by migration of Site groundwater, monitoring was the only remedial option considered for groundwater in this FS. If active cleanup measures such as excavation and off-site disposal are employed to address contaminated soil at the Site, such measures would likely result in improved groundwater quality.

4.3.3 Sediment

This section presents the remediation technology screening evaluation for marine sediments. The technology screening evaluation for sediments is presented in Table 5.

4.3.3.1 No Action

The No Action alternative does not achieve the project objective of protecting human health and the environment and thus has been screened from further evaluation as a Marine Area alternative.

4.3.3.2 Institutional Controls

For sediment remediation projects, permitting review procedures constitute institutional controls. For any aquatic construction project (e.g., dredging), environmental reviews are conducted by permitting agencies including the Corps, Ecology, and other resource agencies. These reviews include a review of area files relating to sediment conditions, and requirements to address materials management and water quality.

Additional institutional controls may be implemented as appropriate, depending on the preferred cleanup action alternative. Such additional controls could include restrictive covenants for platted tidelands, use authorizations for state-owned aquatic lands, and/or documenting the Site cleanup action in County property records, Corps and regulatory agency permit records, and/or records maintained by the State of Washington for state-owned aquatic lands.

Institutional controls can be highly effective, implementable, and cost-effective provided that the cleanup action for which the institutional controls are implemented is consistent with area land and navigation uses. In cases where the proposed cleanup action is in conflict with land use and navigation uses, conflicts can result that jeopardize the effectiveness of institutional controls or that require mitigation.

4.3.3.3 Source Control and Natural Attenuation/Recovery

Natural biotransformation processes such as biodegradation and sedimentation can reduce contaminant concentrations and deleterious characteristics of sediments to acceptable levels over time. Natural recovery is generally not effective for quickly reducing risk from wood waste in the aquatic environment, considering the age of remaining wood deposits at the Site, and the amount of time that would be necessary for natural recovery of submerged wood.

While natural recovery is technically implementable, monitoring may be required to ensure adequate reduction rate, and institutional controls could be required during the treatment period.

Due to the relatively long restoration time frame and at the request of Ecology, natural recovery of sediments has been screened from further evaluation for the Marine Area alternatives.

4.3.3.4 Engineered Containment

Engineered containment is a commonly used technology to manage marine area sediments that require action. Containment for sediments involves placing an engineered aggregate cap to isolate material that could otherwise not be effectively removed through excavation or dredging. In the aquatic environment, the cap must be designed to withstand erosive forces generated by wave action, and must be thick enough to provide the required isolation of the material contained by the cap.

Cap monitoring results at other sites in the Puget Sound region have shown that capping can provide an opportunity for effective and economical sediment remediation, without the risks involved in removing contaminants by dredging (Sumeri 1996). Two typical sediment capping technologies are as follows:

1. **Enhanced Natural Recovery**. Deposition of clean sediment plays a role in the natural recovery of contaminated sediments. Recovery can often be enhanced by actively providing a layer of clean sediment to the target area. This is often referred to as “enhanced” natural recovery or thin-layer cover and generally consists of placing a nominal 6-inch-thick layer of clean sediment over existing contaminated sediments.
2. **Thick-Layer Sediment Capping**. Placing a thicker layer of sediment (typically 1 to 3 ft thick) can provide greater isolation of potentially contaminated sediments. However, thick sediment caps in shallow nearshore areas could eliminate significant areas of aquatic habitat, requiring compensatory mitigation or combination with dredging (dredge-and-cap remedies). Armored caps (e.g., with a gravel surface) may potentially be appropriate for consideration in sediment areas with high potential for disturbance.

A sediment cap would be designed to effectively contain and isolate contaminated sediments from the biologically active surface zone. The cap would be designed to be thick enough and of sufficient grain size to maintain its integrity under reasonable worst-case conditions. The cap would also be designed to ensure continued compliance with porewater cleanup levels (0 to 10 cm) in intertidal sediments, by promoting existing tidal mixing and associated oxidation of sediment porewater that occurs near the sediment/water interface. In the presence of dissolved oxygen, ammonia and sulfide both rapidly undergo chemical and biological oxidation to nitrate and sulfate, respectively. Tidal mixing and associated oxidation processes attenuate potential ammonia and sulfide risks at the Site (Section 2.2.2).

Surface layers of a sediment cap system would likely be constructed of clean sand, and could be placed by a number of mechanical and hydraulic methods. Capping has been used frequently in sediment remediation projects conducted in the Northwest, including nearshore sites where tidal mixing and associated oxidation of sediment porewater was promoted near the sediment/water interface (e.g., Holly Street Landfill in Bellingham; see http://www.ecy.wa.gov/programs/tcp/sites/blhm_bay/sites/holly_st/). Sediment capping is a proven technology to prevent exposure to contaminated sediments and could be easily implemented at the Site. Thin-layer covers and thick-layer sediment caps are relatively inexpensive remediation technologies. Therefore, both technologies have been retained for containment of contaminated sediment.

An engineered thick cap is considered an appropriate remedial technology for this Site, to manage sediments that are otherwise impracticable to remove because they are buried too deeply to access using excavation or dredging techniques. Two presumptive thick cap designs, which consider isolation, stability against erosion, and tidal mixing/oxidation, were evaluated in this FS, as follows:

1. **Rock Armor Cap**. Detailed wind-wave modeling of the Site was performed by Coast and Harbor Engineering (CHE) to support this FS (see Section 4.4). The wind-wave modeling identified areas where long-term erosion of the existing shoreline occurs under existing conditions. The wind-wave modeling also identified preliminary design specifications to stabilize the shoreline using two alternative design approaches: 1) with an armored cap placed on the beach; or 2) with a nearshore wave attenuation/habitat reef structure facilitating reduced armoring requirements on the beach (see below). The preliminary design for the armored beach cap included a 2-ft cap thickness in the relatively high energy beach/surf zone, comprised of rock armor (d_{50} = 1 ft)). Interstices of the rock would be filled with gravel substrate to replace existing habitat functions. Tidal mixing and associated oxidation of sediment porewater would continue to occur at the sediment/water interface (i.e., maintaining existing conditions; see Section 2.2.2).
2. **Gravel Cap**. As an alternative to using a rock armor layer to resist cap erosion, a nearshore wave attenuation structure may provide an effective means of reducing the wave energy reaching the shoreline. Such a system would consist of rock fill areas in the water to an appropriate elevation and extent so as to cause incoming waves to break before reaching the shore. Where a wave attenuation structure is used, the engineered cap could consist of finer-grained gravel substrate. Similar to the rock armor cap above, tidal mixing and associated oxidation of sediment porewater would continue to occur at the sediment/water interface (i.e., maintaining existing conditions).

Due to the objective of zero net loss of aquatic habitat, capping is only considered appropriate in combination with removal so that the cap does not decrease the amount of aquatic habitat (i.e., removal of 2 feet of sediment to accommodate a 2-foot-thick cap).

Where used, sediment caps would be designed using methodology developed by the EPA and the Corps (Palermo et al 1998), also promoting tidal mixing and associated oxidation of sediment porewater at the sediment/water interface. Cap material would either be placed from the water, using a clamshell derrick and a supply barge of cap material, or from the shore at low tide using land-based earthwork equipment.

Engineered caps would need to be protected from ongoing erosion along the shoreline. As outlined above, two different options were modeled for wave attenuation at the Site:

- Offshore wave attenuation structures; and
- Armored substrate.

Based on the CHE modeling (Section 4.4), a wave attenuation structure placed offshore of the Port Uplands Area was determined to provide permanent protection of the Port Uplands Area shoreline from erosion.

As part of a possible separate habitat restoration project, drift sills could potentially be placed within the MJB North Area, including a surficial treatment of habitat sand and gravel overlying the armor rock that would create a pocket beach along the MJB North Area shoreline. Based on similar beaches constructed in other areas of Puget Sound, replenishment of the sand and gravel habitat within the pocket beach would likely be necessary at five to ten-year intervals.

The use of drift sills along the Port Property shoreline is not consistent with the land use for that area, as it would result in changes to Seafarers' Memorial Park requiring the conversion of a portion of the uplands of the park to intertidal (beach) area. Use of drift sills on the Port Property would: 1) alter the relationship of the grassy picnic area to the Park Building; 2) alter the relationship of the Fisherman's Memorial statue to the park and the location; and 3) affect the possible future viability of the seasonal use small craft float. For these reasons, the drift sill option is not a viable habitat restoration option for the Port Property. Within this area of the Site, construction of a wave attenuation structure would provide protection from future shoreline erosion with expected minimal maintenance of the beach habitat. Thus, the wave attenuation structure option was retained for further evaluation in this FS, as it would concurrently provide wave attenuation, erosion protection, and habitat improvements in this portion of the marine area, consistent with existing and anticipated land uses.

Conversely, the armored capping option for shoreline protection was identified as the most appropriate containment remedy for the MJB North Area, consistent with future land uses anticipated in this area. A wave attenuation structure similar in design to that envisioned for the North Marine area would be inconsistent with proposed future marina land uses in the MJB North Area.

4.3.3.5 Removal

Removal of sediments from the aquatic environment is a common approach to addressing materials that require remedial action, and was considered for more detailed evaluation in this FS. Removal could be performed from the water using barge-mounted excavation equipment, or from the land at low tide using land-based earthwork equipment.

The extent of marine area removal may be limited by adjacent upland stability considerations. Within the shoreline area, the depth of marine removal could cause significant undermining of upland structures. Such undermining can be minimized through the use of shoring; however, complete removal of buried deep deposits may still not be possible even with shoring unless substantial upland excavation is performed along with the demolition and replacement of nearshore upland structures. Where deeply buried deposits remain (e.g., deep wood debris deposits in Port Parcels 2 and 3), a cap is likely to be the only practicable remedial option. For this FS, marine removal options were assumed to be integrally tied to the upland actions proposed in a 75 to 100-ft wide "shoreline buffer zone" (the shoreline buffer zone is discussed further in Section 6.0).

Sediments evaluated for cleanup action include those areas exceeding SQS and CSL criteria. Based on the sampling data, removal of an average 2-ft thickness of sediment (including overdredge) would be sufficient to address sediments exceeding proposed sediment cleanup levels.

As previously described, one of the marine objectives is no net loss of aquatic habitat, in part to comply with anticipated substantive permit requirements. Thus, where removal is performed, backfill of the excavation would be performed to the approximate original grades using clean sand and gravel.

Removal would be performed from a barge-mounted clamshell dredge, or from the shore at low tide using land-based earthwork equipment. Because of the shallow nature of the work area, water-based equipment would need to be relatively small with limited draft, or would need to work partial shifts during high tide to prevent grounding out. Due to these considerations, an upland-based operation performed during periods of low tide may be a more cost-effective method for removal, particularly within intertidal areas.

4.3.3.6 Disposal and/or Reuse

A portion of the sediments excavated from the Marine Area will require upland landfill disposal, while much of the woody debris may have some value for beneficial reuse, either as mulch/topsoil or as hog fuel. Potentially feasible disposal and reuse options are discussed below.

There are several options for disposal of marine sediments. For those that pass DMMP suitability evaluations, sediments may be disposed of in an unconfined open water disposal site. Based on existing dioxin data for these sediments, the nearest potentially suitable open water disposal site would be a non-dispersive DMMP site such as the Port Gardner site near Everett.

For debris and sediments that are not suitable for open water disposal, upland disposal at a permitted municipal or private landfill (Subtitle D) would likely be necessary. Sediments excavated using land-based equipment would be loaded onto trucks (and potentially subsequently onto a rail car) for shipment to a regional Northwest landfill. Sediments excavated using water-based equipment would be loaded on a barge, and could potentially be shipped directly to a Canadian landfill, or to a barge-truck-rail transloading facilitate for shipment to a United States landfill with rail access.

While a practicable beneficial reuse opportunity for woody debris material was not identified during this FS, there may be a potential opportunity to reuse some of the wood material beneficially, either as fuel to an industrial boiler, or as topsoil for upland reuse. In either case, debris would need to be screened out, larger pieces chipped, and salt rinsed from the material prior to reuse. Successful sparging of salinity from wood debris has been demonstrated at the Port Gamble Mill site, where wood debris sediments (with characteristics similar to prospective dredged materials from the Site) were dredged from Port Gamble Bay and placed within a nearshore upland stockpile containment structure (4-ft-thick sparging basin). Freshwater was applied through a simple sprinkler system, which reduced porewater salinity within the sparging basin to below secondary drinking water standards (less than 0.5 parts per thousand) within a period of approximately four months (Anchor Environmental, unpublished data). Leachate from the sparging basin did not exceed discharge criteria, and was passively returned to Port Gamble Bay. Much of the sparged Port Gamble material is being reused as an upland soil amendment.

At the Site, the practicability of beneficial reuse of wood debris material is limited by the available land to facilitate sparging, and also by logistics and costs associated with transport of sparged materials to prospective beneficial reuse locations. While specific practicable beneficial reuse opportunities were not identified during this FS, such opportunities would be further explored and evaluated during remedial design.

4.3.3.7 Ex Situ Treatment

As discussed above, ex situ treatment of wood debris using relatively low cost sparging technologies has been demonstrated as a method to remove salt from the material to facilitate beneficial reuse of these materials. However, in order to be cost-effective, ex situ treatment by sparging requires a significant upland space available adjacent to the project site for up to one year while sparging is performed. While other remedial technologies such as thermal desorption, incineration, stabilization, and soil washing could potentially be applied to the Site, such technologies are substantially more expensive than off-site landfill disposal, and many of these technologies have limited effectiveness for sediments with a high organic content (e.g., wood debris). Thus, no other ex situ treatment technologies besides sparging to facilitate beneficial reuse of wood debris materials were retained for further evaluation.

4.3.3.8 In Situ Treatment

ElectroChemical Remediation Technology is an innovative technology for destroying organic contaminants in situ by applying an alternating current across electrodes placed in the subsurface. In theory, the applied voltage creates redox reactions that destroy contaminants and organic materials such as wood debris through oxidation-reduction mechanisms. The primary advantage of this technology is that it has the potential to treat sediment in situ. The disadvantages are that it has produced mixed results at the field level, and studies indicate that treatment is less effective in sediments with high wood organic content such as those common at the Site. Thus, in situ treatment of marine sediments was screened from further evaluation in this FS.

4.4 Pre-Design Shoreline Stability Evaluation

Due to the slope and orientation of the beach to local waves, shoreline erosion is ongoing at the Site. While measures have been taken to minimize erosion (e.g., construction of rock revetments along portions of the Site shoreline), erosion continues, particularly in unprotected areas of the shoreline. In order to control future erosion, shoreline stabilization measures will be required using one or more of the following approaches:

- Reduce the energy of incident waves;

- Increase shoreline armoring in areas of wave attack using larger-sized aggregate, rock or other engineered structures;
- Flatten shoreline slopes to achieve equilibrium beach profiles; and/or
- Nourish the beach over time.

Some of these shoreline stabilization approaches are not compatible with long-term site use or habitat functions. As described below, the FS included an initial screening of these approaches to focus on the more promising shoreline stability controls.

- **Man-Made Armoring**. While engineered structures such as concrete armor mats and geotubes are commonly used in other areas of the U.S. for shoreline erosion control, such structures would not provide functional habitat at the Site. Thus, these methods of shoreline erosion were screened from further evaluation in this FS.
- **Bulkheads**. Bulkheads are also not considered desirable shoreline features at the Site, as they would not support forage fish spawning or juvenile fish shelter due to locally increased wave energy and reduced shallow-water habitat. Thus, bulkheads were also screened from further evaluation in this FS.
- **Flattening Shoreline Slopes**. Given current regulatory and permitting requirements, flattening shoreline slopes at the Site to a typical Puget Sound 7 to 10H:1V equilibrium beach profile would require removal of shoreline soils and loss of existing upland area. The current property owners have stated that such an approach would be inconsistent with existing and planned future land uses. Thus, flattening slopes was screened from further evaluation in this FS.

A pre-design shoreline stability evaluation was completed for the Site to evaluate the more promising wave attenuation and beach armoring alternatives. The shoreline stability evaluation modeling was performed by CHE and is reported in Appendix A.

4.4.1 Shoreline Stability Evaluation Methodology

The shoreline stability evaluation was conducted using wave refraction/diffraction/reflection numerical modeling. Several numerical models were integrated to simulate wave generation in Fidalgo Bay, propagation to the Site, and interaction with the shoreline and existing structures. Initially, a large modeling domain and the two-dimensional numerical model SWAN (Danish Hydraulic Institute) were used to simulate waves under different wind conditions and propagate waves to the Site.

Prior to initiating the pre-design-level wave modeling, CHE performed an analysis of wave-generating winds within the large modeling domain to determine statistical characteristics (e.g., magnitude, orientation, and return period) of “effective” and extreme wind storm events at the Site. The term “effective” in this application implies storm conditions that are critical for stability of the shoreline at the Site, which in turn are used to develop design criteria to ensure long-term beach stability. Consistent with EPA and Corps guidance, typically a 25-year storm event is used to develop preliminary designs for both shoreline erosion protection and contaminated sediment capping projects (Palermo et al. 1998). Accordingly, a 25-year storm was used as the preliminary design criterion for this FS. Modeling was conducted for various wind speeds approaching from the northeast, east, and southeast.

A nested numerical modeling domain was built, and a more advanced wave model was used to analyze specific and detailed wave parameters at the Site and wave/shoreline interactions. A two-dimensional wave refraction/diffraction/reflection model (US CRDF) was used to simulate waves in the Site area and their interaction with the shoreline and existing or potential future structures. The HWAVE model was run by inputting into the model the waves from the large domain modeling along its boundary. Modeling was conducted for different wind directions and three tide elevations: MHHW, mean sea level (MSL), and mean lower low water (MLLW). Modeling was conducted for existing conditions and for the wave attenuation and beach armor alternatives discussed in more detail in Section 7.0.

Bottom orbital wave velocities were extracted from numerical modeling results to determine stable grain size specifications. Using these data, bottom-velocity shear stresses were computed assuming characteristic roughness of different bottom materials (e.g., sand, gravel, cobble, or riprap). Stable sediment particle sizes along various cross sections at the Site were developed using recommended methodologies from the Corps Coastal Engineering Manual, incorporating conservative factors of safety to ensure the integrity and protectiveness of the preliminary designs.

The stability analysis was conducted for a 25-year storm event approaching from the southeast, as that condition generated the highest bottom shear stress (i.e., critical design condition). Analysis was conducted for different tide elevations: MHHW, MSL, and MLLW. The area of breaking waves was identified on the cross section for each of the analyzed tide elevation conditions. The cross section areas located seaward and landward from the breaking point were analyzed separately. Orbital bottom velocities were applied for the seaward part of the cross section, while the swash velocities of breaking waves were applied to the landward part of the cross section.

The numerical modeling evaluated both a beach armor alternative and a combination wave attenuation structure (North Marine Area) and beach armor (South Marine Area) alternative for shoreline protection.

4.4.2 Pre-Design Shoreline Stability Evaluation Results

The modeling demonstrated that within the North Marine Area, wave attenuation structures more effectively dissipated wave energy along the Port Uplands Area shoreline by breaking incoming storm-generated waves and by preventing wave reflection from the existing Cap Sante Boat Haven breakwater. Based on the preliminary design evaluations, wave attenuation structures would be constructed using imported rock with crest elevations ranging from +6 ft to +9 ft MLLW. Application of the wave attenuation structure in the North Marine Area was also shown to allow for permanent placement of finer-grained (sand and gravel), habitat-suitable materials along the Port Uplands Area shoreline. The numerical modeling indicated that drift sills, if placed in the North Marine Area (i.e., along the Port Uplands Area shoreline), would not adequately dissipate erosional forces to allow for permanent placement of cap materials. Additionally, the drift sill configuration could not be optimized without extensive modification of the shoreline within the Port park lands, which would be inconsistent with future use of the area as a park. Based on these results, the drift sill alternative was not carried forward as a practicable alternative for the North Marine Area.

The modeling showed that for the South Marine Area offshore of the MJB North Area, application of beach armor rock with or without drift sills would provide protection of the shoreline in a manner consistent with planned land uses. The cap would consist of a 2-ft thick rock armor layer, with the interstices of the rock filled with gravel. Additional discussion of preliminary shoreline stabilization designs is presented in Section 7.0.

5.0 EVALUATION CRITERIA

This section presents a description of the threshold requirements for cleanup actions under MTCA and the additional criteria used in this FS to evaluate the cleanup action alternatives.

5.1 THRESHOLD REQUIREMENTS

Cleanup actions performed under MTCA must comply with several basic requirements. Cleanup actions alternatives that do not comply with these criteria are not considered suitable cleanup actions under MTCA. As provided in WAC 173-340-360(2)(a), the four threshold requirements for cleanup actions are that they must:

- Protect human health and the environment;
- Comply with cleanup standards;
- Comply with applicable state and federal laws; and
- Provide for compliance monitoring.

5.1.1 Protection of Human Health and the Environment

The results of cleanup actions performed under MTCA must ensure that both human health and the environment are protected.

5.1.2 Compliance with Cleanup Standards

Compliance with cleanup standards requires, in part, that cleanup levels are met at the applicable points of compliance. If a remedial action does not comply with cleanup standards, the remedial action is an interim action, not a cleanup action. Where a cleanup action involves containment of soils with hazardous substance concentrations exceeding cleanup levels at the point of compliance, the cleanup action may be determined to comply with cleanup standards, provided the requirements specified in WAC 173-340-740(6)(f) are met.

5.1.3 Compliance with Applicable State and Federal Laws

Cleanup actions conducted under MTCA must comply with applicable state and federal laws. The term "applicable state and federal laws" includes legally applicable requirements and those requirements that Ecology determines to be relevant and appropriate as described in WAC 173-340-710.

5.1.4 Provision for Compliance Monitoring

The cleanup action must allow for compliance monitoring in accordance with WAC 173-340-410. Compliance monitoring consists of protection monitoring, performance monitoring, and confirmational monitoring. Protection monitoring is conducted to confirm that human health and the environment are adequately protected during construction and the operation and maintenance period of a cleanup action. Performance monitoring is conducted to confirm that the cleanup action has attained cleanup standards and, if appropriate, remediation levels or other performance standards. Confirmational monitoring is conducted to confirm the long-term effectiveness of the cleanup action once cleanup standards and, if appropriate, remediation levels or other performance standards have been attained.

5.2 OTHER MTCA REQUIREMENTS

Under MTCA, when selecting from the alternatives that meet the minimum requirements described above, the alternatives shall be further evaluated against the following additional criteria:

- **Use permanent solutions** to the **maximum extent practicable (WAC 173-340-360(2)(b)(i).** MTCA requires that when selecting from cleanup action alternatives that fulfill the threshold requirements, the selected action shall use permanent solutions to the maximum extent practicable [WAC 173-340-360(2)(b)(i)]. MTCA specifies that the permanence of these qualifying alternatives shall be evaluated by balancing the costs and benefits of each of the alternatives using a “disproportionate cost analysis” in accordance with WAC 173-340-460(3)(e). The criteria for conducting this analysis are described in Section 5.3 below.

- **Provide a reasonable restoration time-frame (WAC 173-340-360(2)(b)(ii)).** In accordance with WAC 173-340-360(2)(b)(ii), MTCA places a preference on those cleanup action alternatives that, while equivalent in other respects, can be implemented in a shorter period of time. MTCA includes a summary of factors to be considered in evaluating whether a cleanup action provides for a reasonable restoration time frame [WAC 173-340-360(4)(b)].

- **Consideration of Public Concerns (WAC 173-340-460(2)(b)(iii)).** Ecology will consider public comments submitted during the RI/FS process in making its preliminary selection of an appropriate cleanup action alternative. This preliminary selection is subject to further public review and comment when the proposed remedy is published in the draft CAP.

5.3 MTCA DISPROPORTIONATE COST ANALYSIS

The MTCA disproportionate cost analysis (DCA) is used to evaluate which of the alternatives that meet the threshold requirements are permanent to the maximum extent practicable. This analysis involves comparing the costs and benefits of alternatives and selecting the alternative whose incremental costs are not disproportionate to the incremental benefits. The evaluation criteria for the disproportionate cost analysis are specified in WAC 173-340-360(2) and (3)), and include protectiveness, permanence, cost, long-term effectiveness, management of short-term risks, implementability, and consideration of public concerns.

As outlined in WAC 173-340-360(3)(e), MTCA provides a methodology that uses the criteria below to determine whether the costs associated with each cleanup alternative are disproportionate relative to the incremental benefit of the alternative above the next lowest-cost alternative. The comparison of benefits relative to costs may be quantitative, but will often be qualitative. When possible for this FS, quantitative factors such as mass of contaminant removed or percentage of area of impacts remaining were compared to costs for the alternatives evaluated, but many of the benefits associated with the criteria described below were necessarily evaluated qualitatively. In order to favor the benefits represented by particular criteria associated with the primary goals of the remedial action, a weighting system was devised by Ecology (see http://www.ecy.wa.gov/programs/tcp/sites/whatcom). The criteria associated with environmentally based benefits are more highly weighted than other criteria that are associated with non-environmental factors. Costs are disproportionate to benefits if the incremental costs of the more permanent alternative exceed the incremental degree of benefits achieved by the other lower-cost alternative (WAC 173-340-360(e)(i)). Where two or more alternatives are equal in benefits, Ecology selects the less costly alternative (WAC 173-340-360(e)(ii)(c)).

Each of the MTCA criteria used in the DCA are described below.

5.3.1 Protectiveness

The overall protectiveness of a cleanup action alternative is evaluated based on several factors. First, the extent to which human health and the environment are protected and the degree to which overall risk at a site is reduced are considered. Both on-site and off-site reduction in risk resulting from implementing the alternative are considered. Protectiveness also gauges the degree to which the cleanup action may perform above the level of the specific standards presented in MTCA. Finally, it is a measure of the improvement of the overall environmental quality at the site. For the Scott Mill Site, Ecology recommends a weighting factor of 30% applied toward the overall benefit analysis. This means that, despite being only one of 6 factors (17%) for which a numeric value is assigned, the numeric factor assigned to protectiveness for each alternative is up-weighted to represent 30% of the numeric benefit analysis. This high weighting is warranted due to the overall importance of protection of human health and the environment as a primary goal of cleanup at the Site.

5.3.2 Permanence

MTCA specifies that when selecting a cleanup action alternative, preference shall be given to actions that are "permanent solutions to the maximum extent practicable." Evaluation criteria include the degree to which the alternative permanently reduces the toxicity, mobility or mass of hazardous substances, including the effectiveness of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment processes, and the characteristics and quantity of treatment residuals generated. At Ecology's recommendation, a weighing factor of 20 percent was be assigned to the numeric values associated with this evaluation criterion. This criterion has the second highest weighting factore.

5.3.3 Cost

The analysis of cleanup action alternative costs under MTCA includes all costs associated with implementing an alternative, including design, construction, long-term monitoring, and institutional controls. Costs are intended to be comparable among different alternatives to assist in the overall analysis of relative costs and benefits of the alternatives. The costs to implement an alternative include the cost of construction, the net present value of any long-term costs, and agency oversight costs. Long-term costs include operation and maintenance costs, monitoring costs, equipment replacement costs, and the cost of maintaining institutional controls. Cost estimates for treatment technologies describe pretreatment, analytical, labor, and waste management costs. The design life of the cleanup action is estimated, and the costs of replacement or repair of major elements are included in the cost estimate. Costs are compared against benefits to assess cost-effectiveness and practicability of the cleanup action alternatives. No weighting actor is applied to this quantitative category, as costs are compared against the numeric analysis.

5.3.4 Long-Term Effectiveness

Long-term effectiveness is a parameter that expresses the degree of certainty that the alternative will be successful in maintaining compliance with cleanup standards over the long-term performance of the cleanup action. The MTCA regulations contain a specific preference ranking for different types of technologies that is to be considered as part of the comparative analysis. The ranking places the highest preference on technologies such as reuse/recycling, treatment, immobilization/solidification, and disposal in an engineered, lined, and monitored facility.

Lower preference rankings are applied for technologies such as on-site isolation/containment with attendant engineered controls, and institutional controls and monitoring. The regulations recognize that, in most cases, the cleanup alternatives will combine multiple technologies to accomplish the CAOs. The MTCA preference ranking must be considered along with other site-specific factors in the evaluation of long-term effectiveness. Ecology recommends a weighting factor of 20% be assigned to the long-term effectiveness.

5.3.5 Management of Short-term Risks

Evaluation of this criterion considers the relative magnitude and complexity of actions required to maintain protection of human health and the environment during implementation of the cleanup action. Cleanup actions carry short-term risks, such as potential mobilization of contaminants during construction, or safety risks typical of large construction projects. In-water dredging activities carry a risk of temporary water quality degradation and potential sediment recontamination. Some short-term risks can be managed through the use of best practices during project design and construction, while other risks are inherent to project alternatives and can offset the long-term benefits of an alternative. Ecology recommends a weighting factor of short-term risk management for this evaluation of 10 percent. This lower rating is based on the limited time-frame associated with the risks and the general ability to correct short-term risks during construction without significant effect on human health and the environment.

5.3.6 Implementability

Implementability is an overall metric expressing the relative difficulty and uncertainty of implementing the cleanup action. Evaluation of implementability includes consideration of technical factors such as the availability of mature technologies and experienced contractors to accomplish the cleanup work. It also includes administrative factors associated with permitting and completing the cleanup. The weighting factor for implementability recommended by Ecology is 10 percent. Implementability is less associated with the primary goal of the cleanup action, protection of human health and the environment, and therefore has a lower weighting factor. In addition, the issues associated with the implementability of a remedy are often duplicated in the remedy costs.

5.3.7 Consideration of Public Concerns

The public involvement process under MTCA is used to identify potential public concerns regarding cleanup action alternatives. The extent to which an alternative addresses those concerns is considered as part of the evaluation process. This includes concerns raised by individuals, community groups, local governments, tribes, federal and state agencies, and other organizations that may have an interest in or knowledge of the site. The weighting factor recommended by Ecology for this criterion is 10 percent. Similar to the applied factor for implementability, the low weighting of public concerns prevents duplication of issues that are addressed with other criteria. In particular, the public concerns for this Site would generally be associated with environmental concerns and performance of the cleanup action, which are addressed under other criteria such as protectiveness and permanence.

5.4 ADDITIONAL SMS EVALUATION CRITERIA

Remedy selection criteria under SMS regulations are generally the same as those required under MTCA. The SMS evaluation criteria are specified in WAC 173-204-560(4)(f) through (k), and include the following:

- Overall protection of human health and the environment;
- Attainment of cleanup standards;
- Compliance with applicable state, federal, and local laws;
- Short-term effectiveness;
- Long-term effectiveness;
- Ability to be implemented;
- Cost;
- The degree to which community concerns are addressed;
- The degree to which recycling, reuse, and waste minimization are employed; and
- Analysis of environmental impacts consistent with SEPA requirements.

Requirements under SMS for cleanup decisions are specified in WAC 173-204-580(2) through (4). This portion of the regulation specifies factors that are to be considered by Ecology in making its cleanup decision. Most of these requirements overlap with the cleanup decision requirements under MTCA. SMS cleanup decision requirements include the following:

- Achieve protection of human health and the environment;
- Comply with applicable state, federal, and local laws;
- Comply with site cleanup standards;
- Achieve compliance with sediment source control requirements;
- Provide for landowner review of the cleanup study and consider public concerns raised during review of the draft cleanup report;
- Provide adequate monitoring to ensure the effectiveness of the cleanup action;
- Provide a reasonable restoration time frame;
- Consider the net environmental effects of the alternatives;
- Consider the relative cost-effectiveness of the alternatives in achieving the approved site cleanup standards; and
- Consider the technical effectiveness and reliability of the alternatives.

Like MTCA, the SMS regulations include a requirement for a reasonable restoration time frame. However, SMS includes a preference for restoration time frames that are less than ten years [WAC 173-204-580(3)]. Longer restoration time frames may be authorized, but only where it is not practicable to accomplish the cleanup action within a ten-year period.

Of the SMS evaluation criteria listed above, all but two are addressed as part of the MTCA evaluation of alternatives presented in this FS. The two exceptions are: 1) the completion of a SEPA analysis of environmental impacts, and 2) consideration of the net environmental effects of the alternatives. These criteria will be addressed during development of the CAP.

6.0 DEVELOPMENT AND EVALUATION OF CLEANUP ACTION ALTERNATIVES FOR UPLANDS AREAS

In this section, the technologies and process options for uplands cleanup retained through the screening evaluation described in Section 4.0 are used to develop alternatives to address the CAOs for impacted areas and media within the uplands areas of the Site. This section also provides a comparative analysis of the cleanup action alternatives developed for the uplands areas. Each alternative addresses impacted media with a combination of treatment technologies appropriate for Site conditions. Section 6.1 describes the development and analysis of cleanup action alternatives for the Port Uplands Area; Section 6.2 describes the development and analysis of upland cleanup action alternatives for the MJB North Area. The preferred cleanup action alternatives for the Port Uplands Area and the MJB North Area, respectively, are presented in Sections 6.1.5 and 6.2.6.

The cleanup action alternatives developed in this section are based on conceptual-level design for the implementation of individual technologies described in Section 4.0. The design parameters used to develop the alternatives are based on engineering judgment and current knowledge of Site conditions. The final design for the selected alternative may require additional characterization and analysis to better define the scope and costs associated with the cleanup action.

6.1 PORT UPLANDS AREA

This section describes the four cleanup action alternatives developed for evaluation to address contaminated media at the Port Uplands Area. The description of the cleanup alternatives is followed by a comparative analysis of the alternatives (Section 6.1.4) and selection of the preferred alternative (Section 6.1.5).

The four Port Uplands Area alternatives were developed to be consistent with the current and future land uses at the Site. A detailed description of current and future land use is presented in Section 2.3 of the RI and summarized in Section 1.1 of this FS. Each of the four alternatives are compatible with maintaining the existing use of the Port-owned portion of the Port Uplands Area as public park and meeting space in Parcel 3 and commercial development in Parcels 1 and 2. All of the alternatives would also allow later implementation of an integrated habitat/landscape architecture plan and development of small boat facilities at Seafarer's Memorial Park, as has been planned by the Port. As discussed in Section 4.4, alternatives that would result in significant restriction of the land use at Seafarer's Memorial Park, as well as the Port Uplands Area properties that have been previously sold by the Port, were not considered.

The conceptual plans for the alternatives presented below, as represented by Figures 18 through 21, are based on the current analytical data presented in the RI. Professional judgment was used to interpolate the extent of contamination during development of the remediation areas. This interpolation was required to develop plans that meet the goals of the respective alternatives, with an attempt to be account for the known extent of contamination and using consistent methodologies between alternatives. As discussed in Section 3.1.1, supplemental sampling is planned for the Port Uplands Area with the intent of refining the delineation of contamination at the Site and concurrently performing a more detailed terrestrial ecological evaluation (TEE). The refined extent of contamination and TEE will be applied to each of the four alternatives. This sampling is expected to be performed as part of development of the Cleanup Action Plan (CAP), supporting refined cost estimates for each of the alternatives. In addition to providing more accurate delineation of remediation areas, the supplemental sampling will allow better determination of waste disposal options and costs for the alternative components involving removal and subsequent disposal of contaminated soil. It is expected that the further delineation of contamination at the Site, if found to be different than the current understanding, will proportionally modify each of the alternatives under consideration. As such, the relative comparison presented in this FS is expected to be applicable to new findings resulting from the supplemental sampling and analysis.

6.1.1 Port Uplands Area Alternative PUA-1

The Port Uplands Area Alternative PUA-1 achieves complete removal to address the contaminated media at the Port Uplands Area in a manner that satisfies the upland CAOs to the greatest extent possible. Conceptually, Alternative PUA-1 seeks to meet the CAOs through direct removal to the extent feasible, of contaminated soil containing hazardous concentrations exceeding the proposed human health and terrestrial ecological-based cleanup levels. Specifically, Alternative PUA-1 includes the following components:

- Excavate approximately 68,000 cubic yards of soil from various areas across the Port Uplands Area, including approximately 53,000 cubic yards of contaminated soil and 15,000 cubic yards of overburden soil assumed to be clean. The areas of proposed soil excavation include:
  - Excavate to the extent feasible, upland soil between 0 and 15 ft BGS and within 100 ft of the mean higher-high water (MHHW) line (the “shoreline buffer zone”) containing exceedances of human health and terrestrial ecological-based cleanup levels. Within the shoreline buffer zone, excavation would also address potential erosional sources of localized contaminated sediment deposits identified in Port upland shoreline areas (see Figure 12).
  - Excavate to the extent feasible, soil between 0 and 15 ft BGS in the remaining areas containing TPH, cPAHs, and metals at concentrations exceeding the proposed human health and terrestrial ecological-based cleanup levels.
- Transport stockpiled soil to appropriate disposal facility.
- Backfill excavations with clean imported fill and restore original Site topography, features, and surfaces.
- Replace existing shoreline habitat.
- Install a monitoring well network and monitor groundwater quarterly for at least one year.

The following sections provide further description of the components of Alternative PUA-1.

6.1.1.1 Permitting

The cleanup action within the Port Uplands Area would be performed pursuant to MTCA under the terms of a Consent Decree between Ecology and the implementing party(ies). All actions performed under the Consent Decree meet the permit exemption provisions of MTCA, obviating the need to follow procedural requirements of the various local and state regulations that would otherwise apply to this action. However, the substantive requirements of the applicable regulations must be met. Ecology will be responsible for issuing the final approval for this project, following consultation with other state and local regulators. The substantive state and local permit requirements that would need to be addressed to complete Alternative PUA-1 work as outlined below include provisions related to construction stormwater, shoreline substantial development, grade and fill, and completion of a SEPA Checklist.

The cleanup action alternatives for the Port Uplands Area do not contemplate work below MHHW, and thus the uplands work would not require Corps permits. The shoreline of the Port Uplands Area below MHHW will be addressed as part of the Marine Area remedy. Permit requirements for the Marine Area alternatives are discussed in Section 7.0.

6.1.1.2 Soil Removal

The soil removal activities for Alternative PUA-1 would consist of removing large volumes of soil from the Site. Figure 18 presents the anticipated areas and depths of soil removal and the contaminants targeted for removal within those areas.

Soil exceeding the proposed cleanup levels for TPH, cPAHs, and metals would be removed to the greatest extent feasible under this alternative, as shown in Figure 18. Impacted soil adjacent to the Park Building would be excavated to the greatest extent feasible. Demolition of the Park Building may occur if demolition is the most cost effective method (as opposed to shoring) to achieve complete removal of impacted soil. The most cost-effective means for addressing potential under building contamination will be determined as part of the remedial design and potentially modified by actual field conditions. The cost estimate for this alternative includes costs for demolition and replacement of the Park Building. The removal of the Park Building is a component of each of the Port Uplands alternatives and thus does not influence the comparative analysis; the cost for this component has been included in the FS for completeness.

The soil removal associated with Alternative PUA-1 is expected to be completed using commonly available land-based excavation techniques. The construction methods would be specified during the design of the cleanup action or by the selected cleanup contractor. For the purpose of estimating costs associated with the soil removal component of this alternative, the following assumptions were made:

- Excavation of soil as shown in Figure 18 results in approximately 68,000 cubic yards excavated, including approximately 53,000 cubic yards of contaminated soil and 15,000 cubic yards of overburden soil assumed to be clean.
- If determined to be necessary as part of an integrated upland/marine remedial action, excavation along the shoreline could potentially be performed using a sheet-pile wall or equivalent type shoring installed at or slightly inland from the MHHW line. Such an approach may provide for a dryer excavation and allow upland excavation to be performed outside of the limited time window available for intrusive work beyond the MHHW line.

- Excavation near buildings would utilize sheet-pile walls or shoring to protect the structural integrity of the buildings. Demolition of the Park Building may occur if demolition is the most cost effective method (as opposed to shoring) to achieve complete removal of impacted soil.
- Excavations extending below 10 ft BGS would be performed using commonly available dewatering techniques to allow the driest excavation possible.
- The excavations would be completed in a manner that allows segregation and reuse of clean overburden soil, resulting in approximately 20 percent of excavated soil allowed to be reused as clean backfill.

6.1.1.3 Soil Disposal and Treatment

As noted above, it is assumed that the soil removal activities would be completed in a manner that allows segregation and reuse of clean overburden soil. The excavated soil would be characterized for disposal as required by MTCA and Washington State Dangerous Waste regulations and the selected disposal facility. The impacted soil is expected to fall into two categories: non-dangerous waste suitable for disposal at a Subtitle D landfill, or dangerous waste requiring either disposal at a Subtitle C (hazardous/dangerous waste) facility or treatment prior to disposal at a Subtitle D facility.

For soil to be categorized as non-dangerous waste and suitable for disposal at a Subtitle D landfill, it would be necessary to demonstrate that Site contaminants are not present at concentrations greater than ten times the Universal Treatment Standards (UTS), as defined in 40 CFR 268.48. This requirement includes the results of toxicity characteristic leaching procedure (TCLP) testing for metals.

It is expected that some of the excavated soil would be precluded from disposal at a Subtitle D landfill as non-dangerous waste based on exceeding ten times the UTS for lead. Lead has been detected in soil at the Port Uplands Area at concentrations that would potentially result in failure of this rule based on the TCLP. Further characterization of the concentrations of total lead and lead by TCLP will be performed as part of CAP development to allow more accurate estimation of the costs associated with disposal of lead-impacted soil. For cost estimation purposes at the draft stage of this FS, it was assumed that 30 percent of the soil excavated under Alternative PUA-1 would fail TCLP, and thus could not be immediately disposed of as non-dangerous waste.

Because of the relatively high volume of soil that may fail the TCLP for lead, it would be more practicable to treat this waste component on site by stabilization prior to disposal. The alternative to this approach is to dispose of the soil as a dangerous waste at an appropriate permitted facility, which is anticipated to be approximately four to five times the unit cost of non-dangerous disposal. Ex situ stabilization is a common method of treatment for soil contaminated with metals concentrations that preclude disposal as non-dangerous waste. The soil is mixed with a binder that significantly reduces the leachability of the metal, resulting in an end-product that meets non-dangerous waste requirements for metals TCLP results, and can be disposed of at a Subtitle D landfill at significantly lower cost. The treated soil is expected to be transported and disposed of at the same facility as specified for the soil classified as non-dangerous waste.

6.1.1.4 Groundwater Monitoring

The limited groundwater impacts identified at several interior monitoring wells within the Port Uplands Area are directly associated with areas of soil contamination that would be addressed by this alternative.

The soil removal proposed in this alternative is expected to result in a reduction of contaminant concentrations in groundwater, thereby obviating the need for active groundwater remediation. To verify that the soil removal is protective of groundwater, a network of new monitoring wells would be installed across the Port uplands Area following completion of the soil removal activities. The monitoring wells would be sampled and analyzed during at least four quarterly events to demonstrate that groundwater impacts have been addressed.

6.1.1.5 Institutional Controls

One of the objectives of Alternative PUA-1 is to leave the Port Uplands Area without the need for institutional controls in the form of restrictive covenants that would encumber land value, future use, future sale, and/or development of the Port Property. Through excavation with off-site disposal, Alternative PUA-1 achieves, to the degree feasible, complete removal of contaminants at the Port Uplands Area without the need for restrictive covenants.

6.1.2 Port Uplands Area Alternative PUA-2

The Port Uplands Area Alternative PUA-2 achieves complete removal of contaminated soil within the shoreline buffer zone and in the vicinity of MW-110, and focused removal of remaining contaminated soil with implementation of institutional controls, to address the contaminated media at the Port Uplands Area. Alternative PUA-2 places the greatest emphasis on meeting the upland CAOs and protecting the adjacent Marine Area through complete or partial (to 6 ft BGS) removal of contaminated soil posing a risk to human health and ecological receptors, while utilizing institutional controls to prevent exposure to remaining contaminated soil left in place. Specifically, Alternative PUA-2 includes the following components:

- Excavate approximately 44,000 cubic yards of soil from various areas across the Port Uplands Area, including approximately 31,000 cubic yards of contaminated soil and 13,000 cubic yards of overburden soil assumed to be clean. The areas of proposed soil excavation include:
  - Excavate to the extent feasible, soil between 0 and 15 ft BGS in the shoreline buffer zone containing exceedances of human health and terrestrial ecological-based cleanup levels. Within the shoreline buffer zone, excavation would also address potential erosional sources to of localized contaminated sediment deposits contaminationidentified in Port upland shoreline areas (see Figure 12).
  - TPH, cPAHs, and metals at concentrations exceeding the proposed human health and terrestrial ecological-based cleanup levels.
  - Excavate to the extent feasible, soil between 0 and 10 ft BGS at Port Parcel 1 containing metals at concentrations exceeding the proposed human health and terrestrial ecological-based cleanup levels.
  - Excavate to the extent feasible, soil between 0 and 15 ft BGS in the vicinity of monitoring well MW-110 containing TPH and free product at concentrations exceeding the proposed human health-based cleanup levels.
  - Excavate to the extent feasible, soil between 0 and 6 ft BGS in remaining areas of the Port Uplands Area containing TPH, cPAHs, and metals at concentrations exceeding the proposed human health and terrestrial ecological-based cleanup levels.

- Develop institutional controls in the form of restrictive covenants to address remaining contaminated soil left in place below 6 ft BGS.
- Transport stockpiled soil to appropriate disposal facility.
- Backfill excavations with clean imported fill and restore original Site topography, features, and surfaces.
- Replace existing shoreline habitat.
- Install a monitoring well network and monitor groundwater quarterly for at least one year.

The following sections provide further description of the components of Alternative PUA-2.

6.1.2.1 Permitting

The permitting requirements for Alternative PUA-2 are the same as described above for Alternative PUA-1.

6.1.2.2 Soil Removal

The soil removal activities associated with Alternative PUA-2 are similar to those described above for Alternative PUA-1. The primary difference between the two alternatives is that relatively deeply buried (more than 6 ft BGS) soil in select areas of the Site that exceeds proposed cleanup levels would be left in place with institutional controls. Figure 19 presents the anticipated areas and depths of soil removal in Alternative PUA-2 and the contaminants targeted for removal within those areas.

Soil exceeding the proposed cleanup levels for TPH, cPAHs, and metals would be removed to varying depths, as described above and shown in Figure 19. Within a 100-ft wide shoreline buffer zone, the extent of soil removal is the same as in Alternative PUA-1. This is also true for the limited area of soil removal on Port Parcel 1 and the soil removal in the vicinity of well MW-110, which is intended to prevent further contamination of groundwater from TPH and free product present in deeper soil. As in Alternative PUA-1, it may be necessary to demolish the Park Building to achieve complete removal of impacted soil adjacent to and potentially under the building.

The soil removal associated with Alternative PUA-2 is expected to be performed using commonly available land-based excavation techniques. The construction methods would be specified during the design of the cleanup action or by the selected cleanup contractor. For the purpose of estimating costs associated with the soil removal component of this alternative, the following assumptions were made:

- Excavation of soil as shown in Figure 19 results in approximately 44,000 cubic yards excavated, including approximately 31,000 cubic yards of contaminated soil and 13,000 cubic yards of overburden soil assumed to be clean.
- If determined to be necessary as part of an integrated upland/marine remedial action, excavation along the shoreline could potentially be performed using a sheet-pile wall or equivalent type of shoring installed at or slightly inland from the MHHW line. Such an approach may provide for a dryer excavation and to allow upland excavation to be performed outside of the limited time window available for intrusive work beyond the MHHW line.

- Excavation near buildings would utilize sheet-pile walls or shoring to protect the structural integrity of the buildings. Demolition of the Park Building may occur if demolition is the most cost effective method (as opposed to shoring) to achieve complete removal of impacted soil.
- Excavations extending below 10 ft BGS would be completed using commonly available dewatering techniques to allow the driest excavation possible.
- The excavations would be completed in a manner that allows segregation and reuse of clean overburden soil, resulting in approximately 30 percent of excavated soil allowed to be reused as clean backfill.

6.1.2.3 Soil Disposal and Treatment

The soil disposal and treatment activities proposed for Alternative PUA-2 are expected to be the same as described in Section 6.1.1.3 for Alternative PUA-1.

6.1.2.4 Groundwater Monitoring

The groundwater monitoring activities proposed for Alternative PUA-2 are expected to be the same as described in Section 6.1.1.4 for Alternative PUA-1. Long-term groundwater monitoring may be necessary if initial groundwater monitoring indicates the potential for contaminant transfer from remaining impacted soil to groundwater over time.

6.1.2.5 Institutional Controls

Alternative PUA-2 would leave impacted soil in place below 6 ft BGS in portions of the Port Uplands Area. While this soil is deep enough to not pose immediate risks to human health and terrestrial ecological receptors, future development within areas of the impacted soil will potentially generate soil requiring appropriate handling and disposal.

The 6-ft depth was selected as a proposed conditional point of compliance to reduce potential worker and terrestrial biota exposures at the Port Uplands Area. The existing RI site characterization data show that groundwater at the shoreline wells complies with the proposed groundwater cleanup levels, suggesting that leaching of soil contaminants to groundwater is not an exposure pathway of concern. Therefore, it is assumed that the soil left in place would not be a source of mobile contamination affecting marine surface water or sediments. Potential erosional sources of localized contaminated to sediment deposits identified in Port upland shoreline areas contamination from the Port upland shoreline area (see Figure 12) would also be removed under this alternative (in addition to shoreline erosion controls; see Section 7), thus providing additional protection from recontamination of the Marine Area sediments.

Restrictive covenants would be required for the portions of the Port Uplands Area where complete soil removal was not achieved. The covenants would attach future development restrictions and requirements to property deeds for the lifetime of the remaining contamination. Soil management plans would be required that instruct property owners on Ecology's requirements for performing invasive work in areas of remaining impacted soil. Future management of contaminated material could result in higher future development project costs. The restrictive covenants would require maintenance in the form of periodic reviews and updating of soil management plans.

6.1.3 Port Uplands Area Alternative PUA-3

The Port Uplands Area Alternative PUA-3 achieves complete removal of contaminated soil in the vicinity of MW-110, and focused removal of remaining contaminated soil with implementation of institutional controls, to address the contaminated media at the Port Uplands Area. Alternative PUA-3 places emphasis on meeting the upland CAOs through complete or partial (to 6 ft BGS) removal of contaminated soil posing a risk to human health and ecological receptors, while utilizing institutional controls to prevent exposure to remaining contaminated soil left in place. Alternative PUA-3 addresses the CAOs associated with protection of the adjacent Marine Area by addressing potential erosional sources to of localized contaminated sediment deposits identified in contamination from the Port upland shoreline areas (see Figure 12), and by relying on the capping and wave attenuation components of the Marine Area alternatives (discussed in Section 7.0) to prevent erosion of contaminated soil left in place below 6 ft BGS adjacent to the shoreline. Specifically, Alternative PUA-3 includes the following components:

- Excavate approximately 17,000 cubic yards of soil from various areas across the Port Uplands Area, including approximately 15,500 cubic yards of contaminated soil and 1,500 cubic yards of overburden soil assumed to be clean. The areas of proposed soil excavation include:
  - Excavate to the extent feasible, soil between 0 and 6 ft BGS throughout the Port Uplands Area containing TPH, cPAHs, and metals at concentrations exceeding the proposed human health and terrestrial ecological-based cleanup levels exceedances of human health and terrestrial ecological-based cleanup levels. Within the shoreline buffer zone, excavation would also address potential erosional sources toof localized contaminated sediment deposits contamination identified in Port upland shoreline areas (see Figure 12).
  - Excavate to the extent feasible, soil between 0 and 10 ft BGS at Port Parcel 1 containing metals at concentrations exceeding the proposed human health and terrestrial ecological-based cleanup levels.
  - Excavate to the extent feasible, soil between 0 and 15 ft BGS in the vicinity of monitoring well MW-110 containing TPH and free product at concentrations exceeding the proposed human health-based cleanup levels.
- Develop institutional controls in the form of restrictive covenants to address remaining contaminated soil left in place below 6 ft BGS.
- Transport stockpiled soil to appropriate disposal facility.
- Backfill excavations with clean imported fill and restore original Site topography, features, and surfaces.
- Replace existing shoreline habitat.
- Install a monitoring well network and monitor groundwater quarterly for at least one year.

The following sections provide further description of the components of Alternative PUA-3.

6.1.3.1 Permitting

The permitting requirements for Alternative PUA-3 are the same as described above for Alternative PUA-1.

6.1.3.2 Soil Removal

The soil quantity removed in Alternative PUA-3 is less than in the other three Port Upland Area alternatives. Figure 20 presents the anticipated areas and depths of soil removal in Alternative PUA-3 and the contaminants targeted for removal within those areas.

Soil exceeding the proposed cleanup levels for TPH, cPAHs, and metals would be removed to varying depths, as described above and shown in Figure 20. The soil removal proposed in the vicinity of well MW-110, which is intended to prevent further contamination of groundwater from TPH and free product present in deeper soil, is the same as in Alternatives PUA-1 and PUA-2. Across the remainder of the Port Uplands Area, soil between 0 and 6 ft BGS that exceeds the proposed human health and terrestrial ecological-based cleanup levels for TPH, cPAHs, and metals would be removed to the greatest extent feasible. Potential erosional sources of localized to sediment contamination sediment deposits identified in Port upland shoreline areas (see Figure 12) would also be removed under this alternative, thus providing additional protection from future contamination of the Marine Area sediments (in addition to wave attenuation and cap armor elements; see Section 7). Known soil between 0 and 6 ft BGS in the shoreline buffer zone that exceeds SQS chemical criteria for PCBs, copper, lead, mercury, and zinc would also be removed to the extent feasible. As in Alternatives PUA-1 and PUA-2, demolition of the Park Building may occur if demolition is the most cost effective method (as opposed to shoring) to achieve complete removal of impacted soil.

The soil removal associated with Alternative PUA-3 is expected to be completed using commonly available land-based excavation techniques. The specific construction methods would be specified during the design of the cleanup action or by the selected cleanup contractor. For the purpose of estimating costs associated with the soil removal component of this alternative, the following assumptions were made:

- Excavation of soil as shown in Figure 20 results in approximately 17,000 cubic yards excavated, including approximately 15,500 cubic yards of contaminated soil and 1,500 cubic yards of overburden soil assumed to be clean.
- Excavation near buildings would utilize sheet-pile walls or equivalent means of shoring to allow the greatest possible removal of impacted soil, while protecting the structural integrity of the buildings. Demolition of the Park Building may occur if demolition is the most cost effective method (as opposed to shoring) to achieve complete removal of impacted soil.
- Excavations extending below 10 ft BGS (i.e., the excavation targeting TPH and free product in the vicinity of monitoring well MW-110) would be performed using commonly available dewatering techniques to allow the driest excavation possible.
- The excavations would be performed in a manner that allows segregation and reuse of clean overburden soil, resulting in approximately 10 percent of excavated soil allowed to be reused as clean backfill.

6.1.3.3 Soil Disposal and Treatment

The soil disposal and treatment activities proposed for Alternative PUA-3 are expected to be the same as described in Section 6.1.1.3 for Alternative PUA-1.

6.1.3.4 Groundwater Monitoring

The groundwater monitoring activities proposed for Alternative PUA-3 are expected to be the same as described in Section 6.1.1.4 for Alternative PUA-1. Long-term groundwater monitoring may be necessary if initial groundwater monitoring indicates the potential for contaminant transfer from remaining impacted soil to groundwater over time.

6.1.3.5 Institutional Controls

Alternative PUA-3 would leave impacted soil in place below 6 ft BGS in portions of the Port Uplands Area. While this soil is deep enough to not pose immediate risks to human health and terrestrial ecological receptors, future development within areas of the impacted soil will potentially generate soil requiring appropriate handling and disposal.

The 6-ft depth was selected as a proposed conditional point of compliance to reduce potential worker and terrestrial biota exposures at the Port Uplands Area. The existing RI site characterization data show that groundwater at the shoreline wells complies with the proposed groundwater cleanup levels, suggesting that leaching of soil contaminants to groundwater is not an exposure pathway of concern. Therefore, it is assumed that the soil left in place would not be a source of mobile contamination affecting marine surface water or sediments. Potential erosional sources of localized to sediment deposits contamination identified in Port upland shoreline areas (see Figure 12) would also be removed under this alternative (in addition to shoreline erosion controls; see Section 7), thus providing additional protection from recontamination of the Marine Area sediments.

Restrictive covenants would be required for the portions of the Port Uplands Area where complete soil removal was not achieved. The covenants would attach future development restrictions and requirements to property deeds for the lifetime of the remaining contamination. Soil management plans would be required that instruct property owners on Ecology's requirements for performing invasive work in areas of remaining impacted soil. Future management of contaminated material could result in higher future development project costs. The restrictive covenants would require maintenance in the form of periodic reviews and updating of soil management plans.

6.1.4 Port Uplands Area Alternative PUA-4

Similar to Alternative PUA-3, Alternative PUA-4 achieves complete removal of contaminated soil in the vicinity of MW-110, and focused, removal of remaining contaminated soil with implementation of institutional controls, to address the contaminated media at the Port Uplands Area. Alternative PUA-4 places emphasis on meeting the upland CAOs through complete or partial (to 6 or 10 ft BGS) removal of contaminated soil posing a risk to human health and ecological receptors in other areas of the site, while utilizing institutional controls to prevent exposure to remaining contaminated soil left in place. Relative to Alternative PUA-3, Alternative PUA-4 provides a greater excavation depth along the shoreline (10 ft BGS for PUA-4 versus 6 ft BGS for PUA-3), but uses a narrower (75 ft) shoreline buffer zone. Alternative PUA-4 addresses the CAOs associated with protection of the adjacent Marine Area by removing the majority of the contaminant mass in soil within 75 feet of the MHHW line, and by relying on the capping and wave attenuation components of the Marine Area alternatives (discussed in Section 7.0) to prevent erosion of contaminated soil left in place below 10 ft BGS adjacent to the shoreline. Specifically, Alternative PUA-4 includes the following components:

- Excavate approximately 33,500 cubic yards of soil from various areas across the Port Uplands Area, including approximately 23,500 cubic yards of contaminated soil and 10,000 cubic yards of overburden soil assumed to be clean. The areas of proposed soil excavation include:
  - Excavate to the extent feasible, soil between 0 and 10 ft BGS within 75 feet of the MHHW line containing exceedances of human health and terrestrial ecological-based cleanup levels. Within the shoreline buffer zone, excavation would also address potential erosional sources of localized contaminated to sediment contamination identified in Port upland shoreline areas (see Figure 12).
  - Excavate to the extent feasible, soil between 0 and 10 ft BGS at Port Parcel 1 containing metals at concentrations exceeding the proposed human health and terrestrial ecological-based cleanup levels.
  - Excavate to the extent feasible, soil between 0 and 15 ft BGS in the vicinity of monitoring well MW-110 containing TPH and free product at concentrations exceeding the proposed human health-based cleanup levels.
  - Excavate to the extent feasible, soil between 0 and 6 ft BGS in remaining areas of the Port Uplands Area containing TPH, cPAHs, and metals at concentrations exceeding the proposed human health and terrestrial ecological-based cleanup levels.
- Develop institutional controls in the form of restrictive covenants to address remaining contaminated soil left in place below 10 ft BGS along the shoreline and below 6 ft BGS across the remainder of the Port Uplands Area.
- Transport stockpiled soil to appropriate disposal facility.
- Backfill excavations with clean imported fill and restore original Site topography, features, and surfaces.
- Replace existing shoreline habitat.
- Install a monitoring well network and monitor groundwater quarterly for at least one year.

The following sections provide further description of the components of Alternative PUA-4.

6.1.4.1 Permitting

The permitting requirements for Alternative PUA-4 are the same as described above for Alternative PUA-1.

6.1.4.2 Soil Removal

The soil removal activities associated with Alternative PUA-4 are similar to those described above for Alternative PUA-3. The primary difference between the two alternatives is that soil exceeding proposed cleanup levels will be removed to a greater depth (10 ft BGS versus 6 ft BGS) within 75 ft of the MHHW line. Figure 21 presents the anticipated areas and depths of soil removal in Alternative PUA-4 and the contaminants targeted for removal within those areas.

Soil exceeding the proposed cleanup levels for TPH, cPAHs, and metals would be removed to varying depths, as described above and shown in Figure 21. The proposed areas of soil removal on Port Parcel 1 and in the vicinity of well MW-110 are the same as in Alternative PUA-2. As in Alternatives PUA-1, PUA-2, and PUA-3, demolition of the Park Building may occur if demolition is the most cost effective method (as opposed to shoring) to achieve complete removal of impacted soil.

The soil removal associated with Alternative PUA-4 is expected to be performed using commonly available land-based excavation techniques. The construction methods would be specified during the design of the cleanup action or by the selected cleanup contractor. For the purpose of estimating costs associated with the soil removal component of this alternative, the following assumptions were made:

- Excavation of soil as shown in Figure 21 results in approximately 33,500 cubic yards excavated, including approximately 23,500 cubic yards of contaminated soil and 10,000 cubic yards of overburden soil assumed to be clean.
- If determined to be necessary as part of an integrated upland/marine remedial action, excavation along the shoreline could potentially be performed using a sheet-pile wall or equivalent type of shoring installed at or slightly inland from the MHHW line. Such an approach may provide for a dryer excavation and to allow upland excavation to be performed outside of the limited time window available for intrusive work beyond the MHHW line.
- Excavation near buildings would utilize sheet-pile walls or shoring to protect the structural integrity of the buildings. Demolition of the Park Building may occur if demolition is the most cost effective method (as opposed to shoring) to achieve complete removal of impacted soil.
- Excavations extending below 10 ft BGS would be completed using commonly available dewatering techniques to allow the driest excavation possible.
- The excavations would be completed in a manner that allows segregation and reuse of clean overburden soil, resulting in approximately 30 percent of excavated soil allowed to be reused as clean backfill.

6.1.4.3 Soil Disposal and Treatment

The soil disposal and treatment activities proposed for Alternative PUA-4 are expected to be the same as described in Section 6.1.1.3 for Alternative PUA-1.

6.1.4.4 Groundwater Monitoring

The groundwater monitoring activities proposed for Alternative PUA-4 are expected to be the same as described in Section 6.1.1.4 for Alternative PUA-1. Long-term groundwater monitoring may be necessary if initial groundwater monitoring indicates the potential for contaminant transfer from remaining impacted soil to groundwater over time.

6.1.4.5 Institutional Controls

Alternative PUA-4 would leave impacted soil in place below 6 ft BGS in portions of the Port Uplands Area, and below 10 ft BGS along the shoreline. While this soil is deep enough to not pose immediate risks to human health and terrestrial ecological receptors, future development within areas of the impacted soil could potentially generate soil requiring appropriate handling and disposal.

The 6-ft excavation depth was selected as a proposed conditional point of compliance to reduce potential worker and terrestrial biota exposures at the Port Uplands Area. The 10-ft excavation depth along the shoreline buffer zone was selected to remove the majority of contamination from the area and to further reduce the potential for transport of contamination to the adjacent marine area. The existing RI site characterization data show that groundwater at the shoreline wells complies with the proposed groundwater cleanup levels, suggesting that leaching of soil contaminants to groundwater is not an exposure pathway of concern. Therefore, it is assumed that the soil left in place would not be a source of mobile contamination affecting marine surface water or sediments. Potential erosional sources to localized contaminated sediment deposits contamination identified in Port upland shoreline areas (see Figure 12) would also be removed under this alternative (in addition to shoreline erosion controls; see Section 7), thus providing additional protection from recontamination of the Marine Area sediments.

Restrictive covenants would be required for the portions of the Port Uplands Area where complete soil removal was not achieved. The covenants would attach future development restrictions and requirements to property deeds for the lifetime of the remaining contamination. Soil management plans would be required that instruct property owners on Ecology's requirements for performing invasive work in areas of remaining impacted soil. Future management of contaminated material could result in higher future development project costs. The restrictive covenants would require maintenance in the form of periodic reviews and updating of soil management plans.

6.1.5 Evaluation and Comparison of Port Uplands Area Alternatives

This section provides an evaluation and comparative analysis of the cleanup action alternatives developed for the Port Uplands Area. Each alternative is evaluated with respect to the MTCA evaluation criteria described in Section 5.0, and the alternatives are compared to each other relative to their expected performance under each criterion. The components of the four Port Uplands Area alternatives are described above in Sections 6.1.1 through 6.1.4 and are summarized in Table 6. The detailed evaluation of the alternatives is presented in Table 7, and the results of the evaluation are summarized in Table 8.

6.1.5.1 Threshold Requirements

As described in Table 7, all four alternatives developed for the Port Uplands Area are expected to satisfy the MTCA threshold requirements: protection of human health and the environment, compliance with cleanup standards, compliance with applicable state and federal regulations, and provision for compliance monitoring. The four alternatives differ, however, in the manner in which these requirements would be met. Alternative PUA-1 would result in complete removal, to the extent feasible, of soil between 0 and 15 ft BGS exceeding proposed cleanup levels throughout the Port Uplands Area. Alternative PUA-2 would remove, to the extent feasible, soil between 0 and 15 ft BGS exceeding proposed cleanup levels in the shoreline buffer zone and the vicinity of well MW-110, and soil between 0 and 6 ft BGS exceeding proposed cleanup levels across the remainder of the Port Uplands Area, while utilizing institutional controls to protect potential receptors from impacted soil left in place.

Alternative PUA-3 would remove, to the extent feasible, soil between 0 and 15 ft BGS exceeding proposed cleanup levels in the vicinity of well MW-110, and soil between 0 and 6 ft BGS exceeding proposed cleanup levels across the remainder of the Port Uplands Area (including the shoreline buffer zone), while utilizing institutional controls to protect potential receptors from contaminated soil left in place. This alternative, when implemented in combination with marine area wave attenuation, is protective of human health and the environment by removing the contaminated soil posing immediate risk through direct contact and protecting future site or construction workers using institutional controls, removing the mechanism of erosion and transport of deeper contaminated soil along the shoreline, and eliminating the primary risk to further impacts to groundwater at the site by performing complete removal of the TPH source area. Potential erosional sources of localized to sediment deposits contamination identified in Port upland shoreline areas (see Figure 12) would also be removed under this alternative (in addition to shoreline erosion controls; see Section 7), thus providing additional protection from recontamination of the Marine Area sediments. Upland cleanup levels would be achieved at potential conditional points of compliance near the ground surface and at the shoreline in accordance with WAC 173-340-740(6)(f), while leaving contamination in place at deeper intervals.

Alternative PUA-4 also meets the threshold requirements, but by utilizing a deeper excavation of contaminated soil adjacent to the shoreline relative to Alternative PUA-3 (10 feet versus 6 feet), while limiting the upland extent of the shoreline buffer zone relative to the other three alternatives (75 feet versus 100 feet). As with PUA-3, this alternative leaves contaminated soil in place, but is protective through the use of focused soil removal, institutional controls, and marine wave attenuation.

All four alternatives for the Port Uplands Area are expected to meet cleanup standards. However, Alternatives PUA-2, PUA-3, and PUA-4 rely on institutional controls to prevent exposure to contaminated soil left in place below 6 ft BGS (the proposed conditional point of compliance under these alternatives), whereas Alternative PUA-1 meets cleanup standards without the need for institutional controls.

6.1.5.2 MTCA Disproportionate Cost Analysis

As discussed in Section 5.3, the MTCA analysis of disproportionate costs is used to determine which cleanup alternative that otherwise meets threshold requirements is permanent to the maximum extent practicable. The four Port Uplands Area alternatives meet the requirements of the MTCA threshold criteria, and thus were evaluated based on the relative benefits ranking factors of the disproportionate cost analysis (DCA) as described in Section 5.3. The evaluation of the level of achievement for each individual criterion, using a numeric scoring scale of 1 (lowest) to 5 (highest), is presented in Table 7. Table 8 presents the analysis of these results, including the assignment of weighting factors for each criterion described in Section 5.3, the summation of the resulting scores for each alternative, and the determination of disproportionate cost. The conclusions of this evaluation are summarized below.

Protectiveness

Alternative PUA-1 achieves a high level of protectiveness as a result of the maximum feasible removal of soil exceeding proposed cleanup levels. Alternatives PUA-2 and PUA-4 achieve a medium-high level of protectiveness because of their reliance on institutional controls to prevent exposure to contaminated soil left in place, relative to Alternative PUA-1. Alternative PUA-3 achieves a medium level of protectiveness, as a result of the reduced mass of contaminated soil removed under this alternative, relative to PUA-2 and PUA-4, as well as the increased reliance on the ability of marine area wave attenuation to prevent further erosion of the shoreline.

Permanence

Alternative PUA-1 achieves a high level of permanence relative to the other alternatives, by emphasizing complete removal of contamination from the Site. However, Alternatives PUA-2, PUA-3, and PUA-4 are considered to be permanent if marine wave attenuation is implemented as a component of the selected Marine Area Alternative (Section 7.0) and restrictive covenants are properly maintained for the lifetime of the contamination. Because of the presence of recalcitrant substances (e.g., metals) in the contaminated soil and the reliance of all four alternatives on soil disposal at an appropriate landfill, the MTCA preference for destruction of contaminants is not satisfied by any of the alternatives.

Long-Term Effectiveness

Alternatives PUA-1 achieves a higher degree of long-term effectiveness than the other three alternatives as a result of the limited amount of contaminated soil that would remain following completion of this alternative. Alternatives PUA-2 and PUA-4 achieve a slightly lower score of medium-high, relative to PUA-1 as a result of leaving in place deeper contaminated soil. Alternative PUA-3 is ranked lower than the other alternatives for long-term effectiveness because contaminated soil is left in place below 6 ft BGS in the shoreline buffer zone. While this soil does not pose a current or identified future risk to potential human or ecological receptors, the reduction of risk in the long term relies on the proposed institutional controls (restrictive covenants and soil management plans) and integration with the Marine Area remedy (see Section 7.0) to prevent future exposure to contaminants.

Management of Short-Term Risks

All alternatives involve extensive soil removal, including excavation near occupied buildings and across large areas of open park space currently used by the public. However, the degree of short-term risks associated with the alternatives varies with the level of associated soil removal, particularly along the shoreline. As a result of the extensive excavation associated with Alternative PUA-1, including deep excavations along the shoreline requiring extensive shoring and dewatering, Alternative PUA-1 has a medium-low ranking. Alternatives PUA-2 and PUA-4 both have achieve a higher score (medium) for management of short-term risks, relative to Alternative PUA-1, as a result of the reduced extent of soil removal associated with those alternatives. The short-term risks associated with Alternative PUA-3 are reduced significantly, due to the reduced depth of excavation across the shoreline, resulting in a medium-high score.

Technical and Administrative Implementability

The implementability of the four Port Upland Alternatives varies in a similar manner as the short-term risks described above. The extensive excavation associated with Alternative PUA-1, including deep excavations along the shoreline requiring extensive shoring and dewatering, result in an implementability score of medium-low. Alternatives PUA-2 and PUA-4 both have achieve a higher score (medium) for implementability, relative to Alternative PUA-1, as a result of the reduced extent and difficulty of the soil removal associated with those alternatives. Alternative PUA-3 has significantly reduced extent and technical difficulty of the removal activities and therefore has a medium-high score for implementability.

Remedy Costs

The cost estimates for the four Port Uplands Area alternatives are presented in Tables B-1, B-2, B-3, and B-4 in Appendix B. Alternative PUA-1 has an estimated cost of approximately $18.3 million. The estimated cost for Alternative PUA-2 is approximately $11.5 million. The estimated cost for Alternative PUA-3 is approximately $4.8 million. The estimated cost for Alternative PUA-4 is approximately $9.1 million. The estimated mass of contaminated soil that would be removed as a result of each of the proposed alternatives is 85,000 tons (PUA-1), 50,000 tons (PUA-2), 24,000 tons (PUA-3), and 37,600 tons (PUA-4). This results in the following cost per ton values for the three Port Uplands Area alternatives; $215/ton for alternative PUA-1, $230/ton for alternative PUA-2, $200/ton for alternative PUA-3, and $240/ton for alternative PUA-4.

6.1.5.3 Reasonable Restoration Time Frame

The restoration time frame for the three Port Uplands Area alternatives is expected to be relatively short, on the order of two to three years. The predicted restoration time frame includes project design, permitting, contracting, construction, and site closure activities. Management of institutional controls in the form of restrictive covenants would be required for the impacted soil left in place under Alternatives PUA-2, PUA-3, and PUA-4. Long-term environmental monitoring may be necessary to ensure compliance with the covenants. These requirements could extend the duration of Alternatives PUA-2, PUA-3, and PUA-4.

6.1.5.4 Consideration of Public Concerns

The four Port Upland Alternatives are expected to all have a medium to high level of public acceptance. This criteria will be evaluated further following receipt of public comments on this Feasibility Study.

6.1.6 Preferred Port Uplands Area Alternative

Based on the comparative analysis presented in Section 6.1.5, the preferred cleanup action alternative for the Port Uplands Area is Alternative PUA-3. This alternative reduces immediate risk to potential human and ecological receptors through:

1. Removal of contaminated soils in the vicinity of MW-110 that pose a risk of groundwater contamination; and
2. Removal of soil between 0 and 6 ft BGS posing the greatest risk to human health and ecological receptors, while utilizing institutional controls to prevent exposure to remaining contaminated soil left in place.

Alternative PUA-3 provides long-term protection of Fidalgo Bay and Cap Sante Waterway by relying on the Marine Area remedy (discussed in Section 7.0) to prevent erosion of contaminated soil left in place adjacent to the shoreline. Potential erosional sources of localized to sediment contamination deposits identified in Port upland shoreline areas (see Figure 12) would also be removed under this alternative (in addition to shoreline erosion controls), thus providing additional protection from recontamination of the Marine Area sediments.

As summarized in Table 8, Alternatives PUA-1, PUA-2, and PUA-4 are ranked higher than Alternative PUA-3 for some of the environmental benefits ranking factors. However, the estimated costs of Alternatives PUA-1, PUA-2, and PUA-3, at $18.3 million, $11.5 million, and $9,1 million respectively, are substantial and disproportionately higher than the estimated cost of Alternative PUA-3 ($4.8 million) relative to the incremental environmental benefit of each alternative. Consequently, Alternative PUA-3 is preferred over the other alternatives.

6.2 MJB North Area

The MJB North Area consists of approximately 18.5 acres of primarily gravel surfaced, partially developed land between 17th and 0 th22nd Streets, and between R Avenue and Fidalgo Bay. Metals and cPAHs are the predominant contaminants that exceed the proposed cleanup levels protective of human health and terrestrial ecological receptors. Contaminants are generally found at shallow depths (0 to 2 ft BGS) distributed over much of the site and were also observed in deeper areas (up to 15 ft BGS) along the shoreline. Four cleanup action alternatives were developed using retained technologies to address contamination at the MJB North Area and are described in the following sections. These alternatives are summarized on Table 9. These alternatives have been designed to address areas with only shallow soil contamination (defined as up to 2 ft BGS) and areas with deep soil contamination (defined as greater than

2 ft BGS). As noted previously, no cleanup actions are needed to address groundwater contamination, as RI site characterization data demonstrate that groundwater has not been contaminated by Site releases.

Similar to the Port Uplands Area, the MJB North Area has been divided into two areas for development of cleanup action alternatives. These areas are defined as follows:

- **Shoreline Buffer Zone:** The shoreline buffer zone is defined in this FS as the uplands area within 75 to 100 ft of the MHHW line.
- **Remaining Uplands Area:** The portions of the MJB North Area outside the shoreline buffer zone are designated as the remaining uplands area.

The intent of the shoreline buffer zone is to ensure that the cleanup action alternatives prevent recontamination of marine sediments, and that the cleanup supports habitat development along the shoreline. This section of the FS describes the cleanup action alternatives developed for the MJB North Area.

6.2.1 MJB North Area Alternative MJB-1

Cleanup action Alternative MJB-1 for the MJB North Area provides for the maximum removal of contaminated soils exceeding the proposed cleanup levels presented in this FS. Alternative MJB-1 consists of the following elements:

- Remove soil with contaminant concentrations that exceed either the proposed human health or terrestrial ecological-based cleanup levels in the shoreline buffer zone (estimated maximum depth of 15 ft BGS). This would also result in removal of identified erosional sources of localized contaminated sediment deposits (see Figure 12);
- Remove soil with contaminant concentrations that exceed either the proposed human health or terrestrial ecological-based cleanup levels in the remaining uplands area (estimated maximum depth of 11 ft BGS);
- Characterize and dispose of excavated soil in accordance with applicable regulations;
- Perform confirmation sampling; and
- Backfill excavations with clean fill.

This cleanup action alternative would result in removal and off-site disposal of contaminated soil within the MJB North Area that exceeds proposed cleanup levels discussed in this FS. The majority of upland soils exceeding SQS chemical criteria for Site constituents would also be removed under this alternative. The alternative relies on long-term containment of excavated soil within an off-site, engineered landfill to prevent long-term exposure to soil contaminants. This alternative does not destroy the contaminants and it does not reduce the toxicity of Site soil encapsulated in the off-site landfill.

In addition to engineering and reporting, as specified in the MTCA regulations, several tasks would be completed prior to field construction, including permitting, a utility locate, demolition of the concrete rails on the east side of the property (Figure 22), and abandonment of the existing monitoring wells (MW-1 through MW-7); under this alternative, no groundwater monitoring would be conducted at the MJB North Area after completing the cleanup, as contaminated soil would be removed.

6.2.1.1 Permitting

The cleanup action within the MJB North Area would be performed pursuant to MTCA under the terms of a Consent Decree between Ecology and the implementing party(ies). All actions performed under the Consent Decree meet the permit exemption provisions of MTCA, obviating the need to follow procedural requirements of the various local and state regulations that would otherwise apply to this action. However, the substantive requirements of the applicable regulations must be met. Ecology will be responsible for issuing the final approval for this project, following consultation with other state and local regulators. The substantive state and local permit requirements that would need to be addressed to complete Alternative MJB-1 work as outlined below include provisions related to construction stormwater, shoreline substantial development, grade and fill, and completion of a SEPA Checklist.

The cleanup action alternatives for the MJB North Area do not contemplate work below MHHW, and thus the uplands work would not require Corps permits. The shoreline of the MJB North Area below MHHW will be addressed as part of the Marine Area remedy. Permit requirements for the Marine Area alternatives are discussed in Section 7.0.

6.2.1.2 Shallow Soil

Shallow impacted soil refers to the upper 2 ft of soil that has been impacted by elevated concentrations of Site constituents. For the MJB North Area, arsenic, copper, and zinc have been found in several locations distributed over the property (see Figure 7). In addition, single occurrences of chromium, nickel, and cPAHs were found in one sample (SB-04), and lead in another sample (PP-25). Elevated concentrations of arsenic, copper and zinc are present in a thin surface layer of locally-obtained quarry rock that was used as a top dressing so heavy trucks could easily drive around the property. Elevated concentrations of arsenic, copper, zinc, and probably chromium, appear consistent with the natural background composition of rock of this type and are not thought to be an introduced contaminant release from any operations on site. While Figure 7 depicts contamination in several discrete areas, as suggested by Ecology, it is possible that soil exceedances are more extensive given the association with the locally obtained quarry rock. For this reason, the potential extent of contaminated soil may extend beyond the areas identified for excavation, as shown by the larger potential remediation area in Figure 22. Ecology suggested that the discrete areas determine the likely extent of excavation, and these areas were used for estimating costs for this alternative.

Shoreline Buffer Zone

Under Alternative MJB-1, shallow soil within the shoreline buffer zone that exceeds proposed cleanup levels protective of human health and ecological receptors would be excavated using conventional equipment and disposed of at an appropriate disposal facility. This includes shallow soil contaminated with arsenic, chromium (one location), copper, lead (one location), nickel (one location), zinc, and cPAHs (one location). The Alternative MJB-1 excavation would also concurrently remove the majority of soil within the shoreline buffer zone that has been identified as a potential erosional source of localized contaminated sediment deposits (see Figure 12). It is anticipated that Alternative MJB-1 would remove approximately 2,400 cubic yards of contaminated shallow soil from the shoreline buffer zone, which would be stockpiled for characterization. Stockpiled soil would be tested to determine if it exhibits dangerous waste characteristics; non-dangerous waste soils would be segregated from dangerous waste soils for disposal. After characterization, both non-dangerous and dangerous waste soils would be hauled off site for treatment and/or disposal in a permitted landfill. Once excavation is complete, confirmation samples would be collected from the sidewalls and bottoms of the excavations as described in Section 6.2.1.4.

Remaining Uplands Area

Shallow soil west of the shoreline buffer zone that exceeds the proposed cleanup levels protective of human health and terrestrial ecological receptors would be excavated using conventional equipment and disposed of at an appropriate disposal facility. It is anticipated that approximately 5,800 cubic yards of shallow soil contaminated with arsenic, copper, nickel, and zinc would be hauled off site for disposal. Once excavation is complete, confirmation samples would be collected from the sidewalls and bottoms of the excavations as described in Section 6.2.1.4.

6.2.1.3 Deep Soil

Deeper contamination is present in nine defined areas on the MJB North Area property, as shown in Figures 8 and 9. There are four areas generally within the shoreline buffer zone that extend from sample location PP35 in the north to about halfway between sample locations PP27 and TP-07 in the south. Three smaller areas of deep contamination are located in the southeast portion of the property, located within the shoreline buffer zone and extending to the west; these areas are centered on sample locations SB-11, TP-01, and MW-5. Another relatively small area is centered on SB-07 (north central portion of property), but does not include the other surrounding sample locations where deep soil results were below proposed cleanup levels. The last location is within the remaining uplands area, centered on sample location TP-08. The estimated maximum depth of contamination in the areas within the shoreline buffer zone is 15 ft BGS; contamination within the remaining uplands area, west of the shoreline buffer zone, is estimated to extend to a maximum depth of 11 ft BGS.

Shoreline Buffer Zone

Under Alternative MJB-1, deep soil (deeper than 2 ft BGS) within the shoreline buffer zone that exceeds the final cleanup levels protective of human health and ecological receptors would be excavated to an estimated depth of 15 ft BGS using conventional equipment and disposed of at an appropriate disposal facility. Similar to the shallow soil discussed above, the Alternative MJB-1 excavation would remove the majority of soil within the shoreline buffer zone that has been identified as a potential erosional source of localized contaminated sediment deposits (see Figure 12). No temporary shoring is likely to be necessary for these excavations; sidewalls would be sloped or benched as needed. Clean soil would be segregated for reuse where practicable. Groundwater monitoring during the RI indicated that the depth to groundwater varies from 6.5 to 10 ft BGS and is tidally influenced locally along the shoreline. Accordingly, excavation would proceed during low tide as practicable.

It is estimated that approximately 12,500 cubic yards of deep soil contaminated with metals (antimony, arsenic, copper, lead, thallium, zinc) and cPAHs would be excavated under Alternative MJB-1 from the shoreline buffer zone and disposed of off site, including 1,900 cubic yards of soil that may need to be managed as dangerous waste due to the concentration of TCLP (leachable) lead. Once excavation is complete, sidewall and bottom samples would be collected as described in Section 6.2.1.4. Suspected dangerous waste soil based on sample locations with elevated TCLP lead would be stockpiled separately and characterized prior to disposal. Soils classified as dangerous waste must be stabilized to comply with land disposal restrictions prior to landfill disposal. The remedial design would consider both on-site and off-site stabilization to provide cost-effective waste management if this alternative is selected for implementation. For estimating the cost of this cleanup action alternative, it has been assumed that dangerous waste soil would be treated and disposed at an off-site facility permitted to accept RCRA wastes.

Remaining Uplands Area

Deep soil (deeper than 2 ft BGS) within the remaining uplands area that exceeds the final cleanup levels protective of human health and terrestrial ecological receptors would be excavated under Alternative MJB-1 to a maximum estimated depth of 11 ft BGS (the approximate depth of the native silt/clay layer) using conventional equipment and disposed of at an appropriate disposal facility. The excavations on the east and west side of the western boundary of the shoreline buffer zone would be completed as a continuous excavation. As stated above, sidewalls would be sloped or benched as needed and clean soil segregated for reuse where practicable.

It is estimated that approximately 1,900 cubic yards of contaminated deep soil would be excavated under Alternative MJB-1 and disposed of off site, including 200 cubic yards of soil that may need to be managed as dangerous waste due to the concentration of TCLP (leachable) lead. Suspected dangerous waste would be stockpiled separately and tested prior to disposal. Dangerous waste soil would be managed as described above for the shoreline buffer zone.

6.2.1.4 Confirmation Sampling

Shallow Excavations

Once the shallow excavations are complete, sidewall and bottom confirmation samples would be collected and analyzed for arsenic, copper, nickel, and/or zinc by EPA Method 6010B as appropriate for the area being excavated. Samples would be collected at a frequency of one sample per 300 square ft of bottom area and one sample per 100 linear ft of sidewall. If the sidewall and bottom confirmation samples are below the final cleanup levels, no further excavation would be completed. If sidewall or shallow bottom confirmation sample analytical results exceed the final cleanup levels (in accordance with MTCA compliance monitoring statistical provisions), additional excavation would be conducted. Following each additional excavation, one confirmation sample would be collected from the extended excavation to confirm attainment of the proposed cleanup levels. This process would be repeated until the final cleanup levels have been attained in the sidewalls and shallow excavation bottoms. Once both deep and shallow excavations are complete, the excavations would be backfilled with clean soil and bucket-compacted in 1-ft lifts. Backfill meeting proposed soil cleanup levels and SQS chemical criteria for Site constituents would be used for backfilling excavations in the shoreline buffer zone.

Deep Excavations

Once the deep excavations are complete, sidewall and bottom confirmation samples would be collected. Samples would be collected at a frequency of one sample per 300 square ft of bottom area and one sample per 100 linear ft of sidewall. Samples from the deep excavations would be analyzed for total antimony, arsenic, chromium, copper, lead, nickel, thallium, and zinc by EPA Method 6010B and cPAHs by EPA Method 8270 as appropriate for the area being excavated. If the sidewall and bottom confirmation samples are below the final cleanup levels, no further excavation would be completed. If confirmation samples exceed the final cleanup levels (in accordance with MTCA compliance monitoring statistical provisions), additional excavation would be conducted. Following each additional excavation, one confirmation sample would be collected from the extended excavation to confirm attainment of the final cleanup levels. This process would be repeated until the final cleanup levels have been attained. The deep excavations would then be backfilled with clean soil and bucket-compacted in 1-ft lifts. Backfill meeting final soil cleanup levels for Site constituents would be used for backfilling excavations in the shoreline buffer zone.

Potential dangerous waste that has been segregated would be sampled for additional waste characterization. One five-point composite sample would be collected for each 500 cubic yards of suspected hazardous waste and analyzed for TCLP lead by EPA Methods 1311 and 6010B. Soil represented by samples with dissolved lead concentrations greater than or equal to 5 milligrams per liter (mg/L) in the TCLP extract would be disposed of as dangerous waste. Soil with dissolved lead concentrations less than 5 mg/L in the TCLP extract would be handled with the other non-dangerous waste.

Prior to demobilization, a survey of the excavations, sample locations, and site features would be conducted, and the disturbed areas would be hydroseeded for erosion control and stormwater management until future site development is completed. As part of the anticipated MJB North Area development, riparian planting and a pedestrian walkway would be placed along the shoreline, the final grade of the uplands property would be raised a minimum of 2 ft, and the property would be covered with a combination of pavement, buildings, controlled landscaping, and riparian planting. Soils meeting final cleanup levels would be used for establishing the final grade within the shoreline buffer zone.

6.2.1.5 Institutional Controls

No institutional controls would be implemented for this alternative, as contaminated soil would be removed for off-site disposal.

6.2.2 MJB North Area Alternative MJB-2

Alternative MJB-2 addresses both upland portions of the MJB North Area, as defined above. This cleanup action alternative removes contaminated soil as practicable within the shoreline buffer zone, including nearshore soils identified as a potential erosional source of localized contaminated sediment deposits (see Figure 12). Deeper soil within the shoreline buffer zone would be covered by clean fill. Soil within the upper 6 ft exceeding human health-based cleanup levels within the remaining uplands area would also be excavated for off-site disposal. Remaining soil exceeding terrestrial ecological-based cleanup levels would be homogenized with clean soil, resulting in the permanent reduction of contaminant concentrations to below cleanup levels. Alternative MJB-2 consists of the following elements:

- Remove soil with contaminant concentrations that exceed final human health and terrestrial ecological-based cleanup levels to a depth of 6 ft BGS in the shoreline buffer zone. This would also result in removal of identified erosional sources of localized contaminated sediment deposits (see Figure 12);
- Remove shallow soil (0 to 2 ft BGS) with contaminant concentrations that exceed human-health based cleanup levels in the remaining uplands area;
- Complete a terrestrial ecological evaluation, which may include bioassay and/or bioaccumulation analyses, on shallow soil in the remaining uplands area with contaminant concentrations that exceed the terrestrial ecological-based cleanup levels, to define the areal extent of soil posing a potential risk to terrestrial biota;

- Homogenize soils as necessary that fail the terrestrial ecological evaluation and/or bioassay criteria to permanently reduce contaminant concentrations to below the terrestrial ecological-based cleanup levels;
- Characterize and dispose of excavated soil in accordance with applicable regulations;
- Perform confirmation sampling;
- Backfill excavations with clean fill; and
- Implement institutional controls.

The estimated maximum depth of contamination is 15 ft BGS along the shoreline. Because excavation for Alternative MJB-2 would not extend below 6 ft BGS, localized deeper soil contamination would remain in place. This depth was selected as one that would limit worker restrictions, limit the potential for exposure to terrestrial biota, and protect the Marine Area from future upland contaminated soil erosion (see Marine Area alternatives discussion in Section 7.0). Furthermore, RI site characterization data demonstrated that groundwater at the shoreline wells complies with the proposed groundwater cleanup levels, indicating that leaching of soil contaminants to groundwater is not an exposure pathway of concern. Therefore, the soils left in place would not be a source of mobile contamination that would affect marine surface water or sediments. Contaminated soils that would remain within the shoreline buffer zone are below the MHHW elevation and would be separately addressed by the Marine Area remedy, thereby providing protection of the marine area (see Section 7.0). The identified erosional source of localized contaminated sediment deposits (see Figure 12) would also be removed under this alternative.

Prior to implementation, substantive permitting requirements would be addressed as described in Section 6.2.1.1, a utility locate would be conducted, the concrete rails on the east side of the property (Figure 23) would be demolished, and the existing monitoring wells (MW-1 through MW-7) would be abandoned except where they can be protected during cleanup and redevelopment activities. Replacement wells would be installed as appropriate to provide four wells for post-construction monitoring. It has been assumed that four post-construction monitoring events would be sufficient to confirm that groundwater at the MJB North Area has not been affected by Site contaminants.

6.2.2.1 Permitting

The permitting requirements for Alternative MJB-2 are the same as described above for Alternative MJB-1.

6.2.2.2 Shallow Soil

For the MJB North Area, shallow contaminated soil is generally limited to the upper 2 ft of soil that has been impacted by elevated concentrations of arsenic, copper, and zinc. In addition, single occurrences of chromium, nickel, and cPAHs were found in one nearshore sample (SB-04), and lead in another sample (PP-25) collected near the western boundary of the shoreline buffer zone. The locations of several discrete areas likely to require remediation are shown in Figure 23. Elevated concentrations of arsenic, copper and zinc are present in a thin surface layer of locally-derived quarry rock. Shallow soil contamination is present in relatively large areas of the northern half of the MJB North Area and in isolated areas of the southern portion of the property. While Figure 23 shows contamination in several discrete areas, as suggested by Ecology, it is possible that contamination is more extensive, particularly if associated with the locally obtained quarry rock. For this reason, the potential extent of contaminated soil may extend beyond the areas identified for remediation, as shown by the larger potential remediation area in Figure 23. The discrete areas were used for estimating the cost for this alternative.

Shoreline Buffer Zone

Under Alternative MJB-2, shallow soil within the shoreline buffer zone that exceeds final cleanup levels protective of human health and ecological receptors would be excavated using conventional equipment and disposed of at an appropriate disposal facility. This includes shallow soil impacted with CPAHs (one location), arsenic, chromium (one location), copper, lead (one location), nickel (one location), and zinc. Excavation for Alternative MJB-2 would concurrently remove the majority of soils within the shoreline buffer zone that have been identified as potential erosional sources of localized contaminated sediment deposits (see Figure 12). It is anticipated that approximately 2,400 cubic yards of contaminated shallow soil would be hauled off site from the shoreline buffer zone. Once excavation is complete, confirmation samples would be collected from the sidewalls and bottoms of the excavations as described in Section 6.2.2.4. Excavated soil would be characterized for disposal in accordance with applicable regulations.

Remaining Uplands Area

Under Alternative MJB-2, shallow soil west of the shoreline buffer zone that exceeds the final cleanup levels protective of human health would be excavated using conventional equipment, characterized for disposal, and disposed of at an appropriate, permitted disposal facility. The only contaminant exceeding proposed human health cleanup levels in this area is arsenic. It is estimated that approximately 3,500 cubic yards of contaminated shallow soil would be hauled off site for disposal under this alternative. Once excavation is complete, confirmation samples would be collected from the sidewalls and bottoms of the excavations as described in Section 6.2.2.4.

Soil with copper, nickel, and/or zinc concentrations above the cleanup levels protective of terrestrial ecological receptors would be assessed using a terrestrial ecological risk evaluation, which may include testing using a soil bioassay and/or bioaccumulation analyses, in advance of excavation (likely during remedial design). Results from the terrestrial ecological evaluation and/or bioassay testing would be used to delineate soil that may pose a risk to terrestrial ecological receptors. Soil that fails the terrestrial ecological evaluation and/or bioassay criteria would be mixed with the underlying soil so as to homogenize the metals and reduce soil concentrations within the designated mixing areas to below the proposed terrestrial ecological-based cleanup levels. In some areas, remedial design evaluations may determine that it would not be practicable to homogenize shallow surface soil due to factors such as relatively high concentrations and/or depth of contaminants. The contaminated soil in areas not practicable for homogenization would be excavated for off-site disposal, rather than homogenized. Based on initial evaluations of the RI soil data, an estimated 600 cubic yards of contaminated soil containing elevated metal concentrations (copper and/or zinc) that cannot be practicably homogenized is likely to be excavated for off-site disposal under Alternative MJB-2. Remediation by homogenization would permanently eliminate ecological risks associated with soil contamination by reducing concentrations to levels below the final cleanup levels. Conservatively assuming that none of the soil passes the bioassay criteria, approximately 4,500 cubic yards of soil would be homogenized under Alternative MJB-2.

Soil homogenization would be accomplished using conventional earth handling equipment. Contaminated soils would be mixed with clean soils located above the contaminated soil or below the contaminated soil, or imported from a clean source outside the Site. Soil analytical data would be used to determine the appropriate mixing ratio. It is anticipated that soil homogenization may extend to a maximum depth of 6 ft BGS. As an alternative to excavating clean soil for homogenization, imported clean soil may be mixed into contaminated soil at a ratio designed to achieve the final cleanup levels. Imported clean fill may be used if it is intended to increase the site elevation for development. For purposes of estimating cleanup costs, it has been assumed that contaminated soils are homogenized with clean site soils. Once homogenized, soil confirmation samples would be collected to confirm attainment of the homogenization objective. After homogenization has been completed, disturbed areas would be compacted and graded to support the planned site use. For purposes of estimating cleanup costs, it has been assumed that the disturbed areas would be hydroseeded to control stormwater runoff.

6.2.2.3 Deep Soil

Deeper contamination is present in nine defined areas on the MJB North Area property, as shown in Figures 8 and 9. There are four areas generally within the shoreline buffer zone that extend from sample location PP35 in the north to about halfway between sample locations PP27 and TP-07 in the south. Three smaller areas of deep contamination are located in the southeast portion of the property, located within the shoreline buffer zone and extending to the west; these areas are centered on sample locations SB-11, TP-01, and MW-5. Another very small area is centered on SB-07 (north central portion of property), but does not include the other surrounding sample locations where deep soil results were below proposed cleanup levels. The last location is within the remaining uplands area, centered on sample location TP-08. The estimated maximum depth of contamination in the areas within the shoreline buffer zone is 15 ft BGS; contamination within the remaining uplands area, west of the shoreline buffer zone, is estimated to extend to a maximum depth of 11 ft BGS.

Shoreline Buffer Zone

Under Alternative MJB-2, deep soil (deeper than 2 ft BGS) within the shoreline buffer zone that exceeds the final cleanup levels protective of human health and ecological receptors would be excavated to a maximum depth of 6 ft BGS, characterized as appropriate for disposal, and transported to a permitted disposal facility in accordance with applicable regulations. This depth was selected to limit restrictions for future landscaping and utility workers that may handle MJB North Area soils. No temporary shoring would be necessary for these excavations; sidewalls would be sloped or benched as needed. Excavation for Alternative MJB-2 would remove the majority of soils within the shoreline buffer zone that have been identified as a potential erosional source of localized contaminated sediment deposits (see Figure 12). Clean soil excavated to provide access to contaminated soil would be segregated for reuse, as practicable. Groundwater monitoring during the RI indicated that the depth to groundwater varies from 6.5 to 10 ft BGS and is tidally influenced locally along the shoreline. Accordingly, dewatering is not anticipated to be necessary for this alternative, but excavation would likely proceed during low tide as practicable.

It is estimated that approximately 4,200 cubic yards of deep soil contaminated with arsenic, lead, and cPAHs would be excavated from the shoreline buffer zone under Alternative MJB-2 and disposed of off site, including 700 cubic yards of soil that may need to be managed as dangerous waste due to the concentration of TCLP (leachable) lead. Once excavation is complete, sidewall and bottom confirmation samples would be collected as described in Section 6.2.2.4. Suspected dangerous waste would be stockpiled separately and characterized in accordance with the dangerous waste regulations (WAC 173-303) prior to disposal. Soils classified as dangerous waste must be stabilized to comply with land disposal restrictions prior to landfill disposal. The remedial design would consider both on-site and off-site stabilization to provide cost-effective waste management if this alternative is selected for implementation. For estimating the cost of this cleanup action alternative, it has been assumed that dangerous waste soil would be treated and disposed at an off-site facility permitted to accept RCRA wastes.

Remaining Uplands Area
Deep soil (deeper than 2 ft BGS) within the remaining uplands area that exceeds the final cleanup levels protective of human health would be excavated to a maximum estimated depth of 6 ft BGS using conventional equipment. It is estimated that approximately 940 cubic yards of contaminated deep soil (deeper than 2 ft BGS) would be excavated from the remaining uplands area and disposed of off site, including 140 cubic yards of soil that may need to be managed as dangerous waste due to the concentration of TCLP (leachable) lead. Suspected dangerous waste soil would be stockpiled separately, characterized, and managed as described above for the shoreline buffer zone. If deemed appropriate, the dangerous waste soil may be stabilized prior to disposal. For cost estimation purposes, it has been assumed that dangerous waste soil would be stabilized at the permitted disposal facility prior to disposal in a Subtitle C landfill.

6.2.2.4 Confirmation Sampling

Shallow Soil Remediation
Once the shallow excavations are complete, sidewall and bottom confirmation samples would be collected and analyzed for arsenic by EPA Method 6010B. Sidewall and bottom samples collected from areas excavated for homogenization would be analyzed for copper, nickel, and/or zinc by EPA Method 6010B as appropriate for the area being excavated. Samples would be collected at a frequency of one sample per 300 square ft of bottom area and one sample per 100 linear ft of sidewall. If the sidewall and bottom confirmation samples are below the final cleanup levels, no further excavation would be completed. If sidewall or shallow bottom confirmation sample analytical results exceed the final cleanup levels (in accordance with MTCA compliance monitoring statistical provisions), additional excavation would be conducted. Following each additional excavation, one confirmation sample would be collected from the extended excavation to confirm attainment of the final cleanup levels. This process would be repeated until the final cleanup levels have been attained in the sidewalls and shallow excavation bottoms. Once homogenization and deep excavation is complete, the shallow excavations would be backfilled with clean soil and bucket-compacted in 1-ft lifts. Backfill meeting SQS chemical criteria for Site constituents would be used for backfilling excavations in the shoreline buffer zone.

Once the shallow soil homogenization is complete, composite samples would be collected from the shallow soil stockpiles to determine if the soil has attained the final cleanup levels. One five-point composite soil sample would be collected for every 1,000 cubic yards of mixed soil and analyzed for copper, nickel, and/or zinc by EPA Method 6010B. If the results from a composite sample analysis exceed the final cleanup levels, the soil would be mixed again and re-sampled. Once the composite sample analytical results are below the final cleanup levels, mixing would be considered complete and the disturbed areas compacted and restored as appropriate for future use of the property.

Deep Excavations
Once the deep excavations are complete, sidewall and bottom confirmation samples would be collected. Samples would be collected at a frequency of one sample per 300 square ft of bottom area and one sample per 100 linear ft of sidewall. Samples from the deep excavations would be analyzed for antimony, arsenic, chromium, copper, lead, nickel, thallium, and zinc by EPA Method 6010B and cPAHs by EPA Method 8270 as appropriate for the area being excavated. If the sidewall confirmation samples are below

the final cleanup levels, no further excavation would be completed. Because the excavations would not be completed deeper than 6 ft BGS, some localized impacted soil may remain in place in the deep excavations. Therefore, bottom samples from deep excavations would only be used to determine the contaminant concentrations of the soil left in place. If sidewall confirmation sample analytical results exceed the final cleanup levels (in accordance with MTCA compliance monitoring statistical provisions), additional excavation would be conducted. Following each additional excavation, one confirmation sample would be collected from the extended excavation to confirm attainment of the final cleanup levels. This process would be repeated until the final cleanup levels have been attained in the sidewalls. A geotextile fabric would be laid across the bottom of the deep excavations to demarcate the extent of the excavation and the presence of potentially contaminated soil to future site workers. The deep excavations would then be backfilled with clean soil and bucket-compacted in 1-ft lifts. Backfill meeting SQS chemical criteria for Site constituents would be used for backfilling excavations in the shoreline buffer zone.

Potential dangerous waste that has been segregated would be sampled for additional waste characterization. One five-point composite sample would be collected for each 500 cubic yards of soil and analyzed for TCLP lead by EPA Methods 1311 and 6010B. Soil represented by samples with lead concentrations greater than or equal to 5 mg/L in the TCLP extract would be disposed of as dangerous waste. Soil with dissolved lead concentrations less than 5 mg/L in the TCLP extract would be disposed of as contaminated soil in accordance with applicable regulations.

Prior to demobilization, a survey of the excavations, sample locations, and site features would be conducted, and the disturbed areas would be hydroseeded for erosion control and stormwater management until future site development is completed. If the existing monitoring wells cannot be protected, replacement wells would be installed to ensure that four groundwater monitoring wells are available for future groundwater monitoring (Figure 23). It has been assumed that four post-construction monitoring events would be sufficient to confirm that groundwater at the MJB North Area has not been affected by Site contaminants. As part of the anticipated MJB North Area development, riparian planting and a pedestrian walkway would be placed along the shoreline.

6.2.2.5 Institutional Controls

The following institutional controls are included in Alternative MJB-2 to reduce the risk of human exposure to impacted soil left in place below 6 ft BGS:

- Engineering controls, protocols, and monitoring to ensure that temporary construction workers adhere to WAC 296-62-300, applicable Washington Labor and Industry standards, and Occupational Safety and Health Administration (OSHA) Hazardous Waste Operation and Emergency Response (HAZWOPER) regulations (29 CFR 1919.120) for construction work conducted in exposed areas of impacted soil;
- Notice in the property deed identifying the location and nature of soil contamination remaining at the MJB North Area; and
- Deed restrictions to limit development and use of the MJB North Area.

It is anticipated that these institutional controls would be adequate to protect human health and the environment from potential risks related to contaminated soil remaining at the MJB North Area.

6.2.3 MJB North Area Alternative MJB-3

Cleanup action Alternative MJB-3 is similar in many respects to Alternative MJB-2. Both alternatives would remove contaminated soil exceeding proposed human health-based cleanup levels to a depth of 6 ft BGS in both the shoreline buffer zone and the remaining uplands area. For this alternative, contaminated soil exceeding only terrestrial ecological-based cleanup levels would be isolated from terrestrial biota by placing a surface cover over impacted soil. Surface cover would consist of asphalt pavement; such a cover would effectively prevent exposure to impacted soil. Alternative MJB-3 consists of the following elements:

- Remove soil with contaminant concentrations that exceed human health and terrestrial ecological-based cleanup levels to a depth of 6 ft BGS in the shoreline buffer zone. This would also result in removal of most upland soils that have been identified as a potential erosional source of localized contaminated sediment deposits (see Figure 12);
- Remove shallow soil (0 to 2 ft BGS) with contaminant concentrations that exceed human-health based cleanup levels in the remaining uplands area;
- Complete a terrestrial ecological evaluation, which may include bioassay analyses, on shallow soil in the remaining uplands area with contaminant concentrations that exceed the terrestrial ecological-based cleanup levels, and place an asphalt cover over soil that fails the terrestrial ecological evaluation and/or bioassay;
- Characterize and dispose of excavated soil in accordance with applicable regulations;
- Perform confirmation sampling;
- Backfill excavations with clean fill; and
- Implement institutional controls.

The estimated maximum depth of contamination is 15 ft BGS along the shoreline. Because excavation for Alternative MJB-3 would not extend below 6 ft BGS, some soil contamination would remain in place. This depth was selected as one that would substantially limit potential for site construction and maintenance worker exposure, limit the potential for exposure to terrestrial biota, and protect the Marine Area from erosion of upland contaminated soil. As with the other alternatives, upland soils identified as potential erosional sources of localized contaminated sediment deposits (see Figure 12) would be removed under Alternative MJB-3. Furthermore, the RI site characterization revealed that groundwater at the shoreline wells complies with the proposed groundwater cleanup levels, demonstrating that leaching of soil contaminants to groundwater is not an exposure pathway of concern. Therefore, the soil left in place would not be a source of mobile contamination that would affect marine surface water or sediments. In addition, the current plan for future site development includes raising the final grade of the property a minimum of 2 ft and covering the property with a combination of pavement, buildings, controlled landscaping, and riparian planting.

Prior to implementation, permitting would be completed, a utility locate would be conducted, the concrete rails on the east side of the site (Figure 24) would be demolished, and the existing monitoring wells (MW-1 through MW-7) would be abandoned if they cannot be adequately protected during cleanup and redevelopment activities. Replacement wells would be installed as appropriate to provide four wells for post-construction monitoring. It has been assumed that four post-construction monitoring events would be sufficient to confirm that groundwater at the MJB North Area has not been affected by Site contaminants.

6.2.3.1 Permitting

The permitting requirements for Alternative MJB-3 are the same as described above for Alternative MJB-1.

6.2.3.2 Shallow Soil

For the MJB North Area, shallow contaminated soil is generally limited to the upper 2 ft of soil that has been impacted by elevated concentrations of arsenic, copper, and zinc. In addition, single occurrences of chromium, nickel, and cPAHs were found in one nearshore sample (SB-04), and lead in another sample (PP-25) collected near the western boundary of the shoreline buffer zone. The locations of several discrete areas likely to require remediation are shown in Figure 24. Elevated concentrations of arsenic, copper and zinc are present in a thin surface layer of locally-derived quarry rock. Shallow soil contamination is present in relatively large areas of the northern half of the MJB North Area and in isolated areas of the southern portion of the property. While Figure 24 shows contamination in several discrete areas, as suggested by Ecology, it is possible that contamination is more extensive, particularly if associated with the locally obtained quarry rock. For this reason, the potential extent of contaminated soil may extend beyond the areas identified for remediation, as shown by the larger potential remediation area in Figure 24. The discrete areas were used for estimating the cost for this alternative.

Shoreline Buffer Zone

Under Alternative MJB-3, shallow soil within the shoreline buffer zone that exceeds final cleanup levels protective of human health and ecological receptors would be excavated, characterized, and disposed of at a permitted disposal facility. This includes shallow soil contaminated with cPAHs (one location), arsenic, chromium (one location), copper, lead (one location), nickel (one location), and zinc. Excavation under Alternative MJB-3 would remove the majority of soils within the shoreline buffer zone that have been identified as a potential erosional source of localized contaminated sediment deposits (see Figure 12). It is anticipated that approximately 2,400 cubic yards of contaminated shallow soil would be hauled off site from the shoreline buffer zone. Once excavation is complete, confirmation samples would be collected from the sidewalls and bottoms of the excavations as described in Section 6.2.3.4.

Remaining Uplands Area

Shallow soil west of the shoreline buffer zone that exceeds the final cleanup levels protective of human health would be excavated using conventional equipment, characterized, and disposed of at an appropriate disposal facility. It is anticipated that approximately 2,800 cubic yards of shallow soil contaminated with arsenic would be hauled off-site for disposal under this alternative. This volume is slightly lower than that excavated under Alternative MJB-2 because some soil may not be practicably mixed to attain the final cleanup levels, and would therefore be excavated for off-site disposal under Alternative MJB-2. Once excavation is complete, confirmation samples would be collected from the sidewalls and bottoms of the excavations as described in Section 6.2.3.4.

Soil with copper, nickel, and/or zinc concentrations above the final cleanup levels protective of terrestrial ecological receptors would be assessed using the terrestrial ecological risk evaluation, which may include testing using a soil bioassay and/or a bioaccumulation evaluation. The risk evaluation and bioassay testing would be completed in advance of mobilization. Soil that fails the terrestrial ecological evaluation and/or exceeds the bioassay criteria would be covered with asphalt pavement. This would prevent erosion and access by terrestrial biota. The areal extent of the pavement would extend beyond the contaminated area to prevent terrestrial biota from burrowing into the impacted soil from the perimeter of the pavement.

6.2.3.3 Deep Soil

Deeper contamination is present in nine defined areas on the MJB North Area property, as shown in Figures 8 and 9. There are four areas generally within the shoreline buffer zone that extend from sample location PP35 in the north to about halfway between sample locations PP27 and TP-07 in the south. Three smaller areas of deep contamination are located in the southeast portion of the property, located within the shoreline buffer zone and extending to the west; these areas are centered on sample locations SB-11, TP-01, and MW-5. Another relatively small area is centered on SB-07 (north central portion of property), but does not include the other surrounding sample locations where deep soil results were below final cleanup levels. The last location is within the remaining uplands area, centered on sample location TP-08. The estimated maximum depth of contamination in the areas within the shoreline buffer zone is 15 ft BGS; contamination within the remaining uplands area, west of the shoreline buffer zone, is estimated to extend to a maximum depth of 11 ft BGS.

Shoreline Buffer Zone

Under Alternative MJB-3, deep soil (deeper than 2 ft BGS) within the shoreline buffer zone that exceeds the final cleanup levels protective of human health and ecological receptors would be excavated to a maximum depth of 6 ft BGS using conventional equipment and disposed of at an appropriate disposal facility. This depth was selected to limit restrictions for future landscaping and utility workers that may handle MJB North Area soils. It is assumed that no temporary shoring would be necessary for these excavations; sidewalls would be sloped or benched as needed. Excavation for Alternative MJB-3 would remove the majority of soils within the shoreline buffer zone that have been identified as potential erosional sources of localized contaminated sediment deposits (see Figure 12). Clean soil from the excavation would be segregated for reuse where practicable. As noted in the RI report, the depth to groundwater varies from 6.5 to 10 ft BGS and is tidally influenced locally along the shoreline. Accordingly, dewatering is not anticipated to be necessary for this alternative, but excavation would likely proceed during low tide as practicable.

It is estimated that approximately 4,200 cubic yards of deep soil contaminated with metals (antimony, arsenic, copper, lead, thallium, and zinc) and cPAHs would be excavated from the shoreline buffer zone and disposed of off site, including 700 cubic yards of soil that may need to be managed as dangerous waste due to the concentration of TCLP (leachable) lead. Once excavation is complete, sidewall and bottom confirmation samples would be collected as described in Section 6.2.3.4. Suspected dangerous waste soil would be stockpiled separately and tested prior to disposal. Soils classified as dangerous waste must be stabilized to comply with land disposal restrictions prior to landfill disposal. The remedial design would consider both on-site and off-site stabilization to provide cost-effective waste management if this alternative is selected for implementation. For estimating the cost of this cleanup action alternative, it has been assumed that dangerous waste soil would be treated and disposed at an off-site facility permitted to accept RCRA wastes.

Remaining Uplands Area

Deep soil (deeper than 2 ft BGS) within the remaining uplands area that exceeds the final cleanup levels protective of human health would be excavated to a maximum estimated depth of 6 ft BGS using conventional equipment and disposed of at an appropriate disposal facility. It is estimated that approximately 940 cubic yards of contaminated deep soil (deeper than 2 ft BGS) would then be excavated from the remaining uplands area and disposed of off site, including 140 cubic yards of soil that may need to be managed as dangerous waste due to the concentration of TCLP (leachable) lead. Suspected dangerous waste soil would be stockpiled separately, characterized, and managed as described above for the shoreline buffer zone. For estimating the cost of this cleanup action alternative, it was assumed that dangerous waste soil would be treated and disposed at an off-site facility permitted to accept RCRA wastes.

6.2.3.4 Confirmation Sampling

Shallow Excavations

Once the shallow excavations are complete, sidewall and bottom confirmation samples would be collected and analyzed for arsenic, copper, nickel, and/or zinc by EPA Method 6010B, as appropriate for the area being excavated. Samples would be collected at a frequency of one sample per 300 square ft of bottom area and one sample per 100 linear ft of sidewall. If the sidewall and bottom confirmation samples are below the final cleanup levels, no further excavation would be completed. If sidewall or shallow bottom confirmation sample analytical results exceed the final cleanup levels (in accordance with MTCA compliance monitoring statistical provisions), additional excavation would be conducted. Following each additional excavation, one confirmation sample would be collected from the extended excavation to confirm attainment of the final cleanup levels. This process would be repeated until the final cleanup levels have been attained in the sidewalls and shallow excavation bottoms. Once excavation is complete the shallow excavations would be backfilled with clean soil and bucket-compacted in 1-ft lifts. Backfill meeting final cleanup levels for Site constituents would be used for backfilling excavations in the shoreline buffer zone.

Deep Excavations

Once the deep excavations are complete, sidewall and bottom confirmation samples would be collected. Samples would be collected at a frequency of one sample per 300 square ft of bottom area and one sample per 100 linear ft of sidewall. Samples from the deep excavations would be analyzed for antimony, arsenic, chromium, copper, lead, nickel, thallium, and zinc by EPA Method 6010B and cPAHs by EPA Method 8270, as appropriate for the area being excavated. If the sidewall confirmation samples are below the final cleanup levels, no further excavation would be completed. Because the excavations would not be completed deeper than 6 ft BGS, some localized impacted soil may remain in place in the deep excavations. Therefore, bottom samples from deep excavations would only be used to determine the contaminant concentrations of the soil left in place. If sidewall confirmation sample analytical results exceed the final cleanup levels (in accordance with MTCA compliance monitoring statistical provisions), additional excavation would be conducted. Following each additional excavation, one confirmation sample would be collected from the extended excavation to confirm attainment of the final cleanup levels. This process would be repeated until the final cleanup levels have been attained in the sidewalls. A geotextile fabric would be laid across the bottom of the deep excavations to demarcate the extent of the excavation and the presence of potentially contaminated soil to future site workers. The deep excavations would then be backfilled with clean soil and bucket-compacted in 1-ft lifts. Backfill meeting final cleanup levels for Site constituents would be used for backfilling excavations in the shoreline buffer zone.

Potential dangerous waste that has been segregated would be sampled for additional waste characterization. One five-point composite sample would be collected for each 500 cubic yards of soil and analyzed for TCLP lead by EPA Methods 1311 and 6010B. Soil represented by samples with lead concentrations greater than or equal to 5 mg/L in the TCLP extract would be disposed of as dangerous waste. Soil with dissolved lead concentrations less than 5 mg/L in the TCLP extract would be disposed of as contaminated soil in accordance with applicable regulations.

Prior to demobilization a survey of the excavations, sample locations, and site features would be conducted, and the disturbed areas hydroseeded for erosion control and stormwater management until future site development is completed. If the existing monitoring wells cannot be protected, replacement wells would be installed to ensure that four groundwater monitoring wells are available for future groundwater monitoring (Figure 24). It has been assumed that four post-construction monitoring events would be sufficient to confirm that groundwater at the MJB North Area has not been affected by Site contaminants. As part of the anticipated MJB North Area development, riparian planting and a pedestrian walkway would be placed along the shoreline.

6.2.3.5 Institutional Controls

The following institutional controls are included in Alternative MJB-3 to reduce the risk of human exposure to impacted soil left in place below 6 ft BGS:

- Engineering controls, protocols, and monitoring to ensure that temporary construction workers adhere to WAC 296-62-300, applicable Washington Labor and Industry standards, and OSHA HAZWOPER regulations (29 CFR 1919.120) for construction work conducted in exposed areas of impacted soil;
- Notice in the property deed identifying the location and nature of soil contamination remaining at the MJB North Area; and
- Deed restrictions to limit development and use of the MJB North Area.

It is anticipated that these institutional controls would be adequate to protect human health and the environment from potential risks related to contaminated soil remaining at the MJB North Area.

6.2.4 MJB North Area Alternative MJB-4

Alternative MJB-4 addresses both upland portions of the MJB North Area; however, at the request of Ecology, the upland portions were defined differently for Alternative MJB-4 than for the other three MJB North alternatives. These areas are redefined specifically for this alternative as follows:

- **75-Ft Shoreline Buffer Zone:** The 75-ft shoreline buffer zone is defined for Alternative MJB-4 as the uplands area within 75 ft of the MHHW line.
- **Remaining Uplands Area:** The portions of the MJB North Area outside the shoreline buffer zone are designated as the remaining uplands area.

The intent of the shoreline buffer zone remediation remains the same as with the other alternatives: to ensure that the cleanup action prevents recontamination of marine sediments, and that the cleanup supports habitat development along the shoreline. Figure 25 presents the anticipated areas and depths of soil removal in Alternative MJB-4.

This cleanup action alternative removes contaminated soil to a depth of 10 feet BGS, as practicable, within the shoreline buffer zone; this is the soil considered most likely to impact marine sediments if the shoreline erodes. Deeper soil within the shoreline buffer zone would be covered by clean fill. Soil within the upper 6 ft exceeding human health-based cleanup levels within the remaining uplands area would also be excavated for off-site disposal under this alternative. Remaining soil exceeding terrestrial ecological-based cleanup levels within the remaining uplands area would be homogenized with deeper clean soil, resulting in the permanent reduction of contaminant concentrations to below cleanup levels. Relative to Alternative MJB-2, Alternative MJB-4 provides a greater excavation depth along the shoreline (10 ft BGS for Alternative MJB-4 versus 6 ft BGS for Alternative MJB-2), with excavation limited to a narrower (75 ft) shoreline buffer zone in Alternative MJB-4. The deeper excavation in Alternative MJB-4 removes an estimated 59 percent of the total contaminated soil in the shoreline buffer zone, compared to an estimated mass reduction of 46 percent in the shoreline buffer zone for Alternative MJB-2.

Alternative MJB-4 consists of the following elements:

- Remove soil with contaminant concentrations that exceed proposed human health and terrestrial ecological-based cleanup levels to a depth of 10 ft BGS in the 75-ft shoreline buffer zone;
- Remove shallow soil (0 to 2 ft BGS) with contaminant concentrations that exceed human-health based cleanup levels in the remaining uplands area;
- Complete a terrestrial ecological evaluation, which may include bioassay analyses, on shallow soil in the remaining uplands area with contaminant concentrations that exceed the terrestrial ecological-based cleanup levels, to define the areal extent of soil posing a potential risk to terrestrial biota;
- Homogenize soils as necessary that fail the terrestrial ecological evaluation and/or bioassay criteria to permanently reduce contaminant concentrations to below the terrestrial ecological-based cleanup levels;
- Characterize and dispose of excavated soil in accordance with applicable regulations;
- Perform confirmation sampling;
- Backfill excavations with clean fill; and
- Implement institutional controls.

The estimated maximum depth of contamination is 15 ft BGS along the shoreline. Because excavation for Alternative MJB-4 would not extend below 10 ft BGS, localized areas of deeper soil contamination would remain. The 10 ft excavation depth would limit worker restrictions, limit the potential for terrestrial biota exposure, and protect the Marine Area from future upland contaminated soil erosion (see Marine Area alternatives discussion in Section 7.0). Furthermore, RI site characterization data demonstrated that groundwater at the shoreline wells complies with the proposed groundwater cleanup levels, indicating that leaching of soil contaminants to groundwater is not an exposure pathway of concern. Therefore, the soils left in place under this alternative would not be a source of mobile contamination that would affect marine surface water or sediments. Contaminated soils that would remain within the shoreline buffer zone are below the MHHW elevation and would be separately addressed by the Marine Area remedy, thereby providing protection of the marine area (see Section 7.0). Similar to the other alternatives, the majority of upland soils that have been identified as potential erosional sources of localized contaminated sediment deposits (see Figure 12) would be removed under this alternative.

Prior to implementation, substantive permitting requirements would be addressed as described in Section 6.2.1.1, a utility locate would be conducted, the concrete rails on the east side of the property (Figure 25) would be demolished, and the existing monitoring wells (MW-1 through MW-7) would be abandoned except where they can be protected during cleanup and redevelopment activities. Replacement wells would be installed as appropriate to provide four wells for post-remediation monitoring. It has been assumed that four post-construction monitoring events would be sufficient to confirm that groundwater at the MJB North Area has not been affected by Site contaminants.

6.2.4.1 Permitting

The permitting requirements for Alternative MJB-4 are the same as described above for Alternative MJB-1.

6.2.4.2 Shallow Soil

For the MJB North Area, shallow contaminated soil is generally limited to the upper 2 ft of soil that has been impacted by elevated concentrations of arsenic, copper, and zinc. In addition, single occurrences of chromium, nickel, and cPAHs were found in one nearshore sample (SB-04), and lead in another sample (PP-25) collected near the western boundary of the shoreline buffer zone. The locations of several discrete areas likely to require remediation are shown in Figure 25. Elevated concentrations of arsenic, copper and zinc are present in a thin surface layer of locally-derived quarry rock. Shallow soil contamination is present in relatively large areas of the northern half of the MJB North Area and in isolated areas of the southern portion of the property. While Figure 25 shows excavation in several discrete areas, as suggested by Ecology, it is possible that contamination is more extensive, particularly if associated with the locally obtained quarry rock, as investigation data indicate. For this reason, the potential extent of contaminated soil may extend beyond the areas identified for remediation, as shown by the larger potential remediation area in Figure 25. The discrete areas were used for estimating the cost for this alternative. Actual costs could be substantially greater than estimated for this alternative if excavation is required beyond what is shown by the dashed lines in Figure 25 in order to attain cleanup levels.

Shoreline Buffer Zone

Under Alternative MJB-4, shallow soil within the 75-ft shoreline buffer zone that exceeds final cleanup levels protective of human health and ecological receptors would be excavated using conventional equipment and disposed of at an appropriately designed and permitted, offsite disposal facility. This includes shallow soil impacted with CPAHs (one location), arsenic, chromium (one location), copper, lead (one location), nickel (one location), and zinc. Excavation for Alternative MJB-4 would concurrently remove the majority of soils within the shoreline buffer zone that have been identified as potential erosional sources of localized contaminated sediment deposits (see Figure 12). Based on the discrete excavation areas specified by Ecology, it is estimated that approximately 2,000 cubic yards of contaminated shallow soil would be excavated for off site disposal from the shoreline buffer zone. Excavated soil would be characterized for disposal in accordance with applicable regulations. Once excavation is complete, confirmation samples would be collected from the sidewalls and bottoms of the excavations as described in Section 6.2.4.4. For this alternative, excavation would not continue below a maximum depth of 10 feet BGS despite the confirmation sample results. The potential extent of contaminated soil that may require excavation is shown by the cross-hatching on Figure 25 and the dashed lines indicate the extent of excavation proposed by Ecology for this alternative. Actual costs could be substantially greater than estimated for this alternative if excavation is required beyond what is shown by the dashed lines in order to attain cleanup levels.

Remaining Uplands Area

Under Alternative MJB-4, shallow soil west of the shoreline buffer zone that exceeds the final cleanup levels protective of human health would be excavated using conventional equipment, characterized for disposal, and disposed of at an appropriate, permitted offsite disposal facility. The only contaminant exceeding proposed human health cleanup levels in this area is arsenic. Based on the discrete excavation areas specified by Ecology, it is estimated that approximately 3,500 cubic yards of contaminated shallow soil would be hauled off site for disposal under this alternative. Once excavation is complete, confirmation samples would be collected from the sidewalls and bottoms of the excavations as described in Section 6.2.4.4. Excavation would not continue below a maximum depth of 6 feet BGS in the remaining upland areas. Actual costs could be substantially greater than estimated for this alternative if excavation is required beyond what is shown by the dashed lines in Figure 25.

Soil with copper, nickel, and/or zinc concentrations above the final cleanup levels protective of terrestrial ecological receptors would be handled the same as those described above for Alternative MJB-2. Based on initial evaluations of the RI soil data, an estimated 600 cubic yards of contaminated soil containing elevated metal concentrations (copper and/or zinc) that cannot be practicably homogenized is likely to be excavated for off-site disposal under Alternative MJB-4. Remediation by homogenization would permanently eliminate ecological risks associated with soil contamination by reducing concentrations to levels below the final cleanup levels. Conservatively assuming that none of the soil passes the terrestrial ecological evaluation and/or the bioassay criteria, approximately 4,500 cubic yards of soil would be homogenized under Alternative MJB-4. Soil homogenization for Alternative MJB-4 is expected to be the same as described in Section 6.2.2.2 for Alternative MJB-2.

6.2.4.3 Deep Soil

Deeper contamination is present in nine defined areas on the MJB North Area property, as shown in Figures 8 and 9. There are four areas generally within the shoreline buffer zone that extend from sample location PP35 in the north to about halfway between sample locations PP27 and TP-07 in the south. Three smaller areas of deep contamination are located in the southeast portion of the property, located within the shoreline buffer zone and extending to the west; these areas are centered on sample locations SB-11, TP-01, and MW-5. Another relatively small area is centered on SB-07 (north central portion of property), but does not include the other surrounding sample locations where deep soil results were below proposed cleanup levels. The last location is within the remaining uplands area, centered on sample location TP-08. The estimated maximum depth of contamination in the areas within the shoreline buffer zone is 15 ft BGS; contamination within the remaining uplands area, west of the shoreline buffer zone, is estimated to extend to a maximum depth of 11 ft BGS.

75-ft Shoreline Buffer Zone

Under Alternative MJB-4, deep soil (deeper than 2 ft BGS) within the 75-ft shoreline buffer zone that exceeds the final cleanup levels protective of human health and ecological receptors would be excavated to a maximum depth of 10 ft BGS to the extent practicable, characterized as appropriate for disposal, and transported to a permitted disposal facility in accordance with applicable regulations. This depth was selected by Ecology to evaluate different approaches to sediment recontamination control, and would also limit restrictions for future landscaping and utility workers that may handle MJB North Area soils. It was assumed that no temporary shoring would be necessary for these excavations and that sidewalls would be sloped or benched as needed. Excavation for Alternative MJB-4 would remove the majority of soils within the 75-ft shoreline buffer zone that have been identified as potential erosional sources of localized contaminated sediment deposits (see Figure 12). Clean soil excavated to provide access to contaminated soil would be segregated for reuse, as practicable; however, cost estimates for this alternative assume that no soil is re-used and excavations are backfilled with clean, imported fill from a nearby sand and gravel quarry. Groundwater monitoring during the RI indicated that the depth to groundwater varies from 6.5 to 10 ft BGS and is tidally influenced. It is assumed that the in-water work would be coordinated with the upland work so dewatering is not anticipated to be necessary for this alternative, but excavation would likely proceed during low tide, to the extent practicable.

It is estimated that approximately 6,900 cubic yards of deep soil contaminated with arsenic, lead, and cPAHs would be excavated from the shoreline buffer zone under Alternative MJB-4 and disposed of off site, including 1,100 cubic yards of soil that may need to be managed as dangerous waste due to the concentration of leachable lead. Once excavation is complete, sidewall and bottom confirmation samples would be collected as described in Section 6.2.4.4. Suspected dangerous waste would be stockpiled separately and characterized in accordance with the dangerous waste regulations (WAC 173-303) prior to disposal. Soils classified as dangerous waste must be stabilized to comply with land disposal restrictions prior to landfill disposal. The remedial design would consider both on-site and off-site stabilization to provide cost-effective waste management if this alternative is selected for implementation. For estimating the cost of this cleanup action alternative, it has been assumed that dangerous waste soil would be treated and disposed at an off-site facility permitted to accept and treat RCRA wastes.

Remaining Uplands Area

Deep soil (deeper than 2 ft BGS) within the remaining uplands area that exceeds the final cleanup levels protective of human health would be excavated to a maximum estimated depth of 6 ft BGS using conventional earth handling equipment. It is estimated that approximately 1,060 cubic yards of contaminated deep soil (deeper than 2 ft BGS) would be excavated from the remaining uplands area and disposed of off site, including 160 cubic yards of soil that may need to be managed as dangerous waste due to the concentration of leachable lead. Suspected dangerous waste soil would be stockpiled separately, characterized, and managed as described above for the shoreline buffer zone. If deemed appropriate, the dangerous waste soil may be stabilized onsite prior to transport for disposal. For cost estimation purposes, it has been assumed that dangerous waste soil would be stabilized at the permitted disposal facility prior to disposal in a Subtitle C landfill.

6.2.4.4 Confirmation Sampling

The confirmation sampling activities associated with Alternative MJB-4 are the same as those described above in Section 6.2.2.4 for Alternative MJB-2. Prior to demobilization a survey of the excavations, sample locations, and site features would be conducted, and the disturbed areas would be hydroseeded for erosion control and stormwater management until future site development is completed. As part of the anticipated MJB North Area development, riparian planting and a pedestrian walkway would be placed along the shoreline.

6.2.4.5 Institutional Controls

The following institutional controls are included in Alternative MJB-4 to reduce the risk of human exposure to impacted soil left in place below 6 ft BGS:

- Engineering controls, protocols, and monitoring to ensure that temporary construction workers adhere to WAC 296-62-300, applicable Washington Labor and Industry standards, and Occupational Safety and Health Administration (OSHA) Hazardous Waste Operation and Emergency Response (HAZWOPER) regulations (29 CFR 1919.120) for construction work conducted in exposed areas of impacted soil;
- Notice in the property deed identifying the location and nature of soil contamination remaining at the MJB North Area; and
- Deed restrictions to limit development and use of the MJB North Area.

It is anticipated that these institutional controls would be adequate to protect human health and the environment from potential risks related to contaminated soil remaining at the MJB North Area.

6.2.5 Evaluation and Comparison of MJB North Area Alternatives

All four alternatives developed for the MJB North Area meet the MTCA threshold requirements for cleanup actions. This section evaluates and compares the alternatives based on the MTCA criteria described in Section 5.1. Evaluation of all four alternatives with respect to the evaluation criteria is summarized in Table 10 and discussed below.

6.2.5.1 Protectiveness and Risk Reduction Evaluation

Protectiveness and risk reduction are gauged primarily by the extent of contaminant exposure reduction provided by each alternative. Alternative MJB-1 is expected to remove known contaminated soil from the MJB North Area, giving it the highest ranking for this criterion. Alternative MJB-4 would leave localized deeper contaminated soil in place below 10 ft BGS and thus gets a lower ranking than Alternative MJB-1. Alternative MJB-2 would leave localized deeper contaminated soil in place below 6 ft BGS and would be ranked lower still; however, both Alternative MJB-2 and MJB-4 reduce terrestrial ecological risks within the remaining uplands area by reducing constituent concentrations to protective levels. Alternative MJB-3 provides the least risk reduction, as it relies on engineered controls to provide protection to terrestrial ecological receptors, and therefore receives the lowest ranking.

6.2.5.2 Permanence

Permanence refers to the ability to reduce the toxicity, mobility, or volume of hazardous substances, including the permanent destruction of hazardous constituents. The elemental nature of some Site contaminants (metals) precludes destruction. Although organic constituents (cPAHs) can be destroyed, none of the alternatives provides destruction; all four alternatives rely upon long-term containment for soil contaminated with metals and cPAHs. As a result, none of the four alternatives provides permanent destruction of contaminants. However, Alternatives MJB-2 and MJB-4 provide a permanent risk reduction for terrestrial ecological receptors since contaminant concentrations are permanently reduced to safe levels via soil homogenization. Alternative MJB-1 is rated highest for this criterion because it reduces contaminant mass, toxicity, and volume at the MJB North Area to the greatest extent. Alternatives MJB-2 and MJB-4, which remove less contaminant volume from the MJB North Area than Alternative MJB-1, are ranked medium, with Alternative MJB-4 ranked slightly above MJB-2 because slightly more mass is removed. Alternative MJB-3, which removes the least volume from the MJB North Area, is ranked lowest. It should be noted that contaminated soil removed under all four alternatives from the MJB North Area and placed within an off-site landfill would remain at concentrations exceeding final cleanup levels.

6.2.5.3 Cost
The cost evaluation includes all costs related to implementation of an alternative, including initial design costs, construction costs, maintenance costs, monitoring costs, and compliance/reporting costs. All costs are based on the proposed cleanup levels; final cleanup levels, if they are different, may affect the costs. Details regarding the cost estimates for the three alternatives are presented in Appendix C. The estimated costs (+50%, -30%) for the four alternatives are summarized below:

Alternative	Estimated Cost
MJB-1: Excavation	$8,300,000
MJB-2: Partial Excavation to 6 ft and Soil Homogenization	$4,400,000
MJB-3: Partial Excavation and Asphalt Cover	$4,200,000
MJB-4: Partial Excavation to 10 ft and Soil Homogenization	$5,200,000

As shown in the table above, Alternative MJB-1 has the highest cost, Alternative MJB-4 has the second-highest cost, and Alternatives MJB-2 and MJB-3 have comparable costs. Therefore, Alternatives MJB-2 and MJB-3 rank high for cost, Alternative MJB-1 ranks low, and Alternative MJB-4 ranks medium.

6.2.5.4 Long-Term Effectiveness
Long-term effectiveness includes the degree of certainty and reliability of the alternative and whether treatment residue remains from the alternative that would require management. All four alternatives would produce wastes requiring off-site management. Management of excavated soil in an off-site landfill would require long-term inspection, monitoring, and maintenance to ensure containment is effective, as the metals contaminants would remain at concentrations potentially posing risks and are persistent. Alternative MJB-4 would leave some soil at the site that is above the proposed cleanup levels, but utilizes soil homogenization to reduce site risks, which permanently reduces contaminant concentrations; therefore, this alternative received the highest ranking for long-term effectiveness. Alternative MJB-2, which also utilizes soil homogenization but leaves slightly more contaminated soil in place is ranked slightly lower. Alternative MJB-1 would leave the least amount of contaminated soil on site, but would also require the transportation and long-term containment of the largest quantity of contaminated soil; therefore, it was ranked slightly lower than Alternative MJB-2 for this criterion. Alternative MJB-3 would leave the greatest amount of contaminated soil on site and relies on institutional and engineered controls. As a result it received the lowest ranking.

6.2.5.5 Management of Short-Term Risks
Short-term risk refers to the risk to human health and the environment during implementation of the alternative. Because Alternative MJB-3 would be the simplest to implement and would disturb the smallest volume of contaminated soil, it is rated highest for this criterion. Alternative MJB-1, which disturbs the greatest volume of soil, is ranked lowest. Alternative MJB-2 was ranked slightly higher than Alternative MJB-1, as it requires less transportation and would have lower risks related to transport of contaminated soil along public rights-of-way. Alternative MJB-4 is ranked slightly lower than MJB-2, but higher than MJB-1.

6.2.5.6 Technical and Administrative Implementability
This criterion refers to whether the alternative is technically possible relative to complexity, administrative/regulatory requirements, size, access, and integration with existing operations. All three

alternatives can be implemented. Given that Alternative MJB-3 is the simplest alternative to implement, it is rated highest, whereas Alternative MJB-1, which requires excavation of soil below the water table and in difficult conditions, rates lowest. Alternatives MJB-2 and MJB-4 are ranked in the middle, with Alternative MJB-4 being ranked slightly lower.

6.2.5.7 Public Concerns

This criterion considers potential community concerns with each alternative. Alternative MJB-1 provides the most complete removal of contaminants, but also requires the greatest amount of truck traffic and contaminated soil transport through the City of Anacortes and on public roadways. Alternatives MJB-2 and MJB-4 require less soil transport than Alternative MJB-1, but also would leave some contaminated soil on site. These three alternatives are likely to be ranked the same by the public. Alternative MJB-3 would leave the greatest amount of contaminated soil in place, utilizes engineered controls that must be maintained, and places the greatest reliance on institutional controls; therefore, Alternative MJB-3 was ranked lowest.

6.2.5.8 Reasonable Restoration Time Frame

Restoration time frame considers the practicability of a cleanup action alternative being able to achieve a relatively short restoration time frame with consideration given to a number of factors, including site risks, site use and potential use, effectiveness and reliability of institutional controls, and toxicity of hazardous substances at the site. As a whole, these factors are a measure of the urgency of reducing risk and achieving cleanup goals for the site.

All four alternatives are expected to require approximately two to three years for implementation, and, therefore, have the same initial restoration timeframe. Alternatives MJB-2, MJB-3 and MJB-4 would leave some contaminated soil in place, and would rely on institutional and/or engineered controls to meet long-term cleanup goals. The four alternatives were rated equivalent for this criterion.

6.2.6 Basis for Selection of Preferred MJB North Area Alternative

Selection of a preferred alternative under MTCA requires that a preference be given to alternatives that use permanent solutions to the maximum extent practicable, alternatives that provide for a reasonable restoration time frame, and alternatives that consider public concerns. The analysis below compares the baseline alternative (the alternative that provides the greatest degree of permanence) to the other alternatives based on degree of permanence, reasonable restoration time frame, and public concerns. According to MTCA (WAC 173-340-200), a permanent solution or permanent cleanup action means a cleanup action in which cleanup standards can be met without further action being required at the site involved, other than the approved disposal of any residue from the treatment of hazardous substances.

6.2.6.1 Baseline Cleanup Action Alternative

The baseline alternative for the MJB North Area is Alternative MJB-1. Although all four alternatives could be considered to be permanent cleanup actions in the sense that cleanup standards would be met, Alternative MJB-1 is considered to have a higher degree of permanence for the MJB North Area because it removes the greatest volume of contaminants and does not rely on institutional or engineered controls. However, this alternative does rely on long-term landfill containment of affected soil for protecting human health and the environment.

The evaluation of all four alternatives for the MJB North Area is summarized in Table 10. Only Alternative MJB-1 is capable of attaining the standard point of compliance for soil prescribed by MTCA. However, all four alternatives are capable of meeting a conditional point of compliance corresponding to the upper 6 ft of soil.

6.2.6.2 Comparison to Baseline Alternative

As noted above, Alternative MJB-1 has been defined as the baseline alternative for the MJB North Area. Alternatives MJB-2, MJB-3, and MJB-4 are compared to the baseline alternative below for selection of the preferred alternative. The purpose of this comparison is to assess the benefits and costs of Alternative MJB-1 relative to Alternatives MJB-2, MJB-3, and MJB-4. The evaluation criteria presented above and in Table 10 were established in accordance with the MTCA requirements cited in WAC 173-340(3)(f); the evaluation of benefits is qualitative.

The benefits assessed in this comparison and the relative ranking for the alternatives are summarized in Table 11. The rationale for this comparison is presented below.

- **Reduced risk to on-site worker health.** All four alternatives are equal in reducing risk to site workers because they are all equally protective. Although the baseline alternative would remove the greatest volume of contaminated soil, potential risks to on-site workers would not be reduced substantially below risks posed by the other alternatives. Soil exceeding proposed human health-based cleanup levels would be removed within the upper 6 ft and institutional controls would be implemented to protect worker health. This would eliminate anticipated worker exposures, as most subsurface work for redevelopment is limited to the upper 6 ft.
- **Reduced risk to the environment.** All four alternatives would be protective of the environment because they would attain the proposed soil cleanup levels at a standard point of compliance or at a conditional point of compliance. Because groundwater is not a concern at the Site, migration of soil contamination via groundwater does not pose a risk. Risks to terrestrial ecological receptors would be lowest for Alternatives MJB-2 and MJB-4, as potential exposure concentrations would be permanently reduced to safe levels, totally eliminating risks. Some risks would remain for all four alternatives, as impacted media would remain either within an engineered landfill or on site at concentrations exceeding cleanup levels and, therefore, posing potential risk. Alternative MJB-3, which relies on engineered controls for mitigating ecological risks, would provide the least risk reduction.
- **Potential risk to spread contaminants off site.** The baseline alternative removes the greatest volume of soil contaminants, but requires transporting a relatively large volume of contaminated soil on public roadways for disposal in a landfill. Alternatives MJB-2 and MJB-4 remove soil contaminants to a lesser extent, but also create less potential public exposure to contaminated soil during soil transport. Alternative MJB-3 disturbs the smallest volume of contaminated soil and therefore has the lowest potential risk of spill or spreading.
- **Permanent risk reduction.** Alternative MJB-1 provides significant risk reduction for the MJB North Area, but this risk is transferred to an engineered landfill providing long-term containment for persistent constituents. Alternatives MJB-2 and MJB-4 rely on on-site containment for deep contamination that is known, based on previous investigation results, to be immobile; furthermore, these alternatives include soil homogenization, which is the only permanent remedy considered in any alternative for risk reduction. Soil homogenization would achieve proposed

soil cleanup levels permanently without the risks posed by off-site transport and long-term containment. All four alternatives would remove shoreline soils that have been identified as potential erosional sources of localized contaminated sediment deposits (see Figure 12).

The potential benefit evaluation for the alternatives shows that Alternative MJB-2 and MJB-4, alternatives comprised of partial excavation and soil homogenization, would provide the same level of benefits as Alternative MJB-1, where most of the affected soil would be removed for long-term containment in an off-site landfill. As shown in Table 11, Alternatives MJB-1, MJB-2, and MJB-4 provide the same level of overall benefit and Alternative MJB-3 provides the lowest level of benefit. The negligible improvement in benefits achieved by the baseline alternative over Alternatives MJB-2 and MJB-4 is not justified by the significant increase in costs and is, therefore, disproportionate.

6.2.7 Preferred MJB North Area Alternative

Both Alternative MJB-2, Partial Excavation to 6-ft and Soil Homogenization, and Alternative MJB-4, Partial Excavation to 10-ft and Soil Homogenization are recommended for further consideration in the Cleanup Action Plan as the preferred alternative for the MJB North Area. Under Alternative MJB-2, soil exceeding proposed human health-based cleanup levels would be removed within the upper 6 ft, eliminating most of the risks to construction workers. Under Alternative MJB-4, soil exceeding proposed human health-based cleanup levels would be removed within the upper 10 ft in the shoreline buffer zone and the upper 6 ft in the remaining upland areas, also eliminating most of the risks to construction workers. Both Alternatives MJB-2 and MJB-4 utilize the only permanent risk reduction considered in this FS, soil homogenization, to permanently reduce soil concentrations to levels that do not contribute to terrestrial ecological risks. Groundwater at the MJB North Area has not been impacted by Site constituents, confirming that contaminants within impacted soil are not migrating and will not impact the marine environment. Institutional controls are included in Alternatives MJB-2 and MJB-4 for contaminated soil left in place below 6 ft in depth. In both alternatives, soil that is within 6 ft of the ground surface throughout the property and that exceeds proposed cleanup levels based on human health criteria would be removed for long-term containment in an off-site landfill. In Alternative MJB-4, soil that is within 10 ft of the ground surface within the shoreline buffer zone and that exceeds final cleanup levels based on human health or terrestrial ecological criteria would be removed for long-term containment in an off-site landfill. Contaminated soil remaining within the MJB North Area below 6 ft in depth would be addressed with enforceable institutional controls. Alternative MJB-1, as the baseline remedy, does not provide any significant benefits over Alternatives MJB-2 and MJB-4, and its costs are substantial and disproportionate to the incremental degree of protection achieved. Alternatives MJB-2 and MJB-4 are currently both preferred alternatives for the MJB North Area because they are nearly as effective as the baseline alternative, and both with a substantially lower cost, though Alternative MJB-4 is more expensive than Alternative MJB-2. Further evaluation of Alternatives MJB-2 and MJB-4 would be performed during development of the Cleanup Action Plan, incorporating updates from the evaluation of the terrestrial ecological risks.

Partial excavation and soil homogenization would achieve the expectations for cleanup actions cited in the MTCA regulations at WAC 173-340-370(1) through (8). The relevant expectations are addressed as follows.

- Implement Treatment at Sites with Liquid Wastes, High Contaminant Concentrations, Highly Mobile Materials, or Discrete Areas of Contamination. Ecology expects that treatment will be emphasized for sites meeting these general criteria. The concerns identified in this expectation do not apply to the contaminants at the MJB North Area. The most widely distributed contaminants are metals that are not amenable to treatment to reduce concentration. There is no evidence of liquid wastes. Contaminants are widely distributed in soil; the preferred remedy removes the highest concentration areas for off-site landfill disposal. The contaminants present in MJB North Area soil are not mobile, as groundwater has not been affected. The preferred remedy addresses this expectation.

- Destroy, Detoxify, or Remove Hazardous Substances. Ecology expects that hazardous substances will be destroyed, detoxified, or removed to below cleanup levels. The excavation included in the preferred remedy would remove the highest concentrations of hazardous substances within the biologically active zone and in the depth interval where future workers are most likely to work. Soil homogenization would effectively detoxify metals-impacted soil by permanently reducing their concentrations below cleanup levels for terrestrial ecological receptors. The preferred remedy meets this expectation to the degree practicable; impacted soils remaining after implementing the remedy would not pose substantial risk, as the contaminants have been shown to be immobile and are located below the biologically active zone. Shoreline soils that have been identified as potential erosional sources of localized contaminated sediment deposits (see Figure 12) would be removed under the preferred alternative.
- Implement Engineering Controls for Low Contaminant Concentrations. Ecology recognizes the need for containment for low concentrations of contaminants where treatment is impracticable. The preferred alternative provides containment for deeper soils by backfilling with a minimum of 6 ft of clean soil over contaminated soil that would remain in place; the Marine Area remedy would provide effective capping for remaining impacted soil within the shoreline buffer zone. Excavated soil would be effectively contained in an engineered off-site landfill.
- Prevent Runoff of Hazardous Substances. Ecology expects that cleanup actions will include active measures to prevent precipitation from creating runoff that contains affected soil. This expectation would be met by the preferred alternative, because the residual contamination exceeding human health criteria would be covered with a minimum of 6 ft of clean backfill. Because contaminant migration via groundwater is not a pathway of concern, the soil cover need not be impervious to minimize leaching of contaminants. Soil homogenization would reduce surficial contaminant concentrations to levels below applicable cleanup levels protective of human health and the environment.
- Consolidate On-Site Contaminants Exceeding Cleanup Levels. Ecology expects that when contaminants are left on site exceeding cleanup levels, they will be consolidated to the extent practicable. At this site, due to the location of the contaminants, it is not practicable to consolidate remaining impacted soils. The remedy achieves effective containment for remaining impacted soil by placing clean soil above the impacted soil, significantly reducing the potential for exposure. The Marine Area remedy would provide a cap for the deep soil within the shoreline buffer zone.
- Prevent Runoff and Groundwater Discharge to Surface Water. Ecology expects that the cleanup action will include active measures to prevent or minimize releases to adjacent surface water bodies via runoff or groundwater discharge, and that dilution will not be the sole method for attaining cleanup levels. Under the preferred alternative, contaminated soil would not be exposed to surface water runoff. Additionally, historical groundwater monitoring data have demonstrated

that MJB North Area contaminants are immobile and that groundwater has not been contaminated at concentrations exceeding proposed cleanup levels.

The preferred cleanup action alternative for the MJB North Area would be designed to comply with the applicable regulations discussed in Section 4.2. These regulations govern the design, implementation, residuals management, and monitoring of the cleanup action.

7.0 DEVELOPMENT AND EVALUATION OF CLEANUP ACTION ALTERNATIVES FOR MARINE AREA

Based on data from the RI, cleanup action alternatives were developed to address hazardous substances and deleterious wood debris identified within the intertidal and subtidal parts of the Marine Area. As discussed in the accompanying RI report, the horizontal and vertical distributions of hazardous substances (e.g., metals and PCBs) and wood debris exceeding preliminary sediment cleanup levels were characterized at the Site through diver surveys, surface sediment sampling, core sampling, and confirmatory biological tests.

Preliminary sediment cleanup levels were developed according to MTCA and SMS requirements and direction provided by Ecology. Two SMS criteria are promulgated by Ecology (WAC 173-204-320), the SQS, the concentration below which effects to benthos are unlikely, and the CSL, the concentration above which more than minor adverse biological effects may be expected. Localized hazardous substance deposits exceeding CSL chemical criteria are present on Port- and MJB-owned upland areas located adjacent to the North Marine Area of the Site. While the Marine Area is evidenced to have been a historical source of hazardous substances to the Marine Area through erosion of the upland soils, the temporary shoreline stabilization performed by the Port in this area appears to have reduced contaminant transport and risks at the Site as evidenced by recent reductions in surface sediment PCB concentrations.

There are no promulgated SQS and CSL criteria for wood debris or associated degradation byproducts in sediment. Based on Ecology’s interpretation of the site-specific biological data, summarized in the RI, surface sediment TVS levels greater than 9.7 percent (dry weight basis) and/or wood debris levels greater than 25 percent (by volume) were identified as having the potential for site-specific deleterious effects exceeding SQS biological criteria. Surface sediment TVS levels greater than 15 percent and/or wood debris levels greater than 50 percent were identified as having the potential for deleterious effects exceeding CSL biological criteria.

The RI data reveal that wood debris thickness exceeding prospective SQS and/or CSL sediment cleanup levels in the subtidal portion of the Marine Area decreases from approximately 2 ft in nearshore areas to roughly 0.5 ft further offshore. The thickness of wood debris in the intertidal transition zone bank is substantially thicker, especially near the transition with the uplands where thicknesses are on the order of 20 to 25 feet in places.

The thickness of sediments containing elevated wood debris levels (i.e., above the generally uniform native contact elevation) generally decreases to the east, away from the shoreline. Wood debris content mixed into the near-surface sediments generally ranged from approximately 100 percent near the shoreline to less than 5 percent near the inner harbor line and generally decreases with distance to the south (see Figure 12).

Two Marine Area alternatives have been developed to address sediments exceeding the SQS and CSL screening criteria. Alternative M-1 addresses subtidal and intertidal sediments that exceed the SQS criteria (Figure 24), while Alternative M-2 addresses subtidal and surface sediments that exceed the CSL criteria (Figure 25).

The transitional slope along the Port and MJB properties is subject to erosion due to wave action. To address future shoreline erosion and to maintain the long-term integrity of engineered caps that will be placed on the transitional slope, wave attenuation and cap armoring provisions are provided in both of the Marine Area alternatives.

Consistent with MTCA human health risk assessment procedures (WAC 173-340-708), potential bioaccumulation risks that may remain in the Marine Area following completion of cleanup actions addressing benthic risks (e.g., from hazardous substances and potentially deleterious characteristics of wood debris) are also assessed in this FS. The residual risk assessment considered: 1) the footprint of cleanup actions at the Site under different alternatives; 2) the anticipated effectiveness of remedial technologies (e.g., removal and containment) also considering the potential for dredging residuals; and 3) potential bioaccumulation of post-remedy sediment concentrations using regional biota-sediment accumulation factors (BSAFs). The evaluation also considered Puget Sound regional background concentrations of PCBs as published by Ecology (1997c) and others. Based on the results of the residual risk assessments, including those completed at other Ecology-lead cleanup sites as described in Section 7.3.1.1 below, the cleanup action alternatives presented in this FS required only minor modifications to ensure protection of human health.

7.1 MARINE AREA ALTERNATIVE M-1

Marine Area Alternative M-1 achieves partial removal and capping of shoreline transitional slope wood debris deposits, and removal of subtidal sediment and wood debris exceeding SQS criteria. This alternative includes backfilling of the subtidal excavations after removal has been completed.

Alternative M-1 includes the following elements:

- Remove surficial debris and remove cut off pilings;
- Dredge subtidal sediments exceeding SQS criteria (incorporating the results of additional sediment bioassays to be performed in summer/fall 2008);
- Backfill subtidal excavations with clean sand to restore existing grades and manage anticipated dredge residuals within the excavation area;
- Place a thin (nominal 6-inch) sand cover within a 100-ft radius surrounding the dredge area to manage anticipated dredge residuals outside of the excavation area;
- Construct a wave attenuation structure offshore of Port Uplands and armored caps offshore of MJB uplands to provide transitional slope cap protection;
- Excavate the shoreline transitional slope to facilitate cap placement while maintaining the approximate existing grades;

- Place a minimum of 2 ft of suitably-sized cap material along the Port and MJB property shorelines that have been identified as potential erosional sources of localized contaminated sediment deposits (see Figure 12); and
- Restore the existing seasonal dock structure.

The estimated dredge and excavation volume in Alternative M-1 is 24,100 cubic yards of subtidal sediments exceeding SQS screening criteria, with an additional 10,100 cubic yards of shoreline intertidal excavation to accommodate caps, for a total of 34,200 cubic yards of removal.

7.1.1 Subtidal Area

Under Alternative M-1, sediment and wood debris exceeding the SQS screening criteria would be removed from the subtidal area. The extent of SQS exceedances will be refined based on the results of additional sediment bioassays to be performed in the fall of 2008. Based on the RI data, a nominal 2-ft thick excavation over the subtidal sediment cleanup area has been assumed for this FS. Sediment would be excavated using both land- and water-based equipment depending on work area and tidal conditions. After removal of large woody debris, sediment would be disposed at an approved landfill or at a suitable open-water disposal site such as the Port Gardner non-dispersive DMMP disposal site after larger wood debris greater than DMMP dimensional criteria is removed. During remedial design, sediment within the prospective dredge prism would be further characterized to verify its suitability for open-water disposal. As discussed in Sections 4.3.3.5 and 4.3.3.6, other potential disposal and upland beneficial reuse opportunities for these materials would be explored during remedial design.

The subtidal dredged areas would be backfilled to approximate existing grade with clean materials of differing grain size, depending on stable grain sizes and habitat design specifications for specific locations within the Marine Area (see Section 4.4). A nominal 6-inch sand cover would be spread over the area 100 feet offshore of the SQS footprint to manage dredge residuals.

7.1.2 Intertidal Area (Shoreline Transitional Slope)

In the intertidal area, Alternative M-1 includes excavation of sediment, wood debris, brick, and removal of piling to facilitate placement of a thick cap to contain the thicker wood debris deposits located in the shoreline transitional slope. Removal and disposal methods are similar to those described for the subtidal area.

Adjacent to the northern and central Port Uplands Area, the transitional slope cap would be approximately 2 ft thick and would consist of a sand and gravel mixture. Along the contiguous northern portion of the MJB North Area south of the influence of the wave attenuation structure, a 2-ft-thick armored cap would be placed, consisting of a base layer of armor material with an overlying surface layer of sand and gravel.

In order to meet CAOs at the Site, future headland erosion sources of sand and gravel materials will be effectively cut off. Similar headland erosion control (e.g., riprap protection) is a common feature in Puget Sound to maintain shoreline development.

7.1.3 Erosion Protection

As described in more detail in other sections of this FS (see Section 4.4), the present wave environment in the Marine Area has resulted in significant erosion along the Port Uplands Area and MJB North Area shorelines. As discussed in Section 2.2.3, the source of localized metal and PCB contaminated sediment deposits in the Marine Area is erosion of upland fill material containing similarly elevated contaminant concentrations. Erosion of soil from these shoreline areas is the likely source of down-drift sediment contamination observed just to the south, and erosion protection is thus a key CAO for the Site. These areas of the shoreline are armored with riprap, supplemented most recently by the Port's temporary Bank Stabilization Interim Action along the Seafarers' Memorial Park shoreline completed in February 2005 under the Port's Consent Decree (Landau Associates 2005a). Integrated shoreline erosion and source control objectives would be achieved under Alternative M-1 using the measures described in the sections below.

7.1.3.1 Port Uplands Area Shoreline – Offshore Wave Attenuation

To protect the Port Uplands Area shoreline from future erosion, offshore wave attenuation structures would be constructed that would provide permanent and effective wave attenuation as shown in the Figure 26 plan view and Figures 28 to 30 cross sections. By reducing incoming wave energy, a permanently stable shoreline cap could be constructed using sand and gravel materials, in lieu of larger subsurface armor materials.

Numerical modeling of the Marine Area was performed by CHE (described in Section 4.4). The numerical modeling evaluated both armored cap and wave attenuator alternatives for shoreline protection. The modeling results showed that the wave attenuation structures more effectively dissipated the wave energy along the Port upland shoreline by breaking incoming storm generated waves and preventing wave reflection from the existing Cap Sante Boat haven breakwater. Application of the wave attenuation structure was also shown to allow for permanent placement of sand and gravel materials along the shoreline.

The wave attenuation structure would be constructed using imported rock with crest elevations ranging from +6 to +9 MLLW. The current contour of the shoreline would be re-established by backfilling once the transitional slope excavation has been completed.

7.1.3.2 MJB North Area Shoreline – Armored Cap

Along the MJB North Area shoreline, the shoreline cap would be protected from erosion with a rock armor layer placed along the shoreline. Based on the CHE modeling, armor caps would be constructed to the extents shown in the Figure 26 plan view and Figure 31 cross section. The cap would include a 2-ft thick rock armor layer along with a top-dressing of sand and gravel that would be placed in the interstices of the rock.

7.1.4 Eelgrass Restoration

Subtidal sediments that currently contain wood debris and/or chemical contaminants exceeding cleanup levels would be replaced with clean sand and gravel in areas of existing eelgrass. Eelgrass beds disturbed by the cleanup action would be re-planted after backfilling and capping have been completed. Eelgrass would also be restored in sediment areas located inside (west) of the wave attenuation structures to provide offset for the eelgrass destroyed by the construction of the structures.

7.2 Marine Area Alternative M-2

Marine Area Alternative M-2 is similar in many respects to Alternative M-1 described above, and includes construction of a wave attenuation structure on Port property and a pocket beach on MJB property. However, while Alternative M-1 targets removal of subtidal sediment exceeding SQS screening criteria, Alternative M-2 would only remove sediments exceeding CSL criteria, the limits of which will be refined based on the results of additional sediment bioassays to be performed in fall 2008. This alternative includes backfilling the subtidal excavation after removal has been completed, and capping along the transitional slope areas where deeply buried wood debris cannot be practicably removed. A plan view of Alternative M-2 is presented in Figure 27; representative cross sections are presented in Figure 29 and Figures 31 through 33.

As with Alternative M-1, Alternative M-2 includes the following elements:

- Remove surficial debris and removal of cut off pilings;
- Dredge sediments exceeding CSL criteria (incorporating the results of additional sediment bioassays to be performed in summer/fall 2008);
- Backfill subtidal excavations with clean sand to restore existing grades and manage anticipated dredge residuals inside of the excavation area;
- Place a thin (nominal 6-inch) sand cover within a 100-ft radius surrounding the dredge area, or over the SQS footprint (whichever is greater) to manage anticipated dredge residuals outside of the excavation area;
- Construct a wave attenuation structure offshore of Port Uplands and armored caps offshore of MJB uplands to provide transitional slope cap protection;
- Excavate the shoreline transitional slope to facilitate cap placement while maintaining the approximate existing grades;
- Place a minimum of 2 ft of suitability-sized cap material along the Port and MJB property shorelines; and
- Restore the existing seasonal dock structure.

The estimated dredge and excavation volume in Alternative M-2 is 11,500 cubic yards of subtidal sediments exceeding CSL chemical criteria, with an additional 10,700 cubic yards of intertidal transitional slope excavation to accommodate caps, for a total of 22,900 cubic yards of removal.

7.2.1 Subtidal Area

Under Alternative M-2, sediment exceeding CSL criteria would be removed from the subtidal area. Based on the RI data, a nominal 2-ft thick excavation over the subtidal sediment cleanup area has been assumed for this FS. Sediment would be excavated using both land- and water-based equipment depending on work area and tide condition. After removal of large woody debris, sediment would be disposed at an approved landfill or at a suitable open-water disposal site such as the Port Gardner DMMP site after wood debris greater than DMMP dimensional criteria is removed. During remedial design, sediment within the prospective dredge prism would be further characterized to verify its suitability for open-water disposal. As discussed in Section 4.3.3.5 and 4.3.3.6, other potential disposal and upland beneficial reuse opportunities for these materials would be explored during remedial design.

The subtidal dredged areas would be backfilled to the approximate existing grade using clean materials of differing grain size, depending on the specific location at the Site. A nominal 6-inch sand cover would be spread over the area 100 ft offshore of the CSL footprint, or over the SQS footprint (whichever is larger) to manage dredge residuals.

7.2.2 Intertidal Area

Within the intertidal area, Alternative M-2 includes excavation of sediment, wood debris, brick, and piling to facilitate placement of a thick cap to contain the thicker wood debris deposits located in the shoreline transitional slope. Removal and disposal methods are similar to those described for the subtidal area.

Adjacent to the northern and central Port Upland Area, the transitional slope cap would be approximately 2 ft thick and would consist of a sand and gravel mixture. Along the contiguous northern portion of the MJB North Area south of the influence of the wave attenuation structure, a 2-ft-thick armored cap would be placed, consisting of a base layer of armor material with an overlying top dressing of sand and gravel to fill the interstices of the rock.

7.2.3 Erosion Protection

As with Alternative M-1, offshore wave attenuation structures would be constructed to protect the Port Uplands Area shoreline from erosion, and the MJB North Area shoreline would be protected using an armored cap.

7.2.4 Eelgrass Restoration

As with Alternative M-1, subtidal and intertidal sediments that currently contain wood debris and/or chemical contaminants exceeding cleanup levels would be removed, causing disturbance to existing eelgrass beds. Eelgrass beds disturbed by the cleanup action would be re-planted after backfilling and capping have been completed. Eelgrass would also be restored in sediment areas located inside (west) of the wave attenuation structures to provide offset for the eelgrass destroyed by the construction of the structures.

7.3 Evaluation and Comparison of Marine Alternatives

This section provides an evaluation and comparative analysis of the cleanup action alternatives developed for the Marine Area. Each alternative is evaluated with respect to the MTCA evaluation criteria described in Section 5.0, and the alternatives are compared to each other relative to their expected performance under each criterion. The components of the two Marine Area alternatives are described above in Sections 7.1 and 7.2 and are summarized in Table 12. The detailed evaluation of the alternatives is presented in Table 13, and the results of the evaluation are summarized in Table 14.

7.3.1 Threshold Requirements

Cleanup actions performed under MTCA must comply with several basic requirements. Alternatives that do not comply with these criteria are not considered suitable cleanup actions under MTCA. As provided in WAC 173-340-360(2)(a), the four threshold requirements for cleanup actions are as follows:

- Protect human health and the environment;
- Comply with cleanup standards;
- Comply with applicable state and federal laws; and
- Provide for compliance monitoring.

7.3.1.1 Protection of Human Health and the Environment

The results of cleanup actions performed under MTCA must ensure that both human health and the environment are protected (Table 13). Both Alternatives M-1 and M-2 meet this threshold by removal of impacted sediments, and by placing a stable cap in areas of deeply buried wood waste. The use of a post-dredge residuals cover and re-establishment of impacted eelgrass beds provide protection to the environment from potential construction impacts.

In addition to reduction of benthic and wildlife risks through achieving SQS and/or CSL criteria, MTCA (WAC 173-340-708) also requires consideration of potential residual bioaccumulation risks that may remain in the Marine Area following completion of cleanup actions, to ensure that the alternatives are protective of human health. Under both Alternatives M-1 and M-2, the footprint of cleanup actions encompasses sediments with mercury concentrations above 1.2 mg/kg, the BSAF-based bioaccumulation screening level determined by Ecology to be protective of mercury bioaccumulation exposures at the nearby Whatcom Waterway Site in Bellingham (Whatcom Waterway Site Consent Decree; http://www.ecy.wa.gov/programs/tcp/sites/whatcom/ww.htm). Thus, both Marine Area alternatives are protective of human health mercury bioaccumulation risks.

PCBs are bioaccumulative compounds that are ubiquitous in the environment. As a result, the chemical can be found in sediments (and other media such as tissue) even in relatively pristine environments. This condition imposes a practical limitation on achieving and/or maintaining cleanup levels that are lower than background levels. As discussed in the MTCA Cleanup Regulation and in Ecology (1997c), when risk-based levels are lower than background concentrations, as is typically the case with PCBs, Ecology uses the upper 90^{th} percentile background level as the default cleanup level. As described in Ecology (1997c), the 90^{th} percentile regional background concentration for PCBs in Puget Sound, based on data available in SEDQUAL, is 1.2 mg/kg organic carbon (OC) (approximately 31 micrograms per kilogram dry weight). Under both Alternatives M-1 and M-2, the footprint of cleanup actions encompasses sediments with PCB concentrations detected above 1.2 mg/kg OC (Ecology 1997c). Thus, both Marine Area alternatives are protective of human health PCB bioaccumulation risks.

7.3.1.2 Compliance with Cleanup Standards

Compliance with cleanup standards requires, in part, that cleanup levels are met at the applicable points of compliance. If a remedial action does not comply with cleanup standards, the remedial action is an interim action, not a cleanup action. Where a cleanup action involves containment of soils with hazardous substance concentrations exceeding cleanup levels at the point of compliance, the cleanup action may be determined to comply with cleanup standards, provided the requirements specified in WAC 173-340-740(6)(f) are met. Both Alternatives M-1 and M-2 comply with SMS cleanup standards by addressing contamination in the surface 0-to 10- cm biologically active zone of the Marine Area sediments. In the CAP, Ecology will make a final determination of the Site-specific cleanup standards, considering the information presented in this FS, the results of forthcoming sediment bioassays to be performed in Fall 2008, and public comments on these documents.

7.3.1.3 Compliance with Applicable State and Federal Laws

Cleanup actions conducted under MTCA must comply with applicable state and federal laws. The term "applicable state and federal laws" includes legally applicable requirements and those requirements that Ecology determines to be relevant and appropriate as described in WAC 173-340-710. Both Alternatives M-1 and M-2 comply with applicable or relevant and appropriate requirements.

7.3.1.4 Provision for Compliance Monitoring

The cleanup action must allow for compliance monitoring in accordance with WAC 173-340-410. Compliance monitoring consists of protection monitoring, performance monitoring, and confirmation monitoring. Protection monitoring is conducted to confirm that human health and the environment are adequately protected during construction and the operation and maintenance period of a cleanup action. Performance monitoring is conducted to confirm that the cleanup action has attained cleanup standards and, if appropriate, remediation levels or other performance standards. Confirmation monitoring is conducted to confirm the long-term effectiveness of the cleanup action once cleanup standards and, if appropriate, remediation levels or other performance standards have been attained. Alternatives M-1 and M-2 provide for post-construction monitoring for the performance of the cleanup action, including long-term monitoring of caps constructed on the transitional slope area.

7.3.2 Use of Permanent Solutions to the Maximum Extent Practicable

7.3.2.1 Protectiveness and Risk Reduction

Alternatives M-1 and M-2 are both protective and provide risk reduction because contamination is removed from the aquatic area. Alternative M-1 ranks higher than Alternative M-2 because it removes a greater volume of impacted sediment (Table 13).

7.3.2.2 Permanence

Neither alternative achieves permanent destruction of metals or organic constituents (including wood debris). Where upland disposal is used, considerations about long-term management of sediments in the landfill are the same as those described for the upland soils. However, both alternatives achieve a permanent risk reduction in the aquatic environment by removing impacted sediments. Alternative M-1 achieves marginally greater permanence because it removes sediments above the SQS; however, the greater increment of permanence is achieved at additional cost (see below). For both alternatives, the unavoidable generation of dredge residuals requires the placement of a nominal 6-inch sand layer to ensure a clean post-dredge surface and achieve cleanup standards in a reasonable time frame (Table 13).

The wave attenuation structures offshore of the Port property will allow for placement of permanent caps consisting of finer-grained, habitat-enhancing materials. These caps will not require long-term maintenance and will allow for a stable environment for aquatic habitat to develop.

7.3.2.3 Cost

The table below presents the estimated costs for Alternatives M-1 and M-2, including initial design costs, construction costs, monitoring costs, and compliance/reporting costs. Details regarding the cost estimates for the two alternatives are presented in Appendix D. The estimated total costs (+50 percent, -30 percent) for the two alternatives are summarized below:

Alternative	Estimated Cost
M-1: Dredge to SQS with Containment	$7,100,000
M-2: Dredge to CSL with Containment	$5,800,000

As shown in the table above, Alternative M-1 has the highest cost, while Alternative M-2 is approximately 20 percent lower. Therefore, Alternative M-2 ranks higher for cost and Alternative M-1 ranks lower.

7.3.2.4 Long Term Effectiveness

Alternative M-1 is considered marginally more effective than Alternative M-2 in the long term because it removes a greater volume of potentially harmful sediment from the aquatic environment (Table 13). However, due to the greater volume of dredging in Alternative M-1, there may be an increased potential for dredge residuals compared to Alternative M-2. In both alternatives, residuals would be managed using a post-dredge cover of clean material.

7.3.2.5 Management of Short Term Risks

Alternative M-1 entails a greater volume of dredging and post-dredge cover placement. The construction duration is longer. During construction, there would be a greater potential for short-term water quality impacts associated with dredging, backfilling, capping, and cover placement. In comparison, Alternative M-2 requires a lower volume of dredging, backfill, capping, and cover materials. Thus, Alternative M-2 ranks marginally higher than Alternative M-1 for management of short-term risks (Table 13).

7.3.2.6 Technical and Administrative Implementability

Both alternatives are technically possible to implement relative to complexity, administrative/regulatory requirements, size, access, and integration with existing operations. Alternative M-1 entails removing a greater volume of material from the dredge area, and consequently requires management of more excavated material for disposal or beneficial reuse. Without considering beneficial reuse, both Alternatives M-1 and M-2 are considered to rank equally for technical and administrative implementability (Table 13). If a beneficial reuse option for wood debris material were to become available and determined to be practicable during remedial design, Alternative M-1 would rank lower for implementability because as the dredge volume increases, a greater area of upland space would be needed for beneficial reuse activities.

7.3.3 Consideration of Public Concerns

Both alternatives address general public concerns regarding remediation of subtidal sediments; however, some of the interested public may prefer the larger removal of SQS sediments under Alternative M-1. On the other hand, Alternative M-1 requires a larger volume of material to be moved off site to an upland disposal area. The increased traffic from trucks leaving the Site could be a cause for public concern from

Alternative M-1 when compared to Alternative M-2. Both alternatives maintain the Port public access and park lands located on the adjacent Port Uplands. Both alternatives restore and enhance the habitat of the Marine Area.

7.3.4 Reasonable Restoration Time Frame

Both alternatives provide a reasonable restoration timeframe of two to three years (including time for executing the Consent Decree, performing remedial design, obtaining substantive and required permits, and performing and verifying the cleanup action). Both alternatives are anticipated to achieve SQS cleanup criteria immediately following completion of the cleanup action using a combination of dredging, capping, and cover actions. However, Alternative M-2 provides a slightly shorter construction timeframe because the dredge and excavation volume is approximately 2/3 of the volume for Alternative M-1.

7.3.5 Additional SMS Evaluation Criteria

Remedy evaluation criteria under SMS regulations are generally the same as under MTCA. The SMS evaluation criteria are specified in WAC 173-204-560(4)(f) through (k). Most of these SMS evaluation criteria overlap with those of MTCA. The SMS evaluation criteria include the following:

- Overall protection of human health and the environment;
- Attainment of cleanup standards;
- Compliance with applicable state, federal and local laws;
- Short-term effectiveness;
- Long-term effectiveness;
- Ability to be implemented;
- Cost;
- The degree to which community concerns are addressed;
- The degree to which recycling, reuse, and waste minimization are employed; and
- Analysis of environmental impacts consistent with SEPA requirements.

Requirements under SMS for cleanup decisions are specified in WAC 173-204-580(2) through (4). This portion of the regulation specifies factors that are to be considered by Ecology in making its cleanup decision. Most of these requirements also overlap with those of MTCA. SMS cleanup decision requirements including the following:

- Achieve protection of human health and the environment;
- Comply with applicable state, federal and local laws;
- Comply with site cleanup standards;
- Achieve compliance with sediment source control requirements;
- Provide for landowner review of the cleanup study and consider public concerns raised during review of the draft cleanup report;

- Provide adequate monitoring to ensure the effectiveness of the cleanup action;
- Provide a reasonable restoration time-frame;
- Consider the net environmental effects of the alternatives;
- Consider the relative cost-effectiveness of the alternatives in achieving the approved site cleanup standards; and
- Consider the technical effectiveness and reliability of the alternatives.

Like MTCA, the SMS regulations include a requirement for a reasonable restoration timeframe. However, SMS includes an explicit preference for restoration timeframes that are less than ten years [WAC 173-204-580(3)]. Longer restoration timeframes may be authorized, but only where it is not practicable to accomplish the remedy within a ten-year period.

Of the SMS evaluation criteria listed above, all but two are addressed as part of the MTCA evaluation of alternatives. The two exceptions are: 1) the completion of a SEPA analysis of environmental impacts, and 2) the analysis of net environmental effects of the alternatives. Both Marine Area alternatives have similar environmental impacts associated with in-water construction actions, though Alternative M-2 provides for less environmental impact because the dredge and excavation volume is approximately 2/3 of the volume for Alternative M-1.

Both Marine Area alternatives would provide for similar habitat benefits, since subtidal and intertidal sediments that currently contain wood debris and/or chemical contaminants would be replaced with clean sand and gravel. Eelgrass beds disturbed by the cleanup action would be re-planted after backfilling and capping have been completed. Both Marine Area alternatives would be compatible with possible separate restoration projects (i.e., performed independently of site cleanup) in areas inshore of the wave attenuation structure that do not currently support eelgrass.

7.4 Recommended Cleanup Action Alternative for Marine Area

Alternative M-1, dredging to the SQS with backfilling and engineered containment, is the preferred cleanup action alternative for the Marine Area. Under Alternative M-1, sediment exceeding SQS would be removed to the maximum extent practicable, eliminating risks to the aquatic environment. Alternative M-2 provides lower benefits compared to Alternative M-1 with only a marginal cost savings (Table 14). That is, while the cost of Alternative M-1 is approximately 20 percent greater than that of Alternative M-2, such costs are neither substantial nor disproportionate to the incremental degree of protection and long-term effectiveness that would be achieved.

As noted previously, in developing the CAP, Ecology will make a final determination of the Site-specific cleanup levels based on review and analysis of existing data in the RI, the FS, public comments on these documents, and the forthcoming sediment bioassay testing to be performed in Fall 2008. It is possible that these analyses will indicate that the most practicable sediment cleanup levels are between the SQS and CSL criteria.

8.0 INTEGRATED SITEWIDE CLEANUP ACTION ALTERNATIVE

This section presents the recommended sitewide cleanup action alternative for the Site. The recommended sitewide alternative is based on the conclusions of the comparative analyses presented in Sections 6.0 and

7.0 for the MJB North Area, Port Uplands Area, and Marine Area comprising the Site. This section also describes the separate habitat restoration opportunities and future land use considerations associated with the recommended sitewide alternative.

8.1 RECOMMENDED SITEWIDE CLEANUP ACTION ALTERNATIVE

The recommended sitewide cleanup action alternative is a combination of Port Uplands Area Alternative PUA-3, MJB North Area Alternative MJB-2, and Marine Area Alternative M-1. This alternative satisfies the MTCA expectations for cleanup actions, including protection of human health and the environment and management of long-term risks. The final selection of a sitewide cleanup action alternative will be made following public review and comment on the RI/FS and will be formally documented in the CAP. This section summarizes the components of the recommended sitewide cleanup action alternative.

8.1.1 Port Uplands Area

The recommended sitewide alternative component for the Port Uplands Area (PUA-3) meets the MTCA threshold requirements for cleanup actions and has the most favorable disproportionate cost analysis ranking of the three Port Uplands Area alternatives evaluated.

Alternative PUA-3 places emphasis on meeting the CAOs associated with the most immediate risks to potential human and ecological receptors. It addresses these risks through removal of TPH-contaminated soil between 0 and 15 ft BGS in the vicinity of monitoring well MW-110, and removal of soil between 0 to 6 ft BGS containing TPH, cPAHs, and metals in remaining areas (including the 100-ft wide shoreline buffer zone). Institutional controls would be used to prevent exposure to contaminated soil left in place below 6 ft BGS. Alternative PUA-3 addresses the CAOs associated with protection of Fidalgo Bay and Cap Sante Waterway by relying on the capping and wave attenuation components of the recommended Marine Area alternative (M-1) to prevent erosion of contaminated soil left in place at the shoreline. The technologies incorporated into this alternative are proven and can be readily and effectively implemented considering the complexity of work along the shoreline and the administrative and regulatory requirements. The recommended cleanup approach can also be fully integrated with existing operations and future development. The specific components of this alternative are discussed in Section 6.1.3.

Alternative PUA-3 utilizes institutional controls as an administrative method for preventing human and ecological exposure to impacted soil left in place below the proposed 6-ft BGS conditional point of compliance. Soil left in place along the shoreline below the proposed conditional point of compliance would be protected from erosion as a result of the shoreline cap and wave attenuation structures of the recommended Marine Area alternative. These components of the sitewide cleanup action alternative allow for a reduced level of soil removal and reasonable overall remedy cost, while providing an alternative that is protective of both human and ecological receptors.

8.1.2 MJB North Area

The recommended sitewide alternative components for the MJB North Area (MJB-2 or MJB-4) meets the MTCA threshold requirements for cleanup actions and have the most favorable disproportionate cost analysis ranking of the four MJB North Area alternatives evaluated. Alternative MJB-1 had costs disproportionate to its benefits for the MJB North Area. Alternatives MJB-2 and MJB-4 are protective because contaminated soil left in place below 6 ft BGS (below 10 ft BGS in the shoreline buffer zone under Alternative MJB-4) would be completely covered by clean soil, preventing human contact with contaminated soil during routine subsurface work, and preventing contact by terrestrial ecological receptors. Contaminated soil left in place below 6 ft BGS (Alternative MJB-2) or 10 ft BGS (Alternative MJB-4) along the shoreline would be protected from erosion as a result of integrating these alternatives with the armored cap components of the recommended Marine Area alternative (M-1).

Under Alternatives MJB-2 and MJB-4, soil above 6 ft BGS exceeding cleanup levels would either be excavated for off-site disposal or homogenized with clean soil, making these alternatives capable of meeting a conditional point of compliance corresponding to the upper 6 ft of soil (10 ft in the shoreline buffer zone under Alternative MJB-4). In addition, meeting human health-based cleanup levels within the upper 6 ft of soil and implementing institutional controls would significantly reduce the potential for worker exposures, as most subsurface work for redevelopment and maintenance is limited to the upper 6 ft.

The technologies incorporated into Alternatives MJB-2 and MJB-4 are proven and can be readily and effectively implemented considering the complexity of work along the shoreline and the administrative and regulatory requirements. The recommended cleanup approach can also be fully integrated with existing operations and future development. Soil homogenization would result in the permanent reduction of contaminant concentrations to below cleanup levels, thereby eliminating terrestrial ecological risks. Alternatives MJB-2 and MJB-4 are the only alternatives that include methods (soil homogenization) that permanently reduce the toxicity of hazardous constituents, which results in a high ranking for long-term effectiveness. Relatively low-level contaminated soil that is homogenized would not have to be disposed of off-site, resulting in reduced long-term risks as compared to the other alternatives, and limiting potential short-term risks to the immediate vicinity of the MJB North Area. Because homogenized soil would not require off-site transportation, the potential for public exposure to contaminated soil during soil transport would be significantly lower than for Alternative MJB-1. Alternatives MJB-2 and MJB-4 provide benefits similar to the baseline alternative (Alternative MJB-1) and at a substantially lower cost. Alternative MJB-4 provides additional mass removal of relatively deeply buried contaminated soil in the shoreline buffer area, as compared to Alternative MJB-2, though costs are also higher. Both alternatives provide a relatively low risk of a potential erosional source, should a failure of the shoreline armoring occur. Both of these recommended alternatives are compatible with the MTCA preference for alternatives that use permanent solutions, provide for a reasonable restoration time frame, and consider public concerns. Further evaluation of Alternatives MJB-2 and MJB-4 would be performed during development of the Cleanup Action Plan, incorporating updates from the evaluation of the terrestrial ecological risks.

8.1.3 Marine Area

The recommended sitewide alternative component for the Marine Area (M-1) meets the MTCA threshold requirements for cleanup actions, and the disproportionate cost analysis ranks this alternative as the higher of the two Marine Area alternatives evaluated. In this case, the additional cost associated with Marine Area Alternative M-1 relative to Alternative M-2 was determined to not be disproportionate with respect to the incremental degree of protectiveness achieved by Alternative MA-1.

Under the recommended Alternative M-1, sediment exceeding SQS criteria will be removed to the maximum extent practicable, eliminating risks to the aquatic environment. The recommended Marine Area alternative will satisfy shoreline erosion mitigation, and source control objectives, consistent with the recommended upland alternatives for the Port Uplands Area and MJB North Area described above. The specific components of Marine Area Alternative M-1 are discussed in Section 7.1.

To protect shoreline soil at the Port Uplands Area from future erosion, a permanently stable shoreline cap would be constructed using sand and gravel materials, and offshore wave attenuation structures would be constructed to provide the necessary wave attenuation for long-term permanence. Along the MJB North Area shoreline, the shoreline cap would be protected from erosion with a rock armor layer with and sand/gravel top dressing.

In developing the CAP, Ecology will make a final determination of the Site-specific cleanup levels based on review and analysis of existing data in the RI, the FS, public comments on these documents, and the forthcoming sediment bioassay testing to be performed in Fall 2008. It is possible that these analyses will indicate that the most practicable sediment cleanup levels are between the SQS and CSL criteria.

8.2 HABITAT RESTORATION OPPORTUNITIES FOR THE RECOMMENDED SITEWIDE ALTERNATIVE

Under the Puget Sound Initiative, MTCA cleanup actions are expected, where appropriate, to coincidentally enhance and/or restore habitat. The recommended sitewide cleanup action alternative provides significant habitat restoration opportunities and would restore almost 14 acres of currently degraded intertidal and subtidal habitat. As discussed above, the existing riprap and degraded sediments in the intertidal parts of the Marine Area would be replaced with clean sand and gravel beaches that would provide higher quality habitat, particularly for forage fish. In the North Marine Area, degraded sediments within the transitional beach area protected by the wave attenuation structures would be replaced with clean sand and gravel to provide high quality substrate, and eelgrass would be planted in the areas protected by the wave attenuators. This area currently supports little to no eelgrass because of degraded sediment quality.

8.3 FUTURE LAND USE CONSIDERATIONS FOR THE RECOMMENDED SITEWIDE ALTERNATIVE

The recommended sitewide cleanup action alternative is compatible with future expected land use for both the Port and MJB properties, and provides significant public access opportunities. The future expected land use of the MJB property is commercial/residential on the uplands, with possible marina use in the adjacent Marine Area. The recommended sitewide alternative allows for this expected future development activity and provides opportunities for enhanced public access, including shoreline public access to the pocket beach that would be created on the MJB property.

The recommended sitewide alternative would also provide significantly enhanced public access to Fidalgo Bay at the Port Uplands Area. The Port Uplands Area is expected to continue to be used in its current configuration, with commercial uses on Parcels 1 and 2, and Seafarers' Memorial Park on Parcel 3. The recommended cleanup action alternative, including institutional controls, is compatible with this continued pattern of land use. In addition, the recommended alternative would provide opportunities for enhanced shoreline public access amenities as part of an integrated habitat/landscape architecture plan for the Port Uplands Area, and a new focus on small boat use at Seafarers' Memorial Park. The enhanced small boat use would be facilitated by the new beach and calm water area created by the wave attenuation structures, allowing safe launching/landing of small water craft and an inviting public space for staging small boat excursions and events.

9.0 USE OF THIS REPORT

This FS report has been prepared for the exclusive use of the Port of Anacortes, Kimberly-Clark Corporation, MJB Properties, and the Washington State Department of Ecology. Any use of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and written authorization by GeoEngineers, AMEC Geomatrix, Inc., and Anchor Environmental, shall be at the user's sole risk. Any unauthorized use of (or reliance on) this report shall release GeoEngineers, AMEC Geomatrix, Inc., and Anchor Environmental from any liability resulting from such use (or reliance). Within the limitations of scope, schedule, and budget, GeoEngineers', AMEC Geomatrix, Inc.'s, and Anchor Environmental's respective services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. GeoEngineers, AMEC Geomatrix, Inc., and Anchor Environmental assume no responsibility for any consequence arising from any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available.

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TABLE 1
PROPOSED SOIL CLEANUP LEVELS FOR DETECTED CONSTITUENTS
FORMER SCOTT PAPER COMPANY MILL SITE

Constituent	Concentration Protective of Direct Human Contact (a)	Concentration Protective of Groundwater as Marine Surface Water (b)	Concentration Protective of Terrestrial Ecological Receptors (c)	MTCA Method A Cleanup Level (Unrestricted Land Use)	Typical PQL	Natural Background Concentration (d)	**Proposed Soil Cleanup Level**
METALS (mg/kg)							
Antimony	32	580	--	--	1.1	5	32
Arsenic	20 (e)(ca)	20 (e)	20	20	5.9	7	20
Cadmium	80	1.2	25	2	0.2	1	25
Trivalent Chromium	120,000	1,000,000	42 (f)	2,000	0.9	117 (f)(g)	117
Hexavalent Chromium	240	19	42 (f)	19	0.03	117 (f)(g)	117
Copper	2,960	1.4	100	--	0.4	36	100
Lead	250 (e)	1,600	220	250	1.2	17	220
Mercury	24	0.026	9	2	0.03	0.07	9
Nickel	1,600	11	100	--	3.8	38	100
Thallium	5.6	0.67	--	--	0.12	--	5.6
Zinc	24,000	101	270	--	3.4	86	270
TOTAL PETROLEUM HYDROCARBONS (mg/kg)							
Diesel-Range	2,000 (e)	2,000 (e)	460	2,000	18	--	460
Motor Oil-Range	2,000 (e)	2,000 (e)	--	2,000	24	--	2,000
PAHs (ug/kg)							
2-Chloronaphthalene	6,400,000	37,000	--	--	274	--	6,400,000
Naphthalene	1,600,000	138,000	--	5	6.9	--	1,600,000
2-Methylnaphthalene	--	--	--	--	14	--	--
Carbazole	50,000 (ca)	--	--	--	300	--	50,000
Dibenzofuran	160,000	--	--	--	240	--	160,000
Acenaphthylene	--	--	--	--	12	--	--
Acenaphthene	4,800,000	66,000	--	--	13	--	4,800,000
Fluorene	3,200,000	550,000	--	--	9.0	--	3,200,000
Phenanthrene	--	--	--	--	5.8	--	--
Anthracene	24,000,000	12,000,000	--	--	9.2	--	24,000,000
Fluoranthene	3,200,000	89,000	--	--	11	--	3,200,000
Pyrene	2,400,000	3.400.000	--	--	7.0	--	2,400,000
Benzo(g,h,i)perylene	--	--	--	--	270	--	--
Total cPAHs - TEQ	140 (ca)	350	30,000 (h)	100 (h)	--	--	140
SEMIVOLATILE ORGANIC COMPOUNDS (ug/kg)							
4-Methylphenol	400,000	--	--	--	210	--	400,000
Phenol	48,000,000	5,100,000	--	--	212	--	48,000,000

TABLE 1
PROPOSED SOIL CLEANUP LEVELS FOR DETECTED CONSTITUENTS
FORMER SCOTT PAPER COMPANY MILL SITE

Constituent	Concentration Protective of Direct Human Contact (a)	Concentration Protective of Groundwater as Marine Surface Water (b)	Concentration Protective of Terrestrial Ecological Receptors (c)	MTCA Method A Cleanup Level (Unrestricted Land Use)	Typical PQL	Natural Background Concentration (d)	**Proposed Soil Cleanup Level**
VOLATILE ORGANIC COMPOUNDS (ug/kg)							
Acetone	8,000,000	--	--	--	29	--	8,000,000
Carbon Disulfide	8,000,000	--	--	--	2.5	--	8,000,000
m,p-Xylene	16,000,000	--	--	--	7.7	--	16,000,000
PCBs (ug/kg)							
Total PCBs	1,000 (e)(i)	--	2,000	1,000 (i)	--	--	1,000

(a) Washington State Department of Ecology Cleanup Levels and Risk Calculations (CLARC) MTCA Method B standard formula values, except as noted.
(b) Calculated using fixed parameter three-phase partitioning model [WAC 173-340-747(4)] and preliminary groundwater cleanup levels shown in Table 4 of the RI report. Concentrations protective of groundwater as marine surface water were not selected as proposed cleanup levels because groundwater is addressed through an emperical demonstration.
(c) Concentrations based on simplified terrestrial ecological evaluation in WAC 173-340-7492; concentrations listed in Table 749-2 (unrestricted land use values).
(d) Source: *Natural Background Soil Metals Concentrations in Washington State,* Ecology 1994. Listed values (except chromium) are statewide 90th percentile values.
(e) MTCA Method A value shown.
(f) Listed value is for total chromium.
(g) Site-specific natural background concentration, calculated per WAC 173-340-709 and guidance in *Natural Background Soil Metals Concentrations in Washington State,* Ecology 1994.
(h) Listed value is for benzo(a)pyrene.
(i) Concentration based on federal Toxic Substances Control Act (40 CFR 761.61).
(ca) Concentration based on carcinogenic effects.
cPAHs = Carcinogenic polycyclic aromatic hydrocarbons
PCBs = Polychlorinated biphenyls
PQL = Practical quantitation limit
TEQ = Toxicity Equivalent Quotient
-- = Not established, not applicable/available
mg/kg = milligrams per kilogram
ug/kg = micrograms per kilogram
Note: Shaded cell indicates basis for proposed cleanup level.

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TABLE 2
PROPOSED CLEANUP LEVELS FOR GROUNDWATER AS MARINE SURFACE WATER
FORMER SCOTT PAPER COMPANY MILL SITE

				National Recommended Water Quality Criteria (c)											
Constituent	AWQC for Protection of Aquatic Life - Acute (a)	AWQC for Protection of Aquatic Life - Chronic (a)	AWQC for Protection of Human Health - Organisms Only (b)	Protection of Aquatic Life - Acute	Protection of Aquatic Life - Chronic	Protection of Human Health - Organisms Only (Based on 10^{-6} risk for carcinogens)	MTCA Method B Standard Formula Values Carcinogen	MTCA Method B Standard Formula Values Non Carcinogen	Concentration Associated with 10^{-5} Risk (if carcinogen)	**Unadjusted Preliminary Cleanup Level**	PQL 2004 (d)	PQL 2006 (d)	Background	Other Water Quality Information	**Adjusted Preliminary Cleanup Level**
cPAHs (µg/L)															
EPA 8270C-SIM															
Benzo(a)pyrene	--	--	0.031	--	--	0.018	0.030	--	0.30	0.018	0.10	0.10	--	--	0.10
Chrysene	--	--	0.031	--	--	0.018	0.030	--	0.30	0.018	0.10	0.10	--	--	0.10
Benzo(b)fluoranthene	--	--	0.031	--	--	0.018	0.030	--	0.30	0.018	0.10	0.10	--	--	0.10
DISSOLVED METALS (mg/L)															
EPA 6010/7000															
Antimony	--	--	4.3	--	--	0.64	--	1.0	--	0.64	0.00015	0.00012	--	--	0.64
Arsenic	0.069	0.036	0.00014	0.069	0.036	0.00014	0.000098	0.018	0.00098	0.000098	0.00024	0.00054	0.0080 (e)	--	0.0080
Cadmium	0.04	0.0088	--	0.040	0.0088	--	--	0.0203	--	0.0088	--	0.0020	0.0020	--	0.0088
Chromium	1.1	0.050	--	1.1	0.050	--	--	0.486	--	0.050	--	0.011	0.010	--	0.050
Copper	0.005	0.0031	--	0.0048	0.0031	--	--	2.7	--	0.0031	0.0015	0.00072	0.020 (e)	--	0.020
Lead	0.21	0.0081	--	0.21	0.0081	--	--	--	--	0.0081	0.0019	0.0040	--	--	0.0081
Mercury	0.0018	0.000025	0.00015	0.0018	0.00094	0.3	--	--	--	0.000025	--	0.000040	--	--	0.000040
Nickel	0.074	0.0082	4.6	0.074	0.0082	4.6	--	1.1	--	0.0082	0.00074	0.0027	--	0.067; 0.0224 (m)	0.0224
Zinc	0.090	0.081	--	0.090	0.081	26	--	17	--	0.081	--	0.017	0.16	--	0.16
TOTAL PETROLEUM HYDROCARBONS (µg/L)															
NWTPH-Dx															
Diesel-Range	--	--	--	--	--	--	--	--	--	--	--	180	--	500 (n)	500 (n)
Motor Oil-Range	--	--	--	--	--	--	--	--	--	--	--	430	--	500 (n)	500 (n)
VOLATILES (µg/L)															
EPA 8260B															
Acetone	--	--	--	--	--	--	--	--	--	--	12	22	--	--	--
Carbon Disulfide	--	--	--	--	--	--	--	--	--	--	0.90	0.60	--	--	--
2-Butanone	--	--	--	--	--	--	--	--	--	--	2.8	15	--	--	--
Toluene	--	--	200,000	--	--	15,000	--	19,000	--	15,000	1.2	0.87	--	--	15,000
Styrene	--	--	--	--	--	--	--	--	--	--	0.52	0.63	--	--	--
4-Isopropyltoluene	--	--	--	--	--	--	--	--	--	--	--	--	--	4,400; 48,000 (f)	--
SEMIVOLATILES (µg/L)															
EPA 8270C															
Naphthalene	--	--	--	--	--	--	--	4,940	--	4,940	--	5.6	--	--	4,940
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	5.5	--	--	--
Acenaphthene	--	--	--	--	--	990	--	643	--	643	--	5.8	--	--	643
Fluorene	--	--	14,000	--	--	5,300	--	3,460	--	3,460	--	6.0	--	--	3,460
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	6.3	--	--	--
Anthracene	--	--	110,000	--	--	--	--	25,900	--	25,900	--	5.4	--	--	25,900
Fluoranthene	--	--	370	--	--	140	--	90	--	90	--	6.3	--	--	90
Pyrene	--	--	11,000	--	--	4,000	--	2,590	--	2,590	--	6.8	--	--	2,590
4-Methylphenol	--	--	--	--	--	--	--	--	--	--	3.0	6.2	--	30; 120 (g)	--
Benzoic Acid	--	--	--	--	--	--	--	--	--	--	24	66	--	180,000 (h)	--
bis(2-Ethylhexyl)phthalate	--	--	5.9	--	--	2.2	3.6	400	36	2.2	4.9	6.8	--	--	4.9
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--	300 (i)	--
Benzo(a)pyrene	--	--	0.031	--	--	0.018	0.030	--	0.30	0.018	--	4.7	--	--	4.7
Benzo(a)anthracene	--	--	0.031	--	--	0.018	0.030	--	0.30	0.018	--	6.0	--	--	6.0
Benzo(b)fluoranthene	--	--	0.031	--	--	0.018	0.030	--	0.30	0.018	--	4.9	--	--	4.9
Benzo(k)fluoranthene	--	--	0.031	--	--	0.018	0.030	--	0.30	0.018	--	7.2	--	--	7.2
Chrysene	--	--	0.031	--	--	0.018	0.030	--	0.30	0.018	--	7.0	--	--	7.0
Dibenzo(a,h)anthracene	--	--	0.031	--	--	0.018	0.030	--	0.30	0.018	--	6.9	--	--	6.9
Indeno(1,2,3-cd)pyrene	--	--	0.031	--	--	0.018	0.030	--	0.30	0.018	--	6.0	--	--	6.0

TABLE 2
PROPOSED CLEANUP LEVELS FOR GROUNDWATER AS MARINE SURFACE WATER
FORMER SCOTT PAPER COMPANY MILL SITE

				National Recommended Water Quality Criteria (c)											
Constituent	AWQC for Protection of Aquatic Life - Acute (a)	AWQC for Protection of Aquatic Life - Chronic (a)	AWQC for Protection of Human Health - Organisms Only (b)	Protection of Aquatic Life - Acute	Protection of Aquatic Life - Chronic	Protection of Human Health - Organisms Only (Based on 10^{-6} risk for carcinogens)	MTCA Method B Standard Formula Values Carcinogen	MTCA Method B Standard Formula Values Non Carcinogen	Concentration Associated with 10^{-5} Risk (if carcinogen)	**Unadjusted Preliminary Cleanup Level**	PQL 2004 (d)	PQL 2006 (d)	Background	Other Water Quality Information	**Adjusted Preliminary Cleanup Level**
SEMIVOLATILES (µg/L)															
EPA 8270RA (Resin Acids)															
Sandaracopimaric Acid	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Isopimaric Acid	--	--	--	--	--	--	--	--	--	--	--	--	--	400 (j)	--
Dehydroabietic Acid	--	--	--	--	--	--	--	--	--	--	--	--	--	1,100 (j)	--
Abietic Acid	--	--	--	--	--	--	--	--	--	--	--	--	--	700 (j)	--
CONVENTIONALS AND OTHER ORGANICS (mg/L)															
Chloride (EPA 325.2)	--	--	--	--	--	--	--	--	-	--	1.3	0.52	--	--	--
Ammonia (mg-N/L) (unionized)	0.23	0.035	--	pH and temperature dependent		--	--	--	-	(k)	0.040	0.030	--	--	(k)
Nitrate (mg-N/L, Calculated)	--	--	--	--	--	--	--	--	-	--			--	--	--
Nitrite (mg-N/L, EPA 353.2)	--	--	--	--	--	--	--	--	-	--	0.020	0.050	--	--	--
Sulfate (EPA 375.2)	--	--	--	--	--	--	--	--	-	--	11	3.2	--	--	--
Sulfide (EPA 376.2)	--	--	--	--	--	--	--	--	-	--	0.11	0.13	--	30 (l)	--
Phenol (EPA 420.1)	--	--	4,600	--	--	1,700	--	1,100	-	1,100	0.25	0.19	--	--	1,100
Tannins and Lignins (SM18 5550B)	--	--		--	--	--	--	--	--	--	--	--	--	--	--
PCBs (µg/L)															
EPA 8082															
Total PCBs	10	0.030	0.00017	--	0.030	0.000064	--	--	--	0.000064	--	1.8	--	--	1.8
DIOXINS AND FURANS (ng/L)															
Total dioxins/furans TEQ	--	--	0.000014	--	--	0.0000051	8.6E-06	--	0.000086	0.0000051	0.018	0.034	--	--	0.018/0.034

(a) Ambient water quality criteria for protection of aquatic life from WAC 173-201A-040 and 40 C.F.R. Part 131.
(b) Ambient water quality criteria for protection of human health from 40 C.F.R. Part 131d (National Toxics Rule).
(c) National Recommmended Water Quality Criteria (EPA 2006).
(d) Practical quantitation limit (PQL) calculated from laboratory method detection limit (MDL); PQL = 10x MDL.
(e) Natural background based on "Draft Report, Sections 1-7 Background Concentrations of Selected Chemicals in Water, Soil, Sediments, or Air of Washington State (PTI 1989).
(f) LC50 Opossum shrimp, SW = 4,400; LC50 sheepshead minnow, SW = 48,000; from U.S. EPA EcoTox Database.
(g) Water quality objective, 6-month median; daily maximum from "A Compilation of Water Quality Goals" (CalEPA 2003).
(h) Fresh water ecological LC50 from U.S. EPA Superfund Chemical Data Matrix.
(i) NOAA SQUIRT Screening Quick Reference Tables.
(j) LC50 for rainbow trout from "Biological Degradation of Resin Acids in Wood Chips by Wood-Inhabiting Fungi" (Applied and Environmental Microbiology, Jan. 1995, p. 22-225).
(k) Water quality criterion for unionized ammonia is 0.035 mg N/L. Expressed as total ammonia, this criterion would be 3.2 - 74 mg N/L, using the temperature, pH, and chloride concentrations measured in the shoreline wells. Ammonia cleanup level expressed as total ammonia is calculated for each monitoring event in each shoreline well using Ecology Spreadsheet for Water Quality-Based NPDES Permit Calculations (Ecology 2004b).
(l) 30 mg/L was identified during the 2005 Sediment Management Annual Review Meeting as a concentration in porewater above which significant amphipod mortality may result during standard marine sediment bioassays (Caldwell 2005).
(m) Acute (0.067 mg/L) and chronic (0.0224 mg/L) values for protection of aquatic life based on peer-reviewed data (Hunt et al. 2002). EPA is in the process of updating marine nickel water quality criteria.
(n) MTCA Method A cleanup level used in accordance with WAC 173-340-730(3)(b)(iii)(C) because no cleanup levels protective of marine surface water have been established for TPH.
TEQ = Toxicity Equivalent Quotient
mg/L = milligrams per liter
ug/L = micrograms per liter
ng/L = nanograms per liter
Note: Shaded cell indicates basis for preliminary cleanup level.

TABLE 3
PROPOSED SEDIMENT CLEANUP LEVELS
FORMER SCOTT PAPER COMPANY MILL SITE

Chemicals		Proposed Cleanup Level (1)	CSL
Conventionals (%)			
	Total organic carbon	--	--
	Total volatile solids (%)	9.7 (2)	15 (3)
Metals (mg/kg)			
	Arsenic	57	93
	Cadmium	5.1	6.7
	Chromium	260	270
	Copper	390	390
	Lead	450	530
	Mercury	0.41	0.59
	Silver	6.1	6.1
	Zinc	410	960
PCBs (mg/kg-OC)			
	Total PCBs	12	65
LPAHs (mg/kg-OC)			
	Naphthalene	99	170
	Acenaphthylene	66	66
	Acenaphthene	16	57
	Fluorene	23	79
	Phenanthrene	100	480
	Anthracene	220	1,200
	2-Methylnaphthalene	38	64
	Total LPAH	370	780
HPAHs (mg/kg-OC)			
	Fluoranthene	160	1,200
	Pyrene	1,000	1,400
	Benzo(a)anthracene	110	270
	Chrysene	110	460
	Total benzofluoranthenes	230	450
	Benzo(a)pyrene	99	210
	Indeno(1,2,3-cd)pyrene	34	88
	Dibenzo(a,h)anthracene	12	33
	Benzo(g,h,i)perylene	31	78
	Total HPAH	960	5,300
Misc. SVOCs (mg/kg-OC)			
	1,2-Dichlorobenzene	2.3	2.3
	1,4-Dichlorobenzene	3.1	9
	1,2,4-Trichlorobenzene	0.81	1.8
	Hexachlorobenzene	0.38	2.3
	Dimethylphthalate	53	53
	Diethylphthalate	61	110
	Di-n-butylphthalate	220	1,700
	Butylbenzylphthalate	4.9	64
	bis(2-ethylhexyl)phthalate	47	78
	Di-n-octylphthalate	58	4,500
	Dibenzofuran	15	58
	Hexachlorobutadiene	3.9	6.2
	n-Nitroso-di-phenylamine	11	11
Misc. SVOCs (µg/kg)			
	Phenol	420	1,200
	2-Methylphenol	63	63
	4-Methylphenol	670	670
	2,4-Dimethylphenol	29	29
	Pentachlorophenol	360	690
	Benzyl alcohol	57	73
	Benzoic acid	650	650
Dioxins/Furans (ng/kg)			
	Dioxin TEQ	15 (4)	--

Notes:

(1) Proposed cleanup levels are based on the SQS (Sediment Quality Standards - WAC 173-204-320) unless otherwise indicated.

(2) Total volatile solids SQS criterion based on site-specific bioassays (see text)

(3) Total volatile solids CSL criterion based on site-specific bioassays (see text)

(4) Dioxin toxicity equivalent quotient (TEQ) screening value (PSDDA 2000)

CSL - Cleanup Screening Level

Highlighted analytes denote chemicals of potential concern in Former Scott Mill Site sediments

TABLE 4
SOIL REMEDIATION TECHNOLOGY SCREENING
FORMER SCOTT PAPER COMPANY MILL SITE

General Response Action	Remediation Technology	Process Option	Description	Effectiveness	Implementability	Relative Cost	Summary of Screening
No Action	No Action	None	No institutional controls or treatment.	Not effective for protecting human health and environment.	Implementable but not acceptable to the general public or government agencies.	None	Sometimes used as a baseline for comparison. Not retained
Institutional Controls/ Limited Action	Institutional Control	Deed Notification/ Restriction	Implement deed notification to inform future owners of the presence of potentially hazardous substances at the site and /or implement deed restriction to restrict future use of site.	Effectiveness for protection of human health would depend on enforcement of and compliance with deed restrictions	Technically implementable. Specific legal requirements and authority would need to be met.	Low capital	Potentially applicable in combination with other technologies. Retained
	Access Control	Fencing /warning signage	Construct or maintain existing site fencing and signage to control site access by the general public thereby reducing potential exposure to contaminants	Effective for reducing exposure risk to the general public provided fencing and signage is maintained in the long term.	Technically implementable but not consistent with current and proposed future land use.	Low capital.	Not consistent with current and proposed future land use. Not retained.
Soil Containment	Capping	Surface Cap	Installation of surface cap over contaminated soil areas to prevent or reduce contaminant migration and to prevent exposure. Multiple-component cap may include asphalt or concrete paving, synthetic membranes, low permeability soil caps in landscaped areas, and existing or new buildings or structures.	Effective for preventing direct contact exposure (i.e. dermal contact or ingestion). Limits infiltration and leachate formation, but less effective than source removal options for protection of groundwater.	Technically implementable. The selected capping technology must be consistent with proposed future land use. Existing asphalt and concrete pavement and historical buildings and structures currently cap shallow impacted soil.	Low capital	Potentially applicable in combination with other technologies. Retained
Soil Removal	Removal/Off-Site Disposal	Excavation	Excavation of impacted material using common excavation methods for upland soil removal. Excavation at the site will likely require shoring methods to allow excavation near buildings and dewatering techniques to allow dry excavation.	Effective for complete range of contaminant groups.	Technically implementable in most areas of contaminated soil. Pretreatment of excavated material may be required to meet land disposal restrictions.	Moderate to high capital. Negligible O&M.	Potentially applicable in areas not occupied by buildings. Retained.
Off-site management	Land disposal	Landfill	Disposal of impacted soil at a permitted, off-site landfill. Some of the contaminants or more highly concentrated contaminants may require treatment prior to landfill disposal.	Effective for most contaminant groups. Some soil may require treatment due to land disposal restrictions.	Technically implementable. Impacted soil must be profiled and meet land disposal restrictions. Pre-treatment may be required if material does not meet restrictions.	Moderate to high capital depending on types of waste present. Negligible O&M	Common disposal option for excavated soils, where appropriate. Retained.
Ex Situ Soil Treatment	Physical/Chemical Treatment	Stabilization	Contaminants are physically bound or enclosed within a stabilized mass or chemical reactions are induced between stabilizing agent and contaminants to reduce their mobility.	Stabilization is a common and effective technology for reducing the leachability of metals in soil.	Technically implementable. However most processes result in significant increase in volume.	Moderate capital. Low O&M. Moderate cost relative to other ex situ physical/chemical options. Significant cost savings for disposal.	Potentially applicable for metals impacted soil. Retained.
		Soil Washing	Wash soil with water-based surfactants, detergents, acids, etc., to remove chemicals from soil particles. Treat or dispose of high chemical concentration residuals fluids.	Most effective for high-concentration inorganic chemicals, SVOCs and fuels. Removal of organics adsorbed to clay-sized particles may be difficult.	Difficult to implement for complex waste mixtures. Complex mixtures of contaminants can make formulation of washing fluids difficult. Residuals may be difficult to extract from matrix and may require additional treatment/disposal.	High capital and O&M. High cost relative to other ex situ physical/chemical options	Difficult to implement. Difficult to formulate washing fluids for complex waste mixtures. Soils may remain toxic due to difficulty extracting residual fluids. Not retained.
		Incineration	High temperatures, 871-1,204 °C (1,600-2,200 °F), are used to combust (in the presence of oxygen) organic constituents in hazardous wastes.	Effective for removing/destroying chlorinated hydrocarbons. Not effective for inorganic chemicals.	Technically implementable. Incineration would be accomplished at a permitted off-site facility.	High capital and high O&M. High cost relative to other ex situ options	High cost relative to other ex situ technologies. Not retained.
		Thermal Desorption	Wastes are heated within a continuous flow reactor to 320 to 560 °C to volatilize organic contaminants. A carrier gas or vacuum system transports volatilized organics to the gas treatment system.	Effective for VOCs, SVOCs and fuels. Fine grained soils increase treatment time as a result of binding of contaminants to soil.	Technically implementable. However, particles size screening, dewatering to achieve acceptable moisture content, and off-gas treatment may be required.	High capital. High O&M. Lower cost than incineration.	High cost relative other ex situ technologies. Extensive preparation for treatment will be required. Not retained.
	Biological Treatment	Biopiles	Excavated soils are mixed with soil amendments and placed on a treatment area that includes leachate collection systems and some form of aeration.	Solid-phase (soil) process is most effective for non-halogenated VOCs and fuel hydrocarbons.	Difficult to implement. Treatment area may require complete enclosure. Addition of amendment material results in volumetric increase in treated material. Leachate and off-gas may require treatment.	Moderate capital and O&M. Moderate cost relative to other ex situ biological options	Limited effectiveness for some halogenated VOCs and difficult to implement. Not retained
		Composting	Controlled biological process by which excavated soils are mixed with bulking agents and organic amendments to enhance microorganism conversion of organic contaminants to innocuous, stabilized byproducts.	Most effective for treatment of fuels and PAHs. Moderately effective for treatment of halogenated VOCs.	Difficult to implement. Treatment area may require complete enclosure. Addition of amendment material results in volumetric increase in treated material. Off-gas may require treatment.	Moderate capital and O&M. Moderate cost relative to other ex situ biological options	Difficult to implement. Generally not cost effective for volatile compounds compared to other in situ technologies. Not retained
In Situ Soil Treatment	Biological Treatment	Bioventing	Oxygen is supplied through direct low-flow air injection into residual contamination in soil.	Effective in higher permeability soil for petroleum hydrocarbons and non-halogenated VOCs amenable to aerobic bioremediation. Degradation is relatively slow. Ineffective for inorganics and non-degradable organic constituents.	Technically implementable. Monitoring of off-gasses at ground surface may be required. Venting requires infrastructure of air injection piping, blower, controls, etc.	Moderate capital and O&M. Low cost relative to other in situ options.	Slow technology. Not effective for metals or other recalcitrant contaminants. Not retained.
		Natural Attenuation	Natural biotransformation processes such as volatilization, biodegradation, adsorption, and chemical reactions with soil materials can reduce contaminant concentrations to acceptable levels.	Generally not effective for quickly reducing risk to human health and ongoing threats to groundwater. Effectiveness is highest in combination with other technologies as a final step to achieve cleanup levels when risks to human health and the environment are low.	Technically implementable. Monitoring may be required to ensure adequate reduction rate. May require institutional controls during treatment period.	Negligible capital. Low O&M. Low cost relative to other in situ options	Slow technology. Not effective for metals or other recalcitrant contaminants. Not retained.
	Physical/Chemical Treatment	Soil Flushing	The extraction of contaminants from soil with aqueous solution accomplished by passing fluid through in-place soils using an injection or infiltration process. Extraction fluids must be recovered from underlying aquifer.	Effective for VOCs and inorganic chemicals. Presence of fine grained soils limits effectiveness.	Technically implementable. However, there has been little commercial application. Regulatory concerns over potential to wash contaminants beyond fluid capture zones and introduction of surfactants in to the subsurface make permitting difficult.	High capital and O&M. High cost relative to other in situ options	High cost relative to other in situ soil treatment technologies. Not retained.
		Soil Vapor Extraction	Vacuum is applied through extraction pipes to create a pressure/concentration gradient in impacted areas, which induces gas-phase volatiles to diffuse through soil to extraction wells. The process includes a system for treating off-gas. Air flow also induces aerobic bioremediation of petroleum hydrocarbons.	Effective for VOCs in granular soils. Presence of fine grained soils reduces effectiveness. Not significantly effective for heavier hydrocarbons or in low permeability soil. Ineffective for inorganics and non-volatile organic constituents.	Technically implementable. Typical application involves numerous extraction wells, conveyance piping, and large scale vacuum blowers.	High capital and O&M. High cost relative to other in situ options	Generally not effective for site contaminents. Not retained.

Notes: Shaded Process Options are retained.

TABLE 5
SEDIMENT REMEDIATION TECHNOLOGY SCREENING
FORMER SCOTT PAPER COMPANY MILL SITE

General Response Action	Remediation Technology	Process Option	Description	Effectiveness	Implementability	Relative Cost	Summary of Screening
No Action	No Action	None	No institutional controls or treatment.	Not effective for protecting human health and environment.	Implementable but not acceptable to the general public or government agencies.	None	Sometimes used as a baseline for comparison. Not retained
Sediment and Debris Containment	Capping	Surface Cap	Containment for sediments involves placing an engineered aggregate cap to isolate material that could otherwise not be effectively removed through excavation or dredging. In the aquatic environment, the cap must be designed to withstand erosive forces generated by wave action, and must be thick enough to provide the required isolation of the material contained by the cap	Effective for preventing direct contact exposure and for containing source material from erosion. Aquatic caps are designed using methods developed by the Corps of Engineers.	Technically implementable. Aquatic caps have been successfully constructed in multiple Puget Sound locations, and at marine sites across the country.	Moderate capital. Potentially moderate O&M depending on the design of the cap to resist wave erosion, or the installation of other site features to minimize wave energy on the cap.	Potentially applicable in combination with other technologies. Retained
Sediment and Debris Removal	Removal/Off-Site Disposal	Excavation/Dredging	Excavation of impacted material using common excavation methods. Removal of sediments could be performed from the water using barge-mounted excavation equipment (i.e. dredging), or from the land at low tide using land-based earthwork equipment.	Effective for complete range of contaminant groups. Dredging is considered in conjunction with capping where the target sediments cannot be completely removed due to access issues. Dredging could potentially generate residuals that would be managed by placing a clean cover of sand over the dredge prism limits after dredging has been completed.	Technically implementable. Dredging is commonly used in the marine environment to remove impacted sediments. Placement of clean residuals cover over the dredge prism has been demonstrated at several sites in the Puget Sound area.	Moderate to high capital. Potentially moderate O&M depending on the nature of any cap that is required.	Potentially applicable in combination with other technologies. Retained
Off-site management	Land disposal	Landfill	Disposal of impacted sediment at a permitted, off-site landfill. Based on the RI data, no sediment materials have been identified that would require treatment prior to landfill disposal. Regional landfills are available that can accept free liquids along with the sediment.	Effective for all identified contaminant groups.	Technically implementable. Impacted sediment must be profiled to verify that the materials meet land disposal restrictions.	Moderate to high capital cost. Negligible O&M.	Common disposal option for excavated and/or dredged sediments, where appropriate. Retained.
	Open-water disposal at a suitable non-dispersive DMMP site	Bottom-dump barge release	Large woody debris would need to be separated from the sediments and either reused or disposed at a suitable upland location. Sediments targeted for open-water disposal would require a suitability determination from the DMMP. Based on the RI data, offshore woody debris sediments appear suitable for disposal at the Port Gardner site.	Effective for all identified contaminant groups, subject to concurrence by the DMMP.	Technically implementable. Impacted sediment must be profiled to verify that the materials meet DMMP suitability criteria.	Low to moderate capital cost depending on the degree of rehandling required for intertidal and subtidal sediments. Negligible O&M.	Common disposal option for dredged sediments, where appropriate. Retained.
In Situ Sediment Treatment	Biological Treatment	Natural Attenuation	Natural biotransformation processes such as biodegradation and sedimentation can reduce contaminant concentrations and deleterious characteristics to acceptable levels over time.	Generally not effective for quickly reducing risk from wood waste in the aquatic environment, considering the age of remaining wood deposits at the site.	Technically implementable. Monitoring may be required to ensure adequate reduction rate. May require institutional controls during treatment period.	Negligible capital. Low O&M.	Very slow technology for wood waste materials. Not retained.

Notes: Shaded Process Options are retained.

TABLE 6
DESCRIPTION OF CLEANUP ACTION ALTERNATIVES - PORT UPLANDS AREA
FORMER SCOTT PAPER COMPANY MILL SITE

Site Subunit	Matrix	Contaminants Exceeding Proposed Cleanup Levels	Objective	CLEANUP ACTION ALTERNATIVE COMPONENTS			
				Alternative PUA-1	Alternative PUA-2	Alternative PUA-3	Alternative PUA-4
Shoreline Buffer Zone (1)	Soil Exceeding Human Health and Terrestrial Ecological Cleanup Levels and Sediment Quality Standards for Mercury, Lead, and Copper	TPH, PAHs, Metals	Prevent terrestrial ecological and human contact with soil containing contaminants above proposed cleanup levels based on risk to respective receptors. Remove source material with potential to cause contamination of adjacent Marine Area sediments. Restore shoreline habitat.	- Excavate to the extent feasible, soil between 0 and 15 ft BGS exceeding human health and terrestrial ecological cleanup levels in a shoreline buffer zone between the MHHW line and 100 ft inland from the MHHW line. Within the shoreline buffer zone, excavation would also achieve the sediment quality standard for mercury, lead, and copper. - Dispose of contaminated soil at approved off-site disposal facility based on contaminant concentrations. - Backfill to restore original land topography, restore site features and surfaces. - Restore shoreline habitat.	- Excavate to the extent feasible, soil between 0 and 15 ft BGS exceeding human health and terrestrial ecological cleanup levels in a shoreline buffer zone between the MHHW line and 100 ft inland from the MHHW line. Within the shoreline buffer zone, excavation would also achieve the sediment quality standard for mercury, lead, and copper. - Dispose of contaminated soil at approved off-site disposal facility based on contaminant concentrations. - Backfill to restore original land topography, restore site features and surfaces. - Restore shoreline habitat.	- Excavate to the extent feasible, soil between 0 and 6 ft BGS exceeding human health and terrestrial ecological cleanup levels in a shoreline buffer zone between the MHHW line and 100 ft inland from the MHHW line. Within the shoreline buffer zone, excavation would also achieve the sediment quality standard for mercury, lead, and copper. - Dispose of contaminated soil at approved off-site disposal facility based on contaminant concentrations. - Backfill to restore original land topography, restore site features and surfaces. - Restore shoreline habitat. - Develop institutional controls in the form of restrictive covenants to ensure current and future property owners are aware of remaining contaminated soil and the requirements for protection of future site workers and terrestrial ecological receptors.	- Excavate to the extent feasible, soil between 0 and 10 ft BGS exceeding human health and terrestrial ecological cleanup levels in a shoreline buffer zone between the MHHW line and 75 ft inland from the MHHW line. Within the shoreline buffer zone, excavation would also achieve the sediment quality standard for mercury, lead, and copper. - Dispose of contaminated soil at approved off-site disposal facility based on contaminant concentrations. - Backfill to restore original land topography, restore site features and surfaces. - Restore shoreline habitat. - Develop institutional controls in the form of restrictive covenants to ensure current and future property owners are aware of remaining contaminated soil and the requirements for protection of future site workers and terrestrial ecological receptors.
Remaining Upland Areas	Soil - 0 to 6 ft BGS Exceeding Human Health and Terrestrial Ecological Cleanup Levels	TPH, PAHs, Metals	Prevent terrestrial ecological and human contact with soil containing contaminants above proposed cleanup levels based on risk to respective receptors.	- Excavate to the extent feasible, soil exceeding human health and terrestrial ecological cleanup levels. - Disposal and site restoration as per shoreline buffer zone description. - Additional soil bioassay testing to be performed may show that terrestrial ecological risks are not present in certain areas of the Site.	- Excavate to the extent feasible, soil exceeding human health and terrestrial ecological cleanup levels. - Disposal and site restoration as per shoreline buffer zone description. - Additional soil bioassay testing to be performed may show that terrestrial ecological risks are not present in certain areas of the Site.	- Excavate to the extent feasible, soil exceeding human health and terrestrial ecological cleanup levels. - Disposal and site restoration as per shoreline buffer zone description. - Additional soil bioassay testing to be performed may show that terrestrial ecological risks are not present in certain areas of the Site.	- Excavate to the extent feasible, soil exceeding human health and terrestrial ecological cleanup levels. - Disposal and site restoration as per shoreline buffer zone description. - Additional soil bioassay testing to be performed may show that terrestrial ecological risks are not present in certain areas of the Site.
	Soil - 6 to 15 ft BGS Exceeding Human Health and Terrestrial Ecological Cleanup Levels	TPH, PAHs, Metals	Prevent terrestrial ecological and human contact with soil containing contaminants above proposed cleanup levels based on risk to respective receptors.	- Excavate to the extent feasible, soil exceeding human health and terrestrial ecological cleanup levels. - Disposal and site restoration as per shoreline buffer zone description.	- Excavate soil at sample location ET-TP03 on Parcel 1 that exceeds human health cleanup level for arsenic (approximately 10 ft BGS). - Disposal and site restoration as per shoreline buffer zone description. - Develop institutional controls in the form of restrictive covenants to ensure current and future property owners (Parcels 2 and 3) are aware of remaining contaminated soil and the requirements for protection of future site workers and terrestrial ecological receptors.	- Excavate soil at sample location ET-TP03 on Parcel 1 that exceeds human health cleanup level for arsenic (approximately 10 ft BGS). - Develop institutional controls in the form of restrictive covenants to ensure current and future property owners are aware of remaining contaminated soil and the requirements for protection of future site workers and terrestrial ecological receptors.	- Excavate soil at sample location ET-TP03 on Parcel 1 that exceeds human health cleanup level for arsenic (approximately 10 ft BGS). - Disposal and site restoration as per shoreline buffer zone description. - Develop institutional controls in the form of restrictive covenants to ensure current and future property owners (Parcels 2 and 3) are aware of remaining contaminated soil and the requirements for protection of future site workers and terrestrial ecological receptors.
			Remove source of free-phase petroleum product in MW-110. Prevent contamination of groundwater and surface water through potential transfer of TPH from soil to groundwater.	-Excavate to the extent feasible, soil containing TPH and free product exceeding human health cleanup levels in the vicinity of monitoring well MW-110. - Disposal and site restoration as per shoreline buffer zone description.	-Excavate to the extent feasible, soil containing TPH and free product exceeding human health cleanup levels in the vicinity of monitoring well MW-110. - Disposal and site restoration as per shoreline buffer zone description.	-Excavate to the extent feasible, soil containing TPH and free product exceeding human health cleanup levels in the vicinity of monitoring well MW-110. - Disposal and site restoration as per shoreline buffer zone description.	-Excavate to the extent feasible, soil containing TPH and free product exceeding human health cleanup levels in the vicinity of monitoring well MW-110. - Disposal and site restoration as per shoreline buffer zone description.
	Groundwater Exceeding Cleanup Levels Protective of Marine Surface Water	TPH, Arsenic	Confirm no migration of contaminated groundwater to adjacent soil and sediment or future impacts to surface water.	Install new monitoring well network and monitor a minimum of quarterly for one year.	Install new monitoring well network and monitor a minimum of quarterly for one year; perform long-term monitoring as required by Ecology.	Install new monitoring well network and monitor a minimum of quarterly for one year; perform long-term monitoring as required by Ecology.	Install new monitoring well network and monitor a minimum of quarterly for one year; perform long-term monitoring as required by Ecology.
			Estimated Alternative Cost (+50%/-30%, rounded)	$18,300,000	$11,500,000	$4,800,000	$9,100,000
			Estimated Volume of Contaminated Soil Removed	53,000 cubic yards	31,000 cubic yards	15,500 cubic yards	23,500 cubic yards
			Estimated Timeframe to Closure (2)	Two to three years	Two to three years	Two to three years	Two to three years

Notes:

(1) 100-ft zone inland from MHHW for Alternatives PUA-1, PUA-2, and PUA-3; 75-ft zone inland from MHHW for Alternative PUA-4. Buffer zones established by Ecology.
(2) From initiation of remedial design through construction completion.

TABLE 7
EVALUATION OF CLEANUP ACTION ALTERNATIVES - PORT UPLANDS AREA
FORMER SCOTT PAPER COMPANY MILL SITE

	Alternative PUA-1	Alternative PUA-2	Alternative PUA-3	Alternative PUA-4
Alternative Description	- Excavate to the extent feasible, soil between 0 and 15 ft BGS in the shoreline buffer zone exceeding human health and terrestrial ecological cleanup levels. - Excavate to the extent feasible, soil between 0 and 15 ft BGS in the remaining upland areas exceeding human health and terrestrial ecological cleanup levels. - Dispose of contaminated soil at approved off-site disposal facility based on contaminant concentrations. - Backfill to restore original land topography, restore site features and surfaces. - Install new monitoring well network and monitor a minimum of quarterly for one year. - Restore shoreline habitat.	- Excavate to the extent feasible, soil between 0 and 15 ft BGS in the shoreline buffer zone exceeding human health and terrestrial ecological cleanup levels. - Excavate soil at sample location ET-TP03 on Parcel 1 that exceeds human health cleanup level for arsenic (approximately 10 ft BGS). - Remove TPH-contaminated soil to a depth of up to 15 ft BGS in vicinity of monitoring well MW-110. - Excavate to the extent feasible, soil between 0 and 6 ft BGS in the remaining upland areas exceeding human health and terrestrial ecological cleanup levels to establish a conditional point of compliance. - Dispose of contaminated soil at approved off-site disposal facility based on contaminant concentrations. - Backfill to restore to original land topography, restore site features and surfaces. - Install new monitoring well network and monitor a minimum of quarterly for one year; perform long-term groundwater monitoring as required by Ecology. - Administer institutional controls (restrictive covenants) to prevent future human (site worker) and terrestrial ecological exposure to, and ensure proper disposal of, soil left in place below 6 ft BGS containing contaminants above proposed cleanup levels. - Restore shoreline habitat.	- Excavate to the extent feasible, soil between 0 and 6 ft BGS throught site exceeding human health and terrestrial ecological cleanup levels. - Remove TPH-contaminated soil to a depth of up to 15 ft BGS in vicinity of monitoring well MW-110. - Excavate soil at sample location ET-TP03 on Parcel 1 that exceeds human health cleanup level for arsenic (approximately 10 ft BGS). - Dispose of contaminated soil at approved off-site disposal facility based on contaminant concentrations. - Backfill to restore original land topography, restore site features and surfaces. - Install new monitoring well network and monitor a minimum of quarterly for one year; perform long-term groundwater monitoring as required by Ecology. - Administer institutional controls (restrictive covenants) to prevent future human (site worker) and terrestrial ecological exposure to, and ensure proper disposal of, soil left in place below 6 ft BGS containing contaminants above proposed cleanup levels. - Restore shoreline habitat.	- Excavate to the extent feasible, soil between 0 and 10 ft BGS in a 75-foot shoreline buffer zone exceeding human health and terrestrial ecological cleanup levels. Within the shoreline buffer zone, excavation would also achieve the sediment quality standard for mercury, lead, and copper. - Excavate soil at sample location ET-TP03 on Parcel 1 that exceeds human health cleanup level for arsenic (approximately 10 ft BGS). - Remove TPH-contaminated soil to a depth of up to 15 ft BGS in vicinity of monitoring well MW-110. - Excavate to the extent feasible, soil between 0 and 6 ft BGS in the remaining upland areas exceeding human health and terrestrial ecological cleanup levels to establish a conditional point of compliance. - Dispose of contaminated soil at approved off-site disposal facility based on contaminant concentrations. - Backfill to restore original land topography, restore site features and surfaces. - Install new monitoring well network and monitor a minimum of quarterly for one year; perform long-term groundwater monitoring as required by Ecology. - Administer institutional controls (restrictive covenants) to prevent future human (site worker) and terrestrial ecological exposure to, and ensure proper disposal of, soil left in place below 6 ft BGS containing contaminants above proposed cleanup levels. - Restore shoreline habitat.
Alternative Ranking Under MTCA				
1. Compliance with MTCA Threshold Criteria				
Protection of Human Health and the Environment	Yes - Alternative would protect human health and the environment.	Yes - Alternative would protect human health and the environment through a combination of removal and institutional controls.	Yes - Alternative would protect human health and the environment through a combination of removal and institutional controls.	Yes - Alternative would protect human health and the environment through a combination of removal and institutional controls.
Compliance With Cleanup Standards	Yes - Alternative is expected to comply with cleanup standards as negotiated with Ecology.	Yes - Alternative is expected to comply with cleanup standards as negotiated with Ecology. This alternative utilizes institutional controls to prevent exposure to soil left in place below 6 ft BGS containing contaminants exceeding human health and terrestrial ecological cleanup levels. Compliance would rely on long-term monitoring and maintenance of intitutional controls. Future development of property could potentially require additional environmental cleanup or special provisions.	Yes - Alternative is expected to comply with cleanup standards as negotiated with Ecology. In the limited areas where soil is left in place below 6 ft BGS, this alternative utilizes institutional controls to prevent exposure to soil left in place below 6 ft BGS containing contaminants exceeding human health and terrestrial ecological cleanup levels. Marine wave attenuation would be necessary to prevent potential erosion of contaminated soil left in place in the shoreline buffer zone. Compliance would rely on long-term monitoring and maintenance of intitutional controls. Future development of property could potentially require additional environmental cleanup or special provisions.	Yes - Alternative is expected to comply with cleanup standards as negotiated with Ecology. This alternative utilizes institutional controls to prevent exposure to soil left in place below 6 ft and/or 10 ft BGS containing contaminants exceeding human health and terrestrial ecological cleanup levels. Marine wave attenuation would be necessary to prevent potential erosion of contaminated soil left in place in the shoreline buffer zone. Compliance would rely on long-term monitoring and maintenance of intitutional controls. Future development of property could potentially require additional environmental cleanup or special provisions.
Compliance With Applicable State and Federal Regulations	Yes - Alternative complies with applicable state and federal regulations.	Yes - Alternative complies with applicable state and federal regulations. Future development of property could potentially require additional environmental cleanup or special provisions.	Yes - Alternative complies with applicable state and federal regulations. Future development of property could potentially require additional environmental cleanup or special provisions.	Yes - Alternative complies with applicable state and federal regulations. Future development of property could potentially require additional environmental cleanup or special provisions.
Provision for Compliance Monitoring	Yes - Alternative includes provisions for compliance monitoring.	Yes - Alternative includes provisions for compliance monitoring.	Yes - Alternative includes provisions for compliance monitoring.	Yes - Alternative includes provisions for compliance monitoring.
2. Restoration Time Frame				
	Restoration time frame is relatively short. This alternative is expected to require two to three years for design and construction and would result in no need for additional remedial action.	Initial restoration time frame is relatively short. This alternative is expected to require two to three years for design and construction. The time frame for long-term monitoring is unknown. Potential future maintenance of institutional controls and coordination of proper handling and disposal of contaminated soil during future site development may extend the restoration time frame of this alternative.	Initial restoration time frame is relatively short. This alternative is expected to require two to three years for design and construction. The time frame for long-term monitoring is unknown. Potential future maintenance of institutional controls and coordination of proper handling and disposal of contaminated soil during future site development may extend the restoration time frame of this alternative.	Initial restoration time frame is relatively short. This alternative is expected to require two to three years for design and construction. The time frame for long-term monitoring is unknown. Potential future maintenance of institutional controls and coordination of proper handling and disposal of contaminated soil during future site development may extend the restoration time frame of this alternative.

TABLE 7
EVALUATION OF CLEANUP ACTION ALTERNATIVES - PORT UPLANDS AREA
FORMER SCOTT PAPER COMPANY MILL SITE

	Alternative PUA-1	Alternative PUA-2	Alternative PUA-3	Alternative PUA-4
3. Disproportionate Cost Analysis Relative Benefits Ranking (Scored from 1-lowest to 5-highest)				
Protectiveness	Score = 5 Achieves a high level of overall protectiveness as a result of removal of the soil that poses risk to human and ecological receptors at the Site.	Score = 4 Achieves a medium-high level of overall protectiveness as a result of removal of the near-surface soil that poses risk to human and ecological receptors at the Site. However, this alternative would leave in place deeper contaminated soil, and protectiveness would rely on maintenance of institutional controls to prevent exposure.	Score = 3 Achieves a medium level of overall protectiveness as a result of removal of the near-surface soil that poses risk to human and ecological receptors at the Site. However, this alternative would leave in place deeper contaminated soil, including along the shoreline, and protectiveness would rely on maintenance of institutional controls to prevent exposure and implementation of appropriate marine remedy to prevent erosion.	Score = 4 Achieves a medium-high level of overall protectiveness as a result of removal of the near-surface soil that poses risk to human and ecological receptors at the Site. However, this alternative would leave in place deeper contaminated soil, including along the shoreline, and protectiveness would rely on maintenance of institutional controls to prevent exposure and implementation of appropriate marine remedy to prevent erosion.
Permanence	Score = 5 Achieves a high level of permanent reduction of mass, toxicity, and mobility of hazardous substances at the Site through direct removal and disposal of the excavated material at appropriate off-site facilities. However, the elemental nature of some contaminants (i.e., metals) precludes the MTCA preference for destruction of contaminants. This alternative would reduce to the extent feasible the need to perform additional actions as the result of future development.	Score = 4 Achieves permanent reduction of mass, toxicity, and mobility of hazardous substances at the Site, but to a lower degree than Alternative PUA-1. The quantity of impacted soil allowed to remain on site is greater than with Alternative PUA-1. Future development may require modification of the remedy.	Score = 3 Achieves permanent reduction of mass, toxicity, and mobility of hazardous substances at the Site, but to a lower degree than Alternative PUA-2. Would rely on wave attenuation to prevent erosion of shoreline contaminants. The quantity of impacted soil left in place would be greater than with Alternatives PUA-1 and PUA-2. Future development may require modification of the remedy.	Score = 4 Achieves permanent reduction of mass, toxicity, and mobility of hazardous substances at the Site, but to a lower degree than Alternative PUA-1. Would rely on wave attenuation to prevent erosion of shoreline contaminants. The quantity of impacted soil left in place would be greater than with Alternatives PUA-1 and PUA-2. Future development may require modification of the remedy.
Long-Term Effectiveness	Score = 5 Removes hazardous substances from the Site to the greatest degree feasible and utilizes approved off-site disposal facilities for final disposition.	Score = 4 Removes the majority of hazardous substances from the Site and utilizes approved off-site disposal facilities for final disposition. Achieves complete removal of impacted soil along shoreline, to the extent feasible, but leaves deeper soil in place in areas across the remainder of the site that exceeds cleanup levels. The use of institutional controls reduces the risk to human health and the environment from the residual contamination left in place. Future development may require modification of the remedy.	Score = 3 Removes the majority of hazardous substances from the Site and utilizes approved off-site disposal facilities for final disposition, but leaves soil on site that exceeds cleanup levels. The use of institutional controls reduces the risk to human health and the environment from the residual contamination left in place. This alternative also relies on implementation of appropriate wave energy attenuation to prevent erosion of deeper impacted soil remaining at the shoreline. Future development may require modification of the remedy.	Score = 4 Removes the majority of hazardous substances from the Site and utilizes approved off-site disposal facilities for final disposition, but leaves soil on site that exceeds cleanup levels. The use of institutional controls reduces the risk to human health and the environment from the residual contamination left in place. This alternative also relies on implementation of appropriate wave energy attenuation to prevent erosion of deeper impacted soil remaining at the shoreline. Future development may require modification of the remedy.
Management of Short-Term Risks	Score = 2 Involves extensive soil removal across the Site, including excavation near occupied buildings and across areas of park land currently used by the public. However, the excavation methods required to achieve the level of removal under this alternative are well established and capable of reducing short-term risks.	Score = 3 Involves extensive soil removal across the Site, including excavation near occupied buildings and across areas of park land currently used by the public. However, the excavation methods required to achieve the level of removal under this alternative are well established and capable of minimizing short-term risks.	Score = 4 Involves extensive soil removal across the Site, including excavation near occupied buildings and across areas of park land currently used by the public. However, the excavation methods required to achieve the level of removal under this alternative are much less intrusive and require shorter duration due to the reduced extent of removal.	Score = 3 Involves extensive soil removal across the Site, including excavation near occupied buildings and across areas of park land currently used by the public. However, the excavation methods required to achieve the level of removal under this alternative are well established and capable of minimizing short-term risks.
Technical and Admin. Implementability	Score = 2 Involves extensive soil removal across the Site, including the need for significant shoring and dewatering to achieve removal of deeper soil and soil adjacent to or under buildings. However, while complex, the excavation activities required for this alternative are common and feasible. Temporary site closure to public would allow facilitation of project.	Score = 3 Utilizes the same general construction methods as Alternative PUA-1, but on a smaller scale. Temporary site closure to public would allow facilitation of project.	Score = 4 Utilizes the same general construction methods as Alternatives PUA-1 and PUA-2, with less need for shoring and dewatering to achieve removal due to the shallow depth of excavation along the shoreline. Temporary site closure to public would allow facilitation of project.	Score = 3 Utilizes the same general construction methods as Alternatives PUA-1 and PUA-2, with less need for shoring and dewatering to achieve removal. However, the shoring required for the deeper shoreline excavation is greater than required with Alternative PUA-3. Temporary site closure to public would allow facilitation of project.
Consideration of Public Concerns	Score = 4 Provides for complete removal of contaminated soil from the Site, addressing public concerns associated with exposure to contaminants and restriction on future use and development of Site.	Score = 4 Addresses the most accessible soil that poses the greatest risk to human health and the environment. The remaining contaminated soil left in place would require maintenance of institutional controls and impose limitations on future use and development of the Port public property.	Score = 4 Addresses the most accessible soil that poses the greatest risk to human health and the environment. The remaining contaminated soil left in place would require maintenance of institutional controls and impose limitations on future use and development of the Port public property.	Score = 4 Addresses the most accessible soil that poses the greatest risk to human health and the environment. The remaining contaminated soil left in place would require maintenance of institutional controls and impose limitations on future use and development of the Port public property.

TABLE 8
SUMMARY OF MTCA EVALUATION AND RANKING OF CLEANUP ACTION ALTERNATIVES
PORT UPLANDS AREA
FORMER SCOTT PAPER COMPANY MILL SITE

Alternative Number	PUA-1	PUA-2	PUA-3	PUA-4
Alternative Ranking Under MTCA				
1. Compliance with MTCA Threshold Criteria (1)	YES	YES	YES	YES
2. Restoration Time Frame	Two to three years	Two to three years	Two to three years	Two to three years
3. DCA Relative Benefits Ranking	1st	2nd	4th	3rd
Protectiveness (weighted as 30%)	1.5	1.2	0.90	1.20
Permanence (weighted as 20%)	1.00	0.80	0.60	0.80
Long-Term Effectiveness (weighted as 20%)	1.00	0.80	0.60	0.60
Management of Short-Term Risks (weighted as 10%)	0.20	0.30	0.40	0.30
Technical and Administrative Implementability (weighted as 10%)	0.20	0.30	0.40	0.30
Consideration of Public Concerns (weighted as 10%)	0.40	0.40	0.40	0.40
Total of Scores	**4.3**	**3.8**	**3.3**	**3.6**
4. Disproportionate Cost Analysis				
Probable Remedy Cost (+50%/-30%, rounded)	$18,300,000	$11,500,000	$4,800,000	$9,100,000
Costs Disproportionate to Incremental Benefits	YES	YES	NA (2)	YES
Practicability of Remedy	Practicable	Practicable	Practicable	Practicable
Remedy Permanent to Maximum Extent Practicable	Yes	Yes (3)	Yes (3)	Yes (3)
Overall Alternative Ranking				

Notes
1 Noncompliant alternatives were not considered in this evaluation.
2 Not applicable since this is the lowest cost alternative.
3 May require modification due to future land use or development.

TABLE 9
DESCRIPTION OF CLEANUP ACTION ALTERNATIVES - MJB NORTH AREA
FORMER SCOTT PAPER COMPANY MILL SITE

Site Subunit	Matrix	Contaminants Exceeding Proposed Cleanup Levels	Objective	CLEANUP ACTION ALTERNATIVE COMPONENTS			
				Alternative MJB-1	Alternative MJB-2	Alternative MJB-3	Alternative MJB-4
Shoreline Buffer Zone (1)	Soil - 0' to 6' BGS Exceeding Proposed Human Health or Terrestrial Ecological Cleanup Levels	Metals, PAHs	Prevent terrestrial ecological and human contact with soil containing contaminants above proposed cleanup levels. Prevent contamination of adjacent Marine Area sediments due to releases from contaminated soil. Remove soil exceeding SQS criteria that co-exists with affected soil exceeding proposed cleanup levels.	- Excavate, to the extent practicable, soil exceeding proposed human health and/or terrestrial ecological cleanup levels. - Characterize and dispose of contaminated soil at an approved off-site disposal facility in accordance with applicable regulations. - Backfill with clean soil to restore to original land topography and site drainage. - Construct walkway and riparian habitat.	- Excavate, to the extent practicable, soil exceeding proposed human health and/or terrestrial ecological cleanup levels. - Characterize and dispose of contaminated soil at an approved off-site disposal facility in accordance with applicable regulations. - Backfill with clean soil to restore to original land topography and site drainage. - Construct walkway and riparian habitat.	- Excavate, to the extent practicable, soil exceeding proposed human health and/or terrestrial ecological cleanup levels. - Characterize and dispose of contaminated soil at an approved off-site disposal facility in accordance with applicable regulations. - Backfill with clean soil to restore to original land topography and site drainage. - Construct walkway and riparian habitat.	- Excavate, to the extent practicable, soil exceeding proposed human health and/or terrestrial ecological cleanup levels to a maximum depth of 10' BGS. - Characterize and dispose of contaminated soil at an approved, off-site disposal facility in accordance with applicable regulations. - Backfill with clean soil to restore to original land topography and site drainage. - Construct walkway and riparian habitat.
	Soil 6' - 15' BGS Exceeding Proposed Human Health or Terrestrial Ecological Cleanup Levels	Metals, PAHs	Prevent terrestrial ecological and human contact with soil containing contaminants above proposed cleanup levels. Prevent contamination of adjacent Marine Area sediments due to releases from contaminated soil.	- Excavate, to the extent practicable, soil exceeding human health and/or terrestrial ecological cleanup levels. - Characterize and dispose of contaminated soil at an approved off-site disposal facility in accordance with applicable regulations. - Backfill with clean soil	- Affected soils at depths greater than 6' BGS will remain in place. - Ensure the sediment remedy adequately caps affected soils remaining in place. - Establish institutional controls noting the location and depth of affected soil exceeding proposed cleanup levels and establishing safeguards to protect human health.	- Affected soils at depths greater than 6' BGS will remain in place. - Ensure the sediment remedy adequately caps affected soils remaining in place. - Establish institutional controls noting the location and depth of affected soil exceeding proposed cleanup levels and establishing safeguards to protect human health.	- Affected soils at depths greater than 10' BGS will remain in place. - Ensure the sediment remedy adequately caps affected soils remaining in place. - Establish institutional controls noting the location and depth of affected soil exceeding proposed cleanup levels and establishing safeguards to protect human health.
Remaining Upland Areas	Soil - 0' to 6' BGS Exceeding Proposed Human Health or Terrestrial Ecological Cleanup Levels	Metals, PAHs	Prevent terrestrial ecological and human contact with soil containing contaminants above proposed cleanup levels.	-Assess soils using the terrestrial ecological risk evaluation, which may include collection of soil samples for bioassay testing, to assess extent of affected soil posing a risk to terrestrial biota - Excavate, to the extent practicable, soil exceeding proposed human health cleanup levels and exceeding acceptable terrestrial ecological bioassay levels. - Characterize and dispose of contaminated soil at an approved off-site disposal facility in accordance with applicable regulations. - Backfill with clean soil and restore the site surface consistent with planned site use.	-Assess soils using the terrestrial ecological risk evaluation, which may include collection of soil samples for bioassay testing, to assess extent of affected soil posing a risk to terrestrial biota - Excavate, to the extent practicable, soil exceeding proposed human health cleanup levels. - Homogenize contaminated soil with clean soil to reduce soil contaminant levels to acceptable terrestrial ecological bioassay levels. - Characterize and dispose of contaminated soil at an approved off-site disposal facility in accordance with applicable regulations. - Backfill excavated areas with clean soil. - Restore the site surface consistent with planned site use.	-Assess soils using the terrestrial ecological risk evaluation, which may include collection of soil samples for bioassay testing, to assess extent of affected soil posing a risk to terrestrial biota - Excavate, to the extent practicable, soil exceeding proposed human health cleanup levels. - Provide cover (asphalt or concrete pavement) over soil with contaminant levels exceeding acceptable terrestrial ecological bioassay levels. - Characterize and dispose of contaminated soil at an approved off-site disposal facility in accordance with applicable regulations. - Backfill excavated areas with clean soil. - Restore the site surface consistent with planned site use.	-Assess soils using the terrestrial ecological risk evaluation, which may include collection of soil samples for bioassay testing, to assess extent of affected soil posing a risk to terrestrial biota - Excavate, to the extent practicable, soil exceeding proposed human health cleanup levels to a maximum depth of 6' BGS. - Homogenize contaminated soil with clean soil as appropriate to reduce soil contaminant levels to acceptable terrestrial ecological bioassay levels to a maximum depth of 6' BGS. - Characterize and dispose of excavated soil at an approved off-site disposal facility in accordance with applicable regulations. - Backfill excavated areas with clean soil. - Restore the site surface consistent with planned site use.
	Soil - 6' to 15' BGS Exceeding Proposed Human Health or Terrestrial Ecological Cleanup Levels	Metals, PAHs	Prevent terrestrial ecological and human contact with soil containing contaminants above proposed cleanup levels.	- Excavate, to the extent practicable, soil exceeding proposed human health or terrestrial ecological cleanup levels. - Characterize and dispose of contaminated soil at an approved off-site disposal facility in accordance with applicable regulations. - Backfill with clean soil and restore the site surface consistent with planned site use.	- Affected soils at depths greater than 6' BGS will remain in place. - Establish institutional controls noting the location and depth of affected soil exceeding proposed cleanup levels and establishing safeguards to protect human health.	- Affected soils at depths greater than 6' BGS will remain in place. - Establish institutional controls noting the location and depth of affected soil exceeding proposed cleanup levels and establishing safeguards to protect human health.	- Affected soils at depths greater than 6' BGS will remain in place. - Establish institutional controls noting the location and depth of affected soil exceeding proposed cleanup levels and establishing safeguards to protect human health.
			Estimated Alternative Cost (+50%/-30%, rounded)	$8,300,000	$4,400,000	$4,200,000	$5,200,000
			Estimated Implementation Timeframe (2)	Two to three years	Two to three years	Two to three years	Two to three years

1. Buffer zone established for MJB alternatives in January 23, 2008 and subsequent meetings. The buffer zone for Alternatives MJB-1, -2, and -3 extends 100 ft inland from MHHW. The buffer zone for Alternative MJB-4 extends 75 feet inland from MHHW.
2. From initiation of construction.

TABLE 10
EVALUATION OF CLEANUP ACTION ALTERNATIVES - MJB NORTH AREA
FORMER SCOTT PAPER COMPANY MILL SITE

	Alternative MJB-1	Alternative MJB-2	Alternative MJB-3	Alternative MJB-4
Alternative Description	- Excavate to the extent practicable, soil exceeding proposed human health and terrestrial ecological cleanup levels in the Shoreline Buffer Zone. - Excavate to the extent practicable, soil exceeding human health and terrestrial ecological cleanup levels in the Remaining Upland Area. - Characterize and dispose of contaminated soil at approved, permitted, off-site disposal facility in accordance with applicable regulations. - Backfill and restore excavated areas to support planned use of the property. - Construct a pedestrian path and improve riparian habitat.	- Excavate to the extent practicable, soil exceeding proposed human health and terrestrial ecological cleanup levels in the Shoreline Buffer Zone to a depth of 6 feet bgs. - Excavate to the extent practicable, soil exceeding human health and terrestrial ecological cleanup levels in the Remaining Upland Area (assumed to be within 2 feet of ground surface). - Homogenize, to the extent practicable, soil exceeding terrestrial ecological cleanup levels in the Remaining Upland Area. - Backfill excavations and/or replace homogenized soil to support planned use of the property. - Install new monitoring wells as necessary to establish four monitoring wells along the shoreline to support monitoring of groundwater downgradient of impacted soils remaining onsite. - Institutional controls to prevent future site worker and terrestrial ecological exposure to impacted soils and to ensure proper disposal of, impacted soil that may be excavated in the future. - Construct a pedestrian path and improve riparian habitat.	- Excavate to the extent practicable, soil exceeding proposed human health and terrestrial ecological cleanup levels in the Shoreline Buffer Zone to a depth of 6 feet bgs. - Excavate to the extent practicable, soil exceeding human health and terrestrial ecological cleanup levels in the Remaining Upland Area (assumed to be within 2 feet of ground surface). - Place an asphalt cover over soil exceeding terrestrial ecological cleanup levels in the Remaining Upland Area. - Backfill excavated areas to support planned use of the property. - Install new monitoring wells as necessary to establish four monitoring wells along the shoreline to support monitoring of groundwater downgradient of impacted soils remaining onsite. - Institutional controls to prevent future site worker and terrestrial ecological exposure to impacted soils and to ensure proper disposal of, impacted soil that may be excavated in the future. - Construct a pedestrian path and improve riparian habitat.	- Excavate to the extent practicable, soil exceeding proposed human health and terrestrial ecological cleanup levels in the 75-Ft Shoreline Buffer Zone to a maximum depth of 10 feet BGS. - Excavate to the extent practicable, soil exceeding human health and terrestrial ecological cleanup levels in the Remaining Upland Area (assumed to generally be limited to within 2 feet of ground surface) to a maximum depth of 6 ft BGS. - Homogenize, to the extent practicable, soil exceeding terrestrial ecological cleanup levels in the Remaining Upland Area within the upper 6 ft of soil. - Backfill excavations and/or compact and grade homogenized soil to support planned use of the property. - Install new monitoring wells as necessary to establish four monitoring wells along the shoreline to support monitoring of groundwater downgradient of impacted soils remaining onsite. - Institutional controls to prevent future site worker and terrestrial ecological exposure to impacted soils and to ensure proper disposal of, impacted soil that may be excavated in the future. - Construct a pedestrian path and improve riparian habitat.
Alternative Ranking Under MTCA				
1. Compliance with MTCA Threshold Criteria				
Protection of Human Health and the Environment	Yes - Alternative would protect human health and the environment. Relies on long-term landfill containment to limit exposure to Site contaminants.	Yes - Alternative would protect human health and the environment. Relies on Site institutional controls and long-term landfill containment to limit exposure to Site contaminants.	Yes - Alternative would protect human health and the environment. Relies on Site institutional controls and long-term landfill containment to limit exposure to Site contaminants.	Yes - Alternative would protect human health and the environment. Relies on Site institutional controls and long-term landfill containment to limit exposure to Site contaminants.
Compliance With Cleanup Standards	Yes - Alternative is expected to comply with MTCA cleanup standards. If practicable, this alternative may attain the standard point of compliance.	Yes - Alternative is expected to comply with MTCA cleanup standards. Alternative relies on institutional controls and a conditional point of compliance. Future development of property may require actions specified under institutional controls to manage impacted soils remaining onsite.	Yes - Alternative is expected to comply with MTCA cleanup standards. Alternative relies on engineering controls, institutional controls and a conditional point of compliance. Continued maintenance is necessary for compliance. Future development of property may require actions specified under institutional controls to manage impacted soils remaining onsite.	Yes - Alternative is expected to comply with MTCA cleanup standards. Alternative relies on institutional controls and a conditional point of compliance. Future development of property may require actions specified under institutional controls to manage impacted soils remaining onsite.
Compliance With Applicable State and Federal Regulations	Yes - Alternative can be designed and implemented in compliance with applicable state and federal regulations.	Yes - Alternative complies with applicable state and federal regulations. Future development of property may require additional environmental cleanup or special provisions.	Yes - Alternative complies with applicable state and federal regulations. Future development of property may require additional environmental cleanup or special provisions.	Yes - Alternative complies with applicable state and federal regulations. Future development of property may require additional environmental cleanup or special provisions.
Provision for Compliance Monitoring	No. Monitoring is not required, as contaminated media would be removed from site.	Yes - Alternative includes provisions for compliance monitoring.	Yes - Alternative includes provisions for compliance monitoring.	Yes - Alternative includes provisions for compliance monitoring.
2. Restoration Time Frame				
	Restoration time frame is relatively short. This alternative is expected to require two to three years for design and construction and would likely result in no need for institutional controls or long-term monitoring and maintenance.	Initial restoration time frame is relatively short. This alternative is expected to require two to three years for design and construction. Post-remediation monitoring would be necessary to confirm effectiveness of remedy. Relies on institutional controls for long-term protectiveness.	Initial restoration time frame is relatively short. This alternative is expected to require two to three years for design and construction. Post-remediation monitoring and cover maintenance would be necessary to confirm and maintain effectiveness of remedy. Relies on engineering and institutional controls for long-term protectiveness.	Initial restoration time frame is relatively short. This alternative is expected to require two to three years for design and construction. Post-remediation monitoring would be necessary to confirm effectiveness of remedy. Relies on institutional controls for long-term protectiveness.
3. Relative Benefits Ranking				
Protectiveness	High Achieves a high level of overall protectiveness as a result of removal of the soil that poses risk to human and ecological receptors at the Site. Under this alternative, only impacted soils that are not directly accessible for removal using standard methods (i.e., under buildings or other structures) would be left in place. Some residual risk would remain due to long-term containment of Site contaminants in an engineered offsite landfill.	Medium Achieves a medium level of overall protectiveness as a result of removal of the near-surface soil that poses risk to human and ecological receptors at the Site. However, this alternative leaves in place deeper contaminated soil, and protectiveness would rely on maintenance of institutional controls to prevent exposure.	Low Achieves a low level of overall protectiveness as a result of removal of the near-surface soil that poses risk to human and ecological receptors at the Site. Most soils in the upper 6 feet that exceed SQS chemical criteria for sediments would be removed. However, this alternative leaves in place deeper contaminated soil, and protectiveness would rely on maintenance of institutional and engineered controls to prevent exposure.	Medium Achieves a medium level of overall protectiveness as a result of removal of the near-surface soil that poses risk to human and ecological receptors at the Site. However, this alternative leaves in place deeper contaminated soil, and protectiveness would rely on maintenance of institutional controls to prevent exposure.

TABLE 10
EVALUATION OF CLEANUP ACTION ALTERNATIVES - MJB NORTH AREA
FORMER SCOTT PAPER COMPANY MILL SITE

	Alternative MJB-1	Alternative MJB-2	Alternative MJB-3	Alternative MJB-4
Permanence	High Achieves nearly complete reduction of mass and toxicity for hazardous substances remaining at the Site through direct removal of affected soil. Does not permanently destroy Site COCs; relies on long-term containment of persistent COCs in an engineered, offsite landfill. As monitoring data shows Site COCs are not mobile, this alternative does not affect contaminant mobility. This alternative reduces to the extent practicable the potential for future corrective actions at the MJB North Area.	Medium Achieves partial reduction of mass and toxicity for hazardous substances remaining at the Site through direct removal of affected soil. Does not permanently destroy Site COCs, but permanently reduces terrestrial ecological risks over much of the Remaining Upland Area. Relies on long-term containment of persistent COCs in an engineered, offsite landfill. As monitoring data shows Site COCs are not mobile, this alternative does not affect contaminant mobility. Since affected soils exceeding proposed cleanup levels remain under this alternative, there would be some potential for future corrective actions at the MJB North Area.	Low Achieves a similar reduction of mass of hazardous substances at the Site, but relies on engineering controls to mitigate risks. Does not permanently destroy Site COCs and relies on long-term containment of persistent COCs in an engineered, offsite landfill. Requires ongoing maintenance for long-term effectiveness. Future development is likely to affect the remedy.	Medium Achieves partial, but significant reduction (more than MJB-2 in Shoreline Buffer Zone) of mass and toxicity for hazardous substances remaining at the Site through direct removal of affected soil. Does not permanently destroy Site COCs, but permanently reduces terrestrial ecological risks over much of the Remaining Upland Area. Relies on long-term containment of persistent COCs in an engineered, offsite landfill. As monitoring data shows Site COCs are not mobile, this alternative does not affect contaminant mobility. Since affected soils exceeding proposed cleanup levels remain under this alternative, there would be some potential for future corrective actions at the MJB North Area.
Long-Term Effectiveness	Medium Removes hazardous substances from the Site to the greatest degree practicable and utilizes engineered, offsite landfill containment for long-term risk management. If hazardous substances remain at the Site (such as below buildings) they would pose minimal risk to human health and the environment.	High Removes affected soil causing the greatest risks from the MJB North Area and utilizes engineered, offsite landfill containment for long-term risk management of excavated soil. Utilizes onsite management of deep contaminated soil that exceeds proposed cleanup levels; The demonstrated low mobility of Site COCs and the institutional controls would minimize residual risks to human health and the environment under this alternative. Alternatives MJB-2 and MJB-4 permanently reduce toxicity over much of the property via soil homogenization; these are alternatives considered with any permanent risk reduction, and both alternatives provide the same level of permanence in the Remaining Upland Area.	Low Removes affected soil causing the greatest risks from the MJB North Area and utilizes engineered, offsite landfill containment for long-term risk management of excavated soil. Utilizes onsite management of deep contaminated soil that exceeds proposed cleanup levels and engineering controls to mitigate ecological risks. Long-term maintenance of engineering controls limits long-term effectiveness. Future development may require modification of the remedy.	High Removes affected soil causing the greatest risks from the MJB North Area and utilizes engineered, offsite landfill containment for long-term risk management of excavated soil. Utilizes onsite management of deep contaminated soil that exceeds proposed cleanup levels; The demonstrated low mobility of Site COCs and the institutional controls would minimize residual risks to human health and the environment under this alternative. Alternatives MJB-2 and MJB-4 permanently reduce toxicity over much of the property via soil homogenization; thiese are alternatives considered with any permanent risk reduction, and both alternatives provide the same level of permanence in the Remaining Upland Area.
Management of Short-Term Risks	Low Substantial short term risks would be created by the extensive soil removal across the MJB North Area and transportation of a large volume contaminated soil through the City of Anacortes and on public roadways. These risks can be mitigated, however, using proven earthwork and transportation methods capable of minimizing short-term risks.	Medium Involves extensive soil removal and soil handling across the MJB North Area. Requires less shipment of contaminated soil through the City of Anacortes and on public roadways than Alternative MJB-1. These risks can be mitigated, however, using proven earthwork and transportation methods capable of minimizing short-term risks.	Medium Involves extensive soil removal at the MJB North Area. Requires less shipment of contaminated soil through the City of Anacortes and on public roadways than Alternative MJB-1 and less disruptive soil handling than Alternative MJB-2. These risks can be mitigated, however, using proven earthwork and transportation methods capable of minimizing short-term risks.	Medium Involves extensive soil removal and soil handling across the MJB North Area. Requires less shipment of contaminated soil through the City of Anacortes and on public roadways than Alternative MJB-1. These risks can be mitigated, however, using proven earthwork and transportation methods capable of minimizing short-term risks.
Technical and Admin. Implementability	Medium Requires extensive soil removal across the MJB North Area. The excavation activities required for this alternative are common and practicable, but there may be technical difficulty in accessing deeper soil, especially along the shoreline. No administrative implementability issues are anticipated.	Medium Requires substantial soil removal from the MJB North Area at shallower depths than Alternative MJB-1. Soil homogenization work would be similar to the excavation included in Alternative MJB-1. The excavation activities required for this alternative are common and implementable. No administrative implementability issues are anticipated, although regulatory acceptance would require negotiation.	High Requires substantial soil removal from the MJB North Area at shallower depths than Alternative MJB-1. Requires construction of substantial asphalt cover The excavation and paving activities included in this alternative are common and fully implementable No administrative implementability issues are anticipated, although regulatory acceptance would require negotiation.	Medium Requires substantial soil removal from the MJB North Area at shallower depths than Alternative MJB-1. Soil homogenization work would be similar to the excavation included in Alternative MJB-1. The excavation activities required for this alternative are common and implementable. No administrative implementability issues are anticipated, although regulatory acceptance would require negotiation.
Consideration of Public Concerns	Medium Provides the maximum removal of contaminated soil from the MJB North Area, which may address some public concerns associated with Site contamination. Since a significant volume of contaminated soil must be transported by truck through the City of Anacortes and on public roadways, some public concern for wear and tear of roadways and congestion may accrue. Public concerns can be mitigated through an effective communications program.	Medium Although contaminated soil that poses the greatest risk to human health and the environment would be removed under this alternative, some public concern may result due to the deep soil left in place at the MJB North Area. Since substantially less soil would require truck transport from the Site, public concerns related to transportation of contaminated soil are expected to be lower than for Alternative MJB-1. Public concerns can be mitigated through an effective communications program.	Low Although contaminated soil that poses the greatest risk to human health and the environment would be removed under this alternative, some public concern may result due to the deep soil left in place at the MJB North Area and the use of engineering controls to mitigate ecological risks over a significant portion of the MJB North Area. Since substantially less soil would require truck transport from the Site, public concerns related to transportation of contaminated soil are expected to be lower than for Alternative MJB-1. Public concerns can be mitigated through an effective communications program.	Medium Although contaminated soil that poses the greatest risk to human health and the environment would be removed under this alternative, some public concern may result due to the deep soil left in place at the MJB North Area. Since substantially less soil would require truck transport from the Site, public concerns related to transportation of contaminated soil are expected to be lower than for Alternative MJB-1. Public concerns can be mitigated through an effective communications program.

TABLE 11
SUMMARY OF MTCA EVALUATION AND RANKING OF CLEANUP ACTION ALTERNATIVES
MJB NORTH AREA
FORMER SCOTT PAPER COMPANY MILL SITE

Alternative Number	MJB-1	MJB-2	MJB-3	MJB-4
Alternative Ranking Under MTCA				
1. Compliance with MTCA Threshold Criteria (1)	YES	YES	YES	YES
2. Restoration Time Frame	Two to three years	Two to three years	Two to three years	Two to three years
3. Relative Benefits Ranking	1st	1st	3rd	1st
Protectiveness (weighted as 30%)	1.2	0.9	0.6	0.9
Permanence (weighted as 20%)	0.8	0.6	0.4	0.7
Long-Term Effectiveness (weighted as 20%)	0.6	0.8	0.4	0.8
Management of Short-Term Risks (weighted as 10%)	0.2	0.3	0.4	0.3
Technical and Administrative Implementability (weighted as 10%)	0.3	0.3	0.2	0.3
Consideration of Public Concerns (weighted as 10%)	0.3	0.3	0.2	0.3
Total of Scores	**3.4**	**3.2**	**2.2**	**3.3**
4. Disproportionate Cost Analysis				
Probable Remedy Cost (+50%/-30%, rounded)	$8,300,000	$4,400,000	$4,200,000	$5,200,000
Costs Disproportionate to Incremental Benefits	YES	No	NA (2)	No
Practicability of Remedy	Practicable	Practicable	Practicable	Practicable
Remedy Permanent to Maximum Extent Practicable	Yes	Yes (3)	Yes (3)	Yes (3)
Overall Alternative Ranking	4rd	1st (tie)	3rd	1st (tie)

Notes
1 Noncompliant alternatives were not considered in this evaluation.
2 Not applicable since this is the lowest cost alternative.
3 May require modification due to future land use or development.
4 Benefits are ranked on a scale of 1 to 5, with 5 indicating 100% attainment of the criterion and 1 indicating 0% attainment.

TABLE 12
DESCRIPTION OF CLEANUP ACTION ALTERNATIVES - MARINE AREA
FORMER SCOTT PAPER COMPANY MILL SITE

Site Subunit	Matrix	Contaminants Exceeding Proposed Cleanup Levels	Objective	CLEANUP ACTION ALTERNATIVE COMPONENTS	
				Alternative M-1	Alternative M-2
Intertidal Area	Sediment	PCBs, Metals, Wood Debris	Prevent aquatic ecological exposure to sediment containing contaminants above proposed cleanup levels based on risks to benthic and food web (bioaccumulation) receptors.	-Remove surficial debris and piling along shoreline -Excavate buried wood debris to the extent necessary to facilitate placement of 2-ft thick cap -Dispose of excavated debris at upland landfill and suitable dredge material at open-water disposal site -Place clean cap material within excavation -Protect shoreline from erosion using two methods: (a) Adjacent to MJB property install armored cap (b) Adjacent to Port property create offshore wave attenuation structure on Port property to dissipate the wave energy before it reaches the Port property shoreline	-Remove surficial debris and piling along shoreline -Excavate buried wood debris to the extent necessary to facilitate placement of 2-ft thick cap -Dispose of excavated debris at upland landfill, and suitable dredge material at open-water disposal site -Place clean cap material within excavation -Protect shoreline from future erosion using two methods: (a) Adjacent to MJB property install armored cap (b) Adjacent to Port property create offshore wave attenuation structure on Port property to obstruct and dissipate the wave energy before it reaches the Port property shoreline
Subtidal Area	Sediment	Wood Debris	Prevent aquatic ecological exposure to sediment containing contaminants above proposed cleanup levels based on risks to benthic receptors.	-Excavate surface and subsurface wood debris and sediments exceeding SQS criteria -Dispose of excavated debris at upland landfill, and suitable dredge material at open-water disposal site -Backfill excavation with clean sand and gravel -Place post-dredge residuals cover to 100 ft beyond the water-side edge of the dredge footprint	-Excavate surface and subsurface wood debris and sediments exceeding CSL criteria -Dispose of excavated debris at upland landfill, and suitable dredge material at open-water disposal site -Backfill excavation with clean sand and gravel -Place post-dredge residuals cover over areas exceeding SQS criteria or to a minimum of 100 ft beyond the edge of the dredge footprint, whichever is further
			Estimated Alternative Cost (+50%/-30%, rounded)	$7,100,000	$5,800,000
			Estimated Volume of Contaminated Sediment Removed	31,900 cubic yards	19,900 cubic yards
			Estimated Timeframe to Closure (1)	Two to three years	Two to three years

TABLE 13
EVALUATION OF CLEANUP ACTION ALTERNATIVES - MARINE AREA
FORMER SCOTT PAPER COMPANY MILL SITE

	Alternative M-1	Alternative M-2
Alternative Description	- Remove subtidal sediment and debris exceeding SQS chemical criteria in the marine areas below MHHW. Excavate surface and subsurface wood debris exceeding SQS criteria. - Dispose excavated debris at upland landfill and suitable dredge material at open-water disposal site. - Backfill subtidal excavations and dredged areas with clean sand and gravel to restore to original grade. - Place post-dredge residuals cover to 100 feet beyond the water-side edge of the dredge footprint. - Protect shoreline on Port property with habitat reefs; protect MJB property with armored cap. - Dredge shoreline transitional slope to facilitate cap placement while maintaining the approximate existing grades; place a minimum of 2 ft of cap material along the Port shoreline and 2 ft of cap material along the MJB property shoreline. - Restore eelgrass. - Monitor cap.	- Remove subtidal sediment and debris exceeding CSL chemical criteria in the marine areas below MHHW. Excavate surface and subsurface wood debris exceeding CSL criteria. - Dispose excavated debris at upland landfill and suitable dredge material at open-water disposal site. - Backfill subtidal excavations and dredged areas with clean sand and gravel to restore to original grade. - Place post-dredge residuals cover to 100 feet beyond the water-side edge of the dredge footprint, or over the SQS footprint, whichever is greater. - Protect shoreline on Port property with habitat reefs; protect MJB property with armored cap. - Dredge shoreline transitional slope to facilitate cap placement while maintaining the approximate existing grades; place a minimum of 2 ft of cap material along the Port shoreline and 2 ft of cap material between the drift sills along the MJB property shoreline. - Restore eelgrass. - Monitor cap.
Alternative Ranking Under MTCA		
1. Compliance with MTCA Threshold Criteria		
Protection of Human Health and the Environment	Yes - Alternative will protect human health and the environment without site use restrictions	Yes - Alternative will protect human health and the environment without site use restrictions
Compliance With Cleanup Standards	Yes - Alternative is expected to comply with marine (SQS) cleanup standards to be selected by Ecology.	Yes - Alternative is expected to comply with marine (CSL) cleanup standards to be selected by Ecology.
Compliance With Applicable State and Federal Regulations	Yes - Alternative complies with applicable state and federal regulations.	Yes - Alternative complies with applicable state and federal regulations.
Provision for Compliance Monitoring	Yes - Alternative includes provisions for compliance monitoring.	Yes - Alternative includes provisions for compliance monitoring.
2. Restoration Time Frame		
	This alternative is expected to require two to three years for design, permitting and construction	This alternative is expected to require two to three years for design, permitting and construction

TABLE 13
EVALUATION OF CLEANUP ACTION ALTERNATIVES - MARINE AREA
FORMER SCOTT PAPER COMPANY MILL SITE

	Alternative M-1	Alternative M-2
3. Disproportionate Cost Analysis Relative Benefits Ranking (Scored from 1-lowest to 5-highest)		
Protectiveness	Score = 5 Achieves a high level of overall protectiveness as a result of removal sediment that poses risk to human and ecological receptors by addressing sediments exceeding SQS criteria.	Score = 4 Achieves a medium level of overall protectiveness as a result of removal of sediments that pose risk to human and ecological receptors by addressing sediments exceeding CSL criteria.
Permanence	Score = 5 Achieves risk reduction in the marine area through direct removal and disposal of the excavated material at appropriate off-site facilities. However, landfill disposal precludes the MTCA preference for destruction of contaminants.	Score = 4 Achieves risk reduction in the marine area through direct removal and disposal of the excavated material at appropriate off-site facilities. However, landfill disposal precludes the MTCA preference for destruction of contaminants. The quantity of impacted sediment allowed to remain on site is greater than with Alternative M-1 and will require periodic monitoring.
Long-Term Effectiveness	Score = 5 Residual contaminant concentrations and associated risks are anticipated to be low. This alternative removes hazardous substances from the marine area to the greatest degree possible and utilizes approved off-site disposal facilities for final disposition. If hazardous substances remain at the Site (such as deeply buried wood debris) they will pose little risk to human health and the environment. Wave attenuation structures and armored caps will reduce the potential for contaminant exposure associated with cap erosion along the transitional slope.	Score = 4 Removes the majority of hazardous substances from the marine area and utilizes approved off-site disposal facilities for final disposition, but leaves some sediment in the marine area that exceeds Sediment Quality standards. Wave attenuation structures and armored caps will reduce the potential for contaminant exposure associated with cap erosion along the transitional slope.
Management of Short-Term Risks	Score = 3 Involves extensive sediment removal with a potential for generating dredge residuals. However, the excavation methods required to achieve the level of removal under this alternative are well established and capable of minimizing short-term risks.	Score = 3 Involves sediment removal with a potential for generating dredge residuals. However, the excavation methods required to achieve the level of removal under this alternative are well established and capable of minimizing short-term risks.
Technical and Admin. Implementability	Score = 5 Involves extensive sediment removal at the Site, with a potential for dredge residuals. Dredge residuals would be managed using a post-dredge cover of clean material. The excavation activities required for this alternative are common and feasible but would need to use equipment, staging, and phasing that is compatible with working in a shallow, tidally-influenced environment. Temporary site closure to public will allow facilitation of project.	Score = 5 Involves less sediment removal at the Site, with a potential for dredge residuals. Dredge resduals would be managed using a post-dredge cover of clean material. The excavation activities required for this alternative are common and feasible but would need to use equipment, staging, and phasing that is compatible with working in a shallow, tidally-influenced environment. Temporary site closure to public will allow facilitation of project.
Consideration of Public Concerns	Score = 4 Provides for complete removal of contaminated sediment from the subtidal portion of the marine area, addressing public concerns associated with exposure to contaminants and restriction on future use and development of Site. However, the excavation volume is greater than Alternative M-2, so local traffic impacts from upland disposal activities would be greater.	Score = 3 Addresses the highest level sediment that poses the greatest risk to human health and the environment. However, sediments below the CSL would remain on site.
Restoration Time Frame and Additional SMS Evaluation Criteria	See Sections 7.3.4 and 7.3.5	See Sections 7.3.4 and 7.3.5

TABLE 14
SUMMARY OF MTCA EVALUATION AND RANKING OF CLEANUP ACTION ALTERNATIVES
MARINE AREA
FORMER SCOTT PAPER COMPANY MILL SITE

Alternative Number	M-1	M-2
Alternative Ranking Under MTCA		
1. Compliance with MTCA Threshold Criteria (1)	YES	YES
2. Restoration Time Frame	Two to three years	Two to three years
3. DCA Relative Benefits Ranking	1st	2nd
Protectiveness (weighted as 30%)	1.5	1.2
Permanence (weighted as 20%)	1	0.8
Long-Term Effectiveness (weighted as 20%)	1	0.8
Management of Short-Term Risks (weighted as 10%)	0.3	0.3
Technical and Administrative Implementability (weighted as 10%)	0.5	0.5
Consideration of Public Concerns (weighted as 10%)	0.4	0.3
Total of Scores	**4.7**	**3.9**
4. Disproportionate Cost Analysis		
Probable Remedy Cost (+50%/-30%, rounded)	$7,100,000	$5,800,000
Costs Disproportionate to Incremental Benefits	No	NA (2)
Practicability of Remedy	Practicable	Practicable
Remedy Permanent to Maximum Extent Practicable	Yes	Yes
Overall Alternative Ranking	1st	2nd

Notes
1 Non-compliant alternatives were not considered in this evaluation.
2 Not applicable since this is the lowest cost alternative.

APPENDIX A
PRE-DESIGN SHORELINE STABILITY EVALUATION REPORT

COAST & HARBOR ENGINEERING

Revised Technical Report

Former Scott Paper Mill Remediation Site Coastal Modeling and Analysis

Executive Summary

This Technical Report summarizes the results of coastal numerical modeling and analysis conducted by Coast & Harbor Engineering, Inc. (CHE). The purpose of the analysis was to determine feasibility and develop conceptual engineering plans for alternative shore protection designs at the former Scott Paper Mill Site ("Site"). The information presented herein will assist in evaluation of remedial alternatives for the Site, and will form the basis for developing more detailed engineering designs of the Site alternative ultimately selected by the Washington Department of Ecology ("Ecology"). Two alternative configurations of the shore protection were analyzed with numerical modeling: Configuration 1, consisting of a Sill Alternative placed at the Port and MJB shorelines of the site; and Configuration 2, consisting of a Wave Attenuator located offshore of the Port Marine Area and a Sill Alternative along the MJB Marine Area shoreline.

The feasibility analysis was based on numerical wave modeling and wave-induced sediment mobility analysis. Wave modeling was conducted using two-dimensional wave refraction/diffraction/reflection numerical models. Sediment mobility analysis was conducted with computer software that simulates sediment stability in a wave environment.

Wave modeling was conducted in two steps. First, a large modeling domain and two-dimensional numerical model SWAN (Holthuijsen et al, 2004) was used to simulate waves under selected wind conditions and propagate these waves to the project site. As a second step, nested grid numerical modeling was conducted with the two-dimensional wave refraction/diffraction/reflection model HWAVE (Zheleznyak, et al, 2005) to simulate waves in the project area and their interaction with shoreline and project structures.

The input parameters for wave modeling (bathymetric/topographic survey data, wind characteristics, bottom sediments) were compiled, processed, and formatted to develop numerical modeling grids, input parameters, boundary conditions, and modeling scenarios. For a feasibility level analysis and preliminary engineering purposes, a 25-year return period storm event was selected for comparison of the shore protection alternatives.

Modeling was conducted for storms with various wind speeds approaching from the northeast (NE), east (E), and southeast (SE), and three tide elevation stages: mean lower low water (MLLW), mean tide level (MTL), and mean higher high water (MHHW). Modeling was conducted for existing conditions and for the shore protection alternatives Configuration 1 and Configuration 2.

Modeling of the existing conditions showed a significant wave reflection effect from the existing timber pile breakwater currently protecting the marina. Due to reflection effects, wave energy is amplified along the adjacent shoreline (Port Marine Area) at the former Scott Paper Mill site. The resulting erosion along the shoreline of the Port Marine Area has required placement and ongoing maintenance/replacement of a relatively larger rock (rip rap) material for shoreline stabilization.

Modeling of Configuration 1 showed that for all storm events wave conditions at the Port Marine Area shoreline would be similar to that for existing conditions. A sill is a relatively small feature that does not significantly change the existing wave patterns. Under Configuration 1, the amplified wave energy would not be attenuated and would continue to adversely affect the shoreline as it would not alter or reduce the wave reflecting effect from the timber pile wall. The same conclusion is applicable for the MJB Marine Area shoreline. As a result, cap and habitat material placed at the Site under Configuration 1 would have to be comprised of suitable-sized rock to provide protection from erosion.

Modeling of shore protection option Configuration 2 was conducted to evaluate the feasibility of constructing a wave attenuation alternative offshore of the Port Marine Area, and to develop and initially optimize conceptual engineering plans for this alternative. The modeling results showed that the constructed wave attenuator would provide a wave shading area along part of the shoreline. Wave heights and energy delivered to this shoreline would be reduced significantly under this alternative. During the modeling process, in order to enhance the observed wave energy reduction effect, the wave attenuation alternative was further optimized to reduce the extent of fill areas and volume (and associated costs) as practicable. A north wave attenuator was added to the alternative to eliminate timber pile wall reflection phenomena and enhance attenuation of direct wave impact of waves from the east direction. Crest elevations of the reef were generally reduced to minimize volumes of construction material (and cost) without diminishing the capability of the reef performance.

Shoreline and bottom sediment mobility analysis was conducted with dual purposes: to determine the size of sediment that can be used as a cap material and to determine the size of material to provide shore protection. The analysis of cap material was conducted using a conservative (i.e., highly protective) criterion of no initiation of sediment movement during a 25-year storm event. Modeling demonstrated that this criterion can be achieved over all water surface elevations in the range from MHHW to MLLW using smaller particle sizes than presently occur in the Site area. In practice, limited movement and displacement of sediment under a less conservative design criterion will still achieve shoreline protection, assuming that the sediment remains in the beach area at the site. The armor stone sizes developed from the modeling are consistent with contaminated sediment cap design criteria developed by the U.S. Environmental Protection Agency (EPA; Palmero et al., 1998).

Analysis and determination of non-movable sediment particles in a wave environment consisted of comparing wave-induced shear stresses to shear stresses developed from threshold velocity of sediment motion. Analysis and determination of movable sediment size was conducted based on the assumption that movable sediment makes up a certain fraction of the particle size distribution (the portion that is smaller size) of material classified as non-movable.

Analysis and computations of sediment mobility for Configuration 1 was conducted for the Port and MJB Marine Areas separately. The results of analysis show that for the Sill Alternative in parts of the Port Marine Area (where the cap will occur) a $D_{50\%}$ (medium diameter) size of cap material should be equal to 19-inch (rock). Within the same area, the $D_{50\%}$ material for shore protection purposes should be equal to 6 inches for the upper beach (above MLLW) and approximately 3 inches for the lower beach (bellow MLLW). The beach material for the MJB Marine Area should consist of sediment size $D_{50\%}$ approximately 5 and 2 inches for the upper and lower beaches, respectively.

Analysis and computations of sediment mobility for Configuration 2 shows that the material for shore protection purpose in the Wave Attenuation area should consist of $D_{50\%}$ sediment grain size in the range of 1 to 4 inches for the upper beach and less than 1 inch (sandy gravel) for the lower beach. The beach material for the MJB Marine Area for Configuration 2 should consist of sediment size $D_{50\%}$ equal to 5 and 2 inches (cobble and gravel) for the upper and lower beaches, respectively.

COAST & HARBOR ENGINEERING

Technical Report

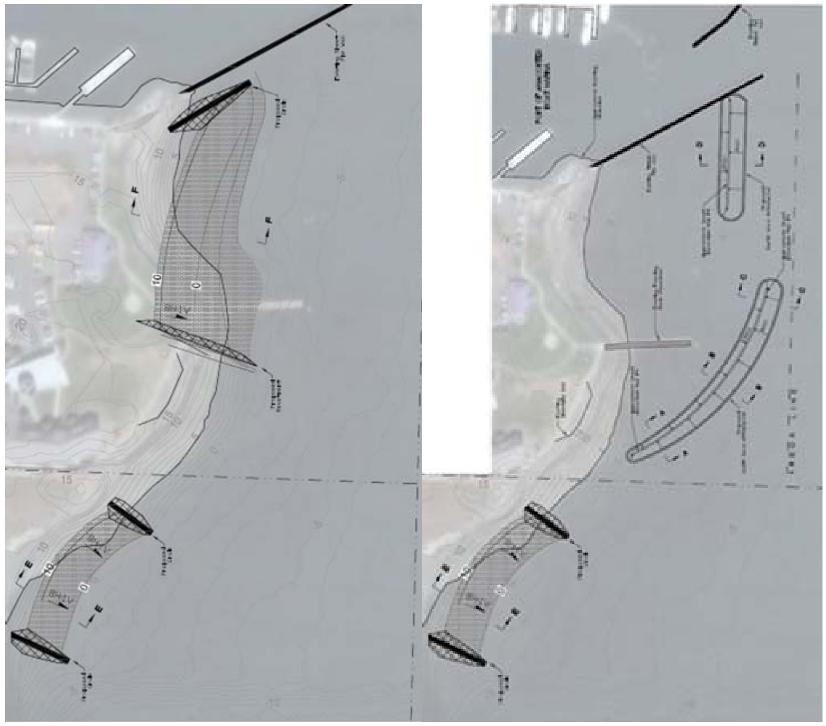
Former Scott Paper Mill Remediation Site Coastal Modeling and Analysis

1. Introduction

This Technical Report summarizes the results of coastal numerical modeling and analysis conducted by Coast & Harbor Engineering, Inc. (CHE). The purpose of the analysis was to determine feasibility for shore protection alternatives at the former Scott Paper Mill Site ("Site") and to develop the basis for more detailed engineering evaluation for each alternative. The information presented herein will assist in evaluations of remedial alternatives for the Site, and will form the basis for developing more detailed engineering designs of the Site alternative ultimately selected by the Washington Department of Ecology ("Ecology"). Two alternative configurations of the shore protection were analyzed with numerical modeling: Configuration 1, consisting of a Sill Alternative placed at the Port and MJB Marine Areas shorelines (Figure 1a); and Configuration 2, consisting of a Wave Attenuator[1][2] at the Port Marine Area and a Sill Alternative at the MJB Marine Area (Figure 1b). Evaluation of the proposed configurations was based on numerical modeling and analysis of wave refraction/diffraction and wave-induced sediment mobility analysis. Wave modeling was conducted using two-dimensional wave refraction/diffraction/reflection numerical models. Sediment mobility analysis was conducted with computer software that simulates sediment stability in a wave environment. The following sections provide information on the project site conditions, method of analysis, and results of the analysis and evaluation.

[1] Please note that the term Wave Attenuator is used herein in lieu of Reef structure. Based on cross-sectional configuration (crest elevation of most of the structure is below MHHW) and performance characteristics (allows partial penetration of wave energy, perching the beach, and maintaining favorable water quality) the proposed structure fits to the "Reef" definition (See Coastal Engineering Manual, US Army Corps of Engineers, 2003).

[2] The configuration of the Wave Attenuator shown in the figure has been optimized to achieve the best performance, including possible environmental benefits with minimal aquatic impact. More detailed information regarding the original "habitat reef" alternative and optimization process is presented in Section 4.4 below.



a) b)

Figure 1. Two configurations of the shore protection measure, a) Configuration 1 and b) Configuration 2

2. Project Site Conditions

The shoreline under consideration extends from the Cap Sante Marina timber pile wall at the Northern end of the Port Marine Area, through the MJB Marine Area, as shown in Figure 2.

The shoreline along the project site has experienced long-term erosion. This erosion is caused by site-specific hydrodynamic, littoral, and morphological conditions exacerbated by manmade activities. Hydrodynamic conditions consist of high energy and frequent occurrences of wind-wave events that remove sediment from the beach and form erosional scarps. The littoral system in the project area has no sediment source except the beach itself (where it still exists), which causes beach erosion and shoreline recession.

Figure 2. Extent of shoreline area analyzed

Manmade activities along the shoreline have resulted in further depleting littoral materials at the project site and exacerbating hydrodynamic forces at shore. Rock revetments along the shoreline (See Figure 3) protrude even to the mid-level beach and further restrict sediment supply to the littoral system.

Figure 3. Revetments reduce already limited source of sediment for feeding the beach

The timber wall breakwater (jetty) produces systems of reflected waves, including during storm events. These reflected waves, when superimposed on incoming waves, are extremely energetic and are capable of removing larger particles including gravel, cobbles, and even rock. Figure 4 shows the size of rock material that protects the shoreline from incoming and reflected waves.

Figure 4. Rock material adjacent to timber wall breakwater that protects shoreline from incoming and reflected waves

The major manmade changes to the shoreline that were made in the last century still continue to contribute to shore erosion. The shoreline had been extended seaward by filling the near-shore area. This action reduced the total length of underwater slope that provides dissipation of wave energy. This resulted in disturbing the relative equilibrium between wave energy and bottom slope configuration. The shoreline was placed (and still is) in the area of not adequately dissipated wave energy. This means that a beach (if built from native material) will try to erode to a flatter slope (than the existing), and the shoreline will retreat until relative equilibrium is attained. This stage of equilibrium would likely occur if the shoreline recedes to the pre-fill location located in the general vicinity of the “Q” Avenue.

Because of the geomorphic processes described above, the remaining beach at the project area (See Figure 5) is in a cycle of continuing long-term erosion. In summary, this cycle can be explained as follows: a) Due to incoming and reflected wave energy and no supply of sediment from outside sources, the beach erodes and the shoreline migrates landward; b) During this recession, some volume of eroded beach material is introduced to the littoral system; c) This released beach material maintains the new beach position for some duration of time; d) Incident and reflected waves of more energetic events deplete sediment from the new beach; and e) The beach recedes and the cycle repeats. The cycling will continue until the position of equilibrium occurs that is probably at the original location of shoreline prior to filling.

Figure 5. Existing erosional beach and possible future shoreline position (after number of erosion cycles) if no shore protection measures are installed

The erosional cycle distinguishes the existing beach at the project site from a so-called "pocket beach." A pocket beach exists at static equilibrium conditions (Silvester, 1993). In the project area the eroding beach is migrating and likely conditions of pocket beach (static equilibrium) may occur only after the shoreline reaches the pre-fill location (if no other shoreline modifications are made).

The proposed shore protection configurations (Configuration 1 and Configuration 2) intend to minimize the erosional cycle processes by limiting sediment movement by placing sills and increasing the size of beach material (Configurations 1), and by reducing the incident and reflected wave energy impacts (Configuration 2). Erosion of the shoreline has been identified as an important process by which contamination at the site is transported to the offshore sediments. Additionally, loss of the shoreline is incompatible with the assumed future use of the site. Therefore, evaluation of the proposed shore protection configurations with regard to their performance is conducted further (See Sections 4 and 5) based on the ability of these alternatives to reduce wave energy (wave height) and size of stable material on the beach. In other words, the configuration is more preferred if after project construction wave heights (reflected and incident) along the beach are smaller and the size of stable material on a beach is finer.

3. Methodology

The evaluation of the proposed concepts was conducted to properly address the performance criteria discussed above: ability to reduce wave heights and minimize size of stable sediment on the beach. Evaluation was conducted based on numerical modeling of wave refraction/diffraction and sediment mobility (induced by wave hydrodynamics) analysis. Wave modeling was conducted using 2-Dimensional wave refraction/diffraction/reflection numerical models. Sediment mobility analysis was conducted with computer software based on methods of analyzing sediment stability in a wave environment presented in the Coastal Engineering Manual (USACE 2002) and other available reliable publications.

Wave modeling was conducted in two steps. First, a large modeling domain and 2-Dimensional numerical model SWAN (Holthuijsen et al, 2004) was used to simulate waves under selected wind conditions and propagate these waves to the project site. The large modeling domain area is shown in Figure 6.

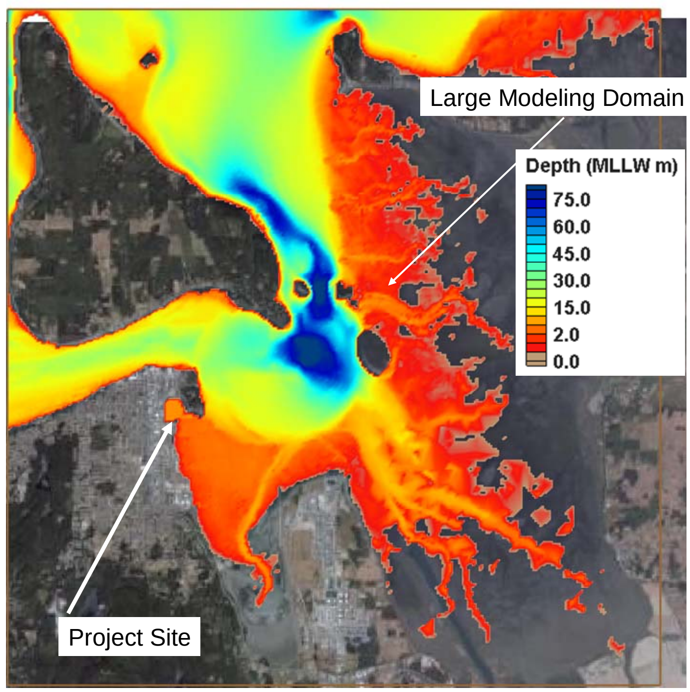
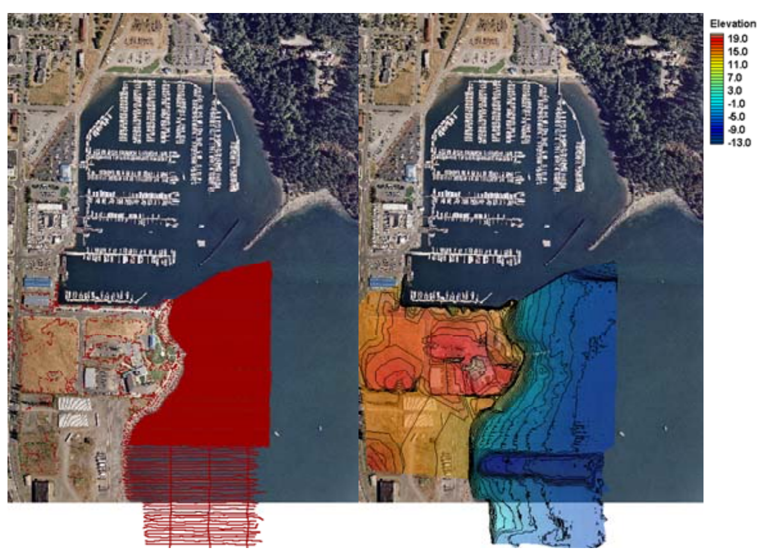


Figure 6. Large Modeling Domain for SWAN modeling



a) b

Figure 7. Density of bathymetric survey data (a) and interpretation of bathymetric survey data in depth color format (b)

As a second step, fine grid numerical modeling was conducted with the model HWAVE, nested within the large grid domain to obtain high resolution simulation results in the vicinity of the project site. The input parameters for wave modeling (bathymetric/topographic survey data, wind characteristics, bottom sediments, others) were compiled, processed and formatted to develop numerical modeling grids, input parameters, boundary conditions, and modeling scenarios. High resolution bathymetric survey data at the project area was obtained from the Port of Anacortes. Figure 7 shows the survey data-points (a) and the processed survey data that represents bottom depths in color format (b).

Historical and recently recorded wind data were compiled from the nearest applicable wind measuring stations. Data were processed and analyzed to develop a representative (for the project conditions and objectives) wind database. Statistical analysis of wave-generated winds along the modeling domain was conducted. Return periods of wind storms from wave-generated winds from various directions were computed and are presented in Table 1. Typically a 25- or 50-year return period storm is considered as design criteria for shore protection projects. For the feasibility level of study to analyze performance of the alternatives and preliminary engineering purposes, a 25-year return period storm event was selected for comparison of shore protection alternatives. In addition, modeling with a 50-year return period storm event was conducted to evaluate the effects of the alternatives on the existing marina structures.

Table 1, Wind speeds and return periods of wind storms from three directions

Return Period	Wind	Speed	(m.p.h.)
Years	NE	E	SE
2	29.8	17.3	33.7
5	35.5	21.5	40.3
10	38.8	25.2	44.1
25	42.4	30.8	48.3
50	44.8	35.4	51.1
100	47.1	40.2	53.7

4. Wave Modeling

4.1 Large Modeling Domain Wave Modeling

As discussed above, a multi-step modeling approach was used in the analysis. A large modeling domain was constructed to simulate waves under different wind conditions and propagate the waves to the project site. The large modeling domain covers the entire Fidalgo Bay and encompasses an area of approximately 70 square miles (8 miles by 9 miles). The large numerical modeling domain grid resolution is approximately 150 ft in both x- and y-directions.

Modeling with SWAN was conducted for various wind speeds approaching from the NE, E, and SE. Modeling was conducted for three different tide elevations; MLLW, MTL, and MHHW. An example of SWAN modeling for the 25-year return period wind from the SE and tide elevation MHHW is shown in Figure 8. The color in the figure specifies a significant wave height.

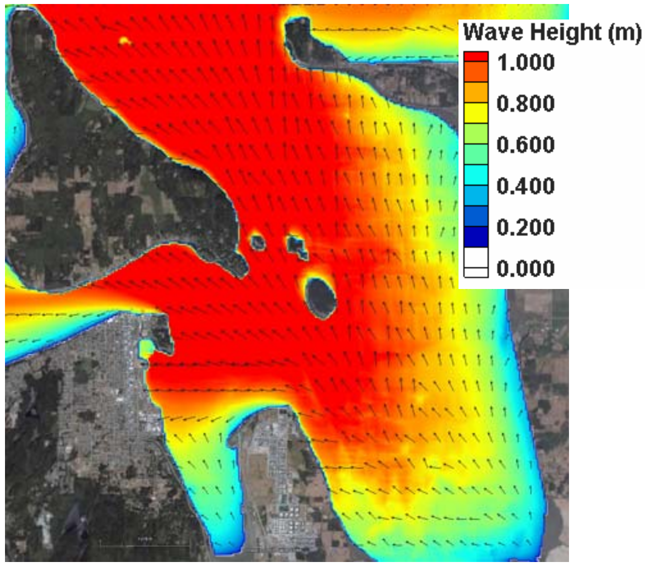


Figure 8. Example of SWAN numerical modeling results, wind speed 8.3 MPH SE (25-year return period), MHHW tide elevation

The figure shows wave growth along the wind fetch. Wave heights approaching the marina during this extreme event is in a range of 3 to 4 ft. The results of large modeling domain modeling are consistent with CHE experience at other similar locations in Puget Sound and observations of local citizens.

4.2 Existing Conditions Wave Modeling

Existing conditions wave modeling was conducted to develop the basis for comparison of the alternatives and to validate, to the extent possible, the wave refraction/diffraction model. Existing conditions modeling was conducted on the nested numerical modeling domain with boundaries extending just offshore from the project vicinity. The nested modeling domain covers an area of approximately 0.2 mile by 0.4 mile and has a grid resolution of 3 ft. in both x- and y-directions. Figure 9 shows the nested numerical modeling grid in color format that was used for the detailed modeling. Output from the large modeling domain at the offshore boundary of the nested model was used as input to the HWAVE model.

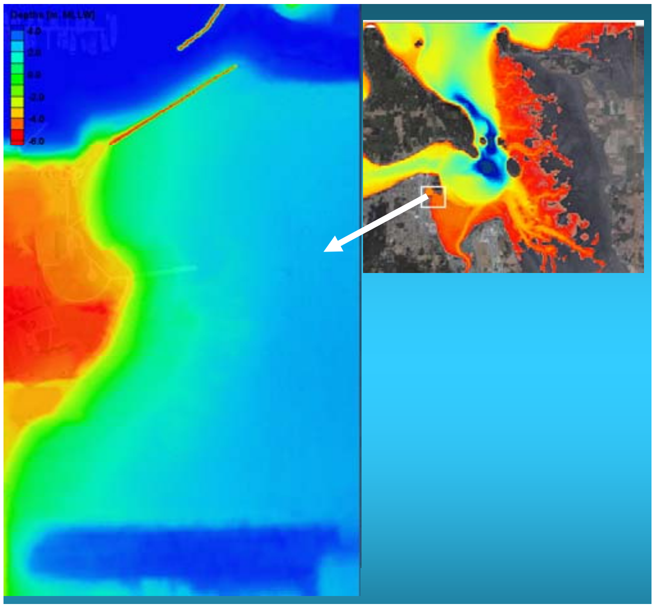


Figure 9. Nested modeling domain for the detailed wave modeling

The 2-Dimensional wave refraction/diffraction/reflection model (Zheleznyak, et al 2005) was used to simulate waves in the project area and their interaction with shoreline and project structures. Wave parameters from the large grid model were input along the HWAVE model boundary. Modeling was conducted for three different wind directions (NE, E, and SE) and three tide elevations, MHHW, MSL, and MLLW. As discussed above (Task 2, Methodology), modeling was conducted for 25- and 50-year return period waves. An example of HWAVE modeling results for a 25-year return period wave storm from the SE direction is shown in Figure 10. The color in the figure specifies a significant wave height.

Note that there is a significant effect of wave reflection from the existing timber pile wall of the marina. Reflection amplifies wave energy along the adjacent shoreline, requiring larger size rock material for shoreline stabilization. Note that the largest rock size observed along the shoreline is located at the timber pile wall (See Figure 11). Additionally, shoreline armoring and maintenance is required along the shoreline where the reflected waves are observed to break.

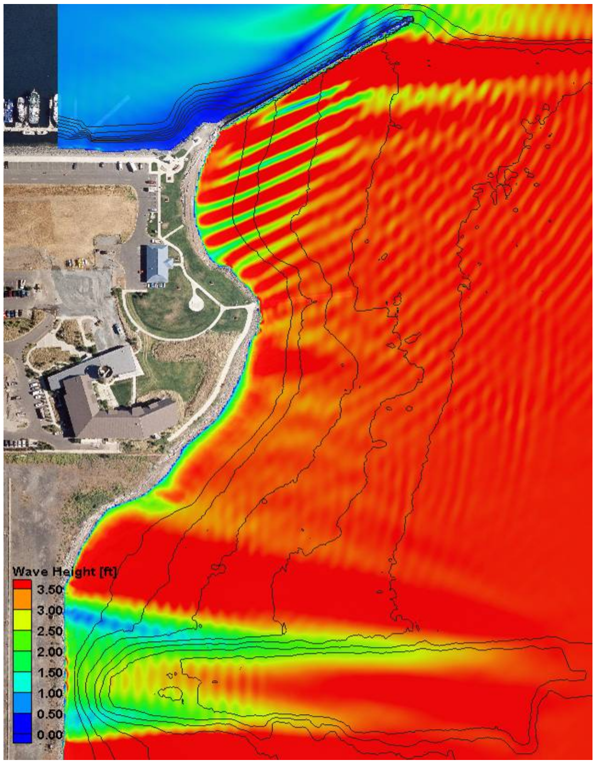


Figure 10. Existing Conditions, example of HWAVE modeling on nested modeling domain, 25-year return period wave storm, MHHW

Figure 11. Rock size for shoreline protection at the timber pile wall

The HWAVE model was validated with photographs taken at the project site on November 29, 2007 during a wave storm approaching from the SE. Figure 12 shows wave conditions at the marina timber pile jetty during this storm event. Numerical modeling was conducted for the same storm conditions, based on the measured wind data from Bellingham airport (determined by analysis of regional and local wind data to be most representative of the site). Results of the modeling are superimposed on Figure 12.

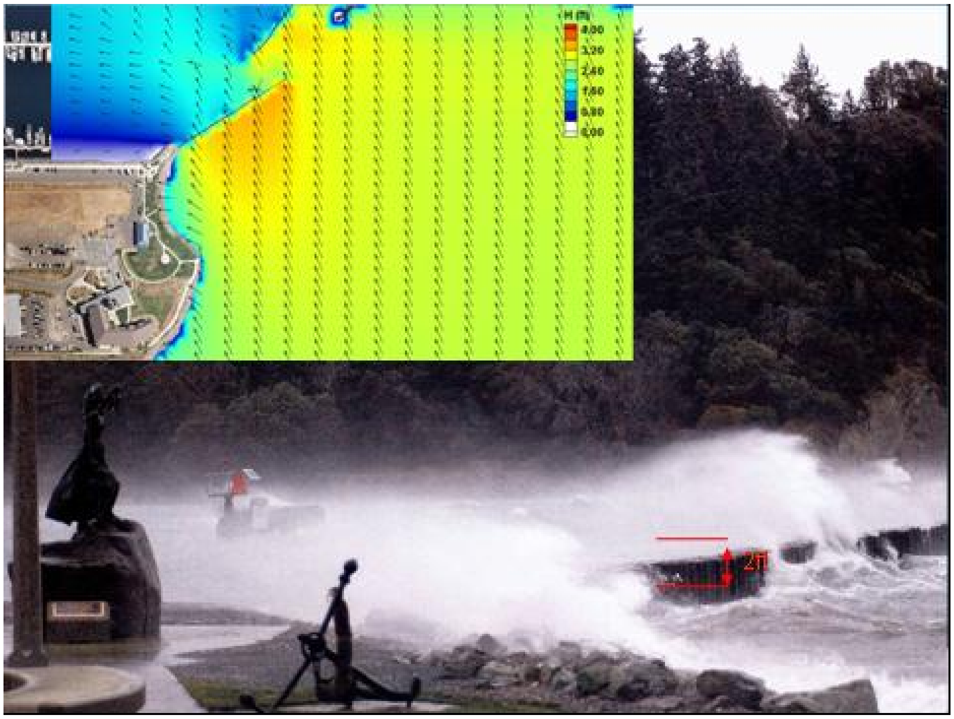


Figure 12. HWAVE model validation with storm photographs of November 29, 2007

It should be noted that comparison of modeling results to a single ground photograph is intended for qualitative (but not quantitative) validation of the model. However, we conclude from the modeling results and photographic evidence, combined with CHE's extensive experience with wave modeling that the HWAVE modeling results at the project site are reliable and can be used for feasibility level of analysis.

4.3 Sill Concept Wave Modeling

Once validated, the HWAVE model was used to evaluate the proposed configurations of the shore protection alternative. Configuration 1, consisting of the Sill Alternative placed at the Port and MJB Marine Area shorelines, was coded into the modeling grid (See Figure 13).

As well as for the existing conditions, modeling was conducted for the Sill Alternative for three different wind directions (NE, E, and SE), three tide elevations (MHHW, MSL, and MLLW), and two return period storm events (25- and 50-year return periods). Example wave numerical modeling results for a 25-year return period storm at MHHW is shown in Figure 14 a. In addition, for visual comparison the figure shows the modeling results for existing conditions (b).

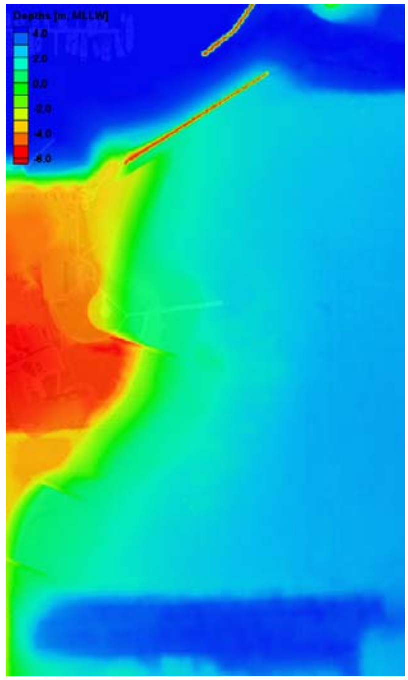
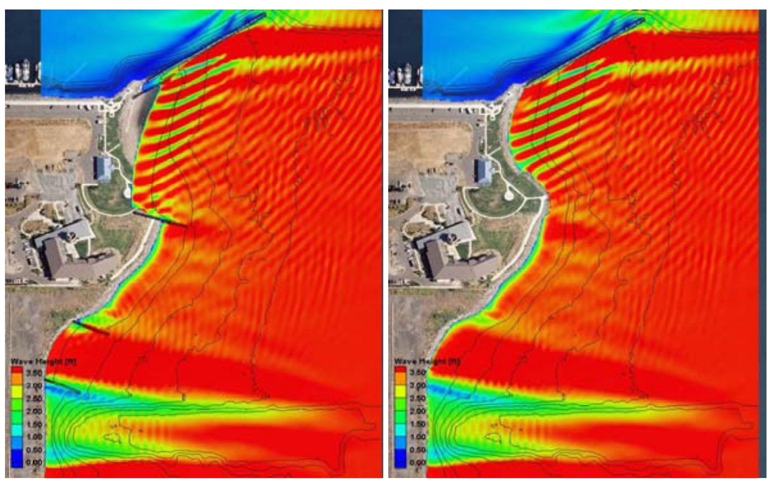


Figure 13. Nested modeling grid with Configuration 1 of shore protection option



a) b)

Figure 14. a) Example of Sill Alternative modeling results, 25-year return period wave storm, MHHW and b) existing conditions modeling results, 25-year return period wave storm, MHHW

The analysis shows that, for all storm wave conditions at the Port Marine Area shoreline with the Sill Alternative would be similar to that for existing conditions. Importantly, the Sill Alternative does not alter the wave reflection effect on the Port Marine Area at the site resulting from the timber pile wall. The same conclusion is applicable for the remaining part of the shoreline at the Port Marine Area. Sills, being relatively small features, do not significantly change the wave pattern at the project area.

4.4 Wave Attenuator Concept Wave Modeling

Modeling of shore protection option Configuration 2 was conducted to achieve two objectives. The first objective was to determine feasibility of the attenuator alternative at the Port Marine Area. The second objective was to optimize configuration of the Wave Attenuator alternative (if indeed this alternative is feasible). The optimization was conducted to meet the performance criteria and simultaneously reduce size of the attenuator structure. A total of 8 Wave Attenuator alternatives were developed and tested with the numerical model during a process of optimization[3]. Each of these alternatives was coded into the modeling grid and tested. Based on modeling results, the adjustment (dimensions and alignment) were conducted, a new alternative was developed, and the modeling was repeated.

The original alternative consisted of a single wave attenuator, extending from the southern boundary of the Port Marine Area toward the north. The crest elevation of the attenuator was designed to preclude wave overtopping during the design (25-year) return period wave storm. Figure 15 shows the nested grid of the original wave attenuator alternative.

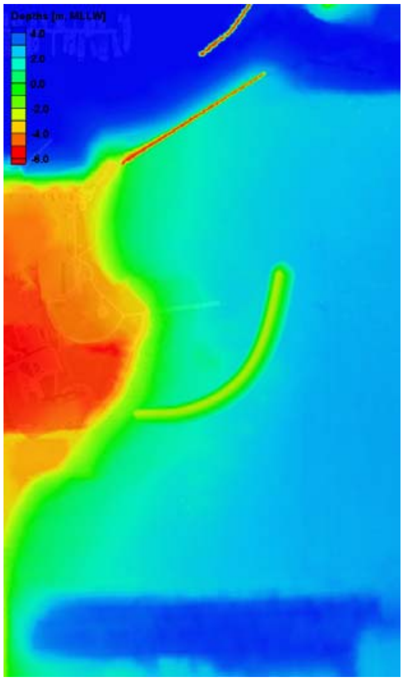


Figure 15. Original Wave Attenuator Alternative numerical modeling grid

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[3] The MJB Marine Area sill alternative was not included in the numerical modeling grid for Configuration 2 because modeling results of this (MJB sill) alternative from Configuration 1 are applicable to Configuration 2.

HWAVE numerical modeling of the wave attenuator alternative was performed for the same wave conditions as Configuration 1. Example wave numerical modeling results for a 25-year return period storm at MHHW is shown in Figure 16a. In addition, for visual comparison, the figure shows the modeling results for existing conditions (16b).

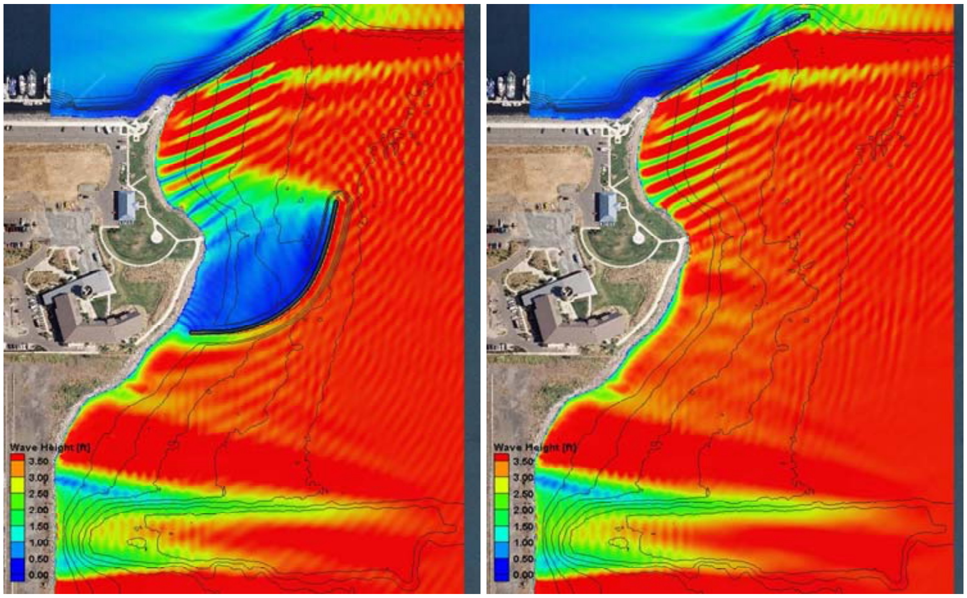
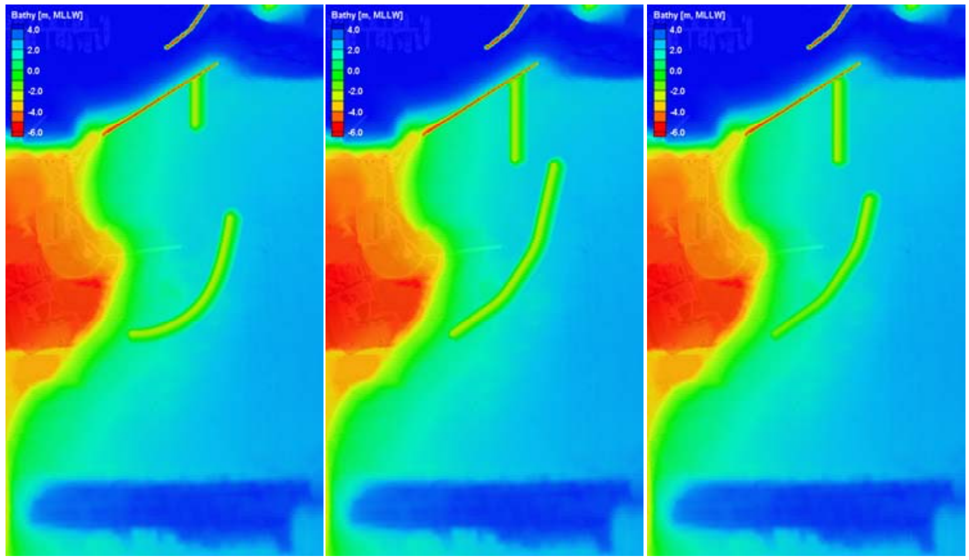


Figure 16. a) Example of original Wave Attenuator Alternative modeling results, 25-year return period wave storm, MHHW and b) existing conditions modeling results, 25-year return period wave storm, MHHW

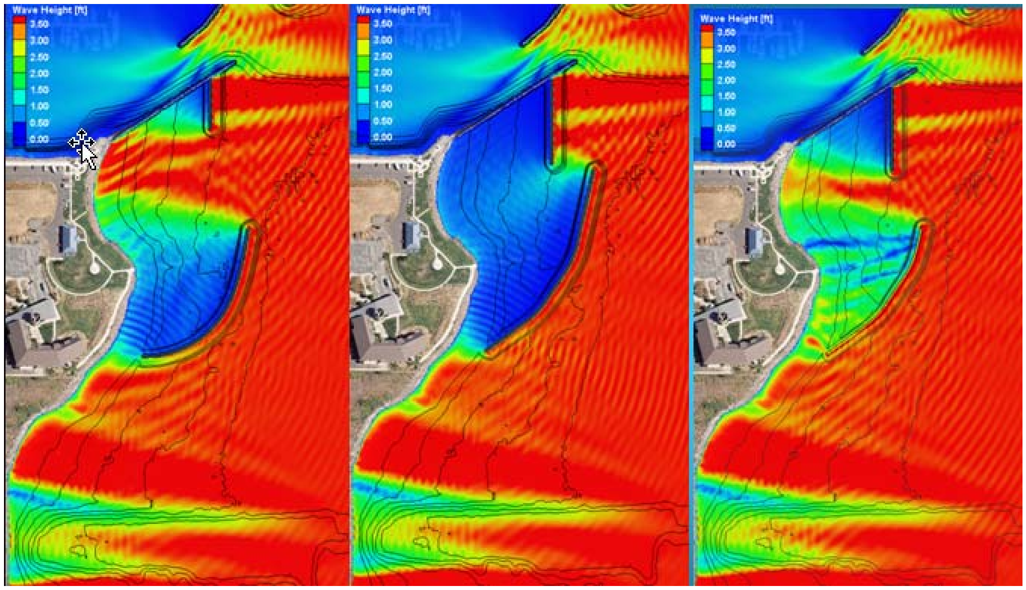
Modeling results showed that the original wave attenuator provides an extensive wave shading area along part of the shoreline. Wave heights and energy delivered to the shoreline are reduced significantly. However, the original alternative did not reduce much the wave reflection effect. Therefore (as discussed above), modifications to the original alternative were conducted to improve performance criteria. Each of these modifications were tested with the model. Figure 17 shows some of the intermediate steps in the optimization process. Figure 18 shows the results of testing alternatives to identify optimal performance.



a) Step i b) Step ii c) Step iii

Figure 17. Intermediate configurations of wave attenuator alternative during optimization

At first a small, second arm of the wave attenuator was added at the north side (14i). When found that it was not sufficient to reduce reflected wave energy (See Figure 18i), a north attenuator was extended to the south to overlap with the south attenuator (See Figure 17ii). The results of modeling showed good wave attenuation effect (Figure 18 ii). However, the cost this structure and footprint were increased dramatically. Therefore, the next alternative included reducing the crest elevation and length of the north attenuator (See Figure 17 iii). The crest elevation along the entire attenuator was reduced below 8 ft MLLW. The test results of these modifications also did not show the optimal conditions (See 18 iii). The process of optimization was therefore conducted through Alternative 8, until an optimized Wave Attenuator alternative was developed, as shown in Figure 19.



F a) Step i b) Step ii c) Step iii

Figure 18. Intermediate configurations of wave attenuator alternative during optimization

Figure 19 shows the optimized alternative as consisting of two components: a south attenuator and a north attenuator. The south attenuator attenuates direct wave impact from SE and NE directions on the shoreline. The north attenuator eliminates timber pile jetty wave reflection and attenuates the direct wave impact from the E direction. The figure also depicts crest elevations along the wave attenuator. Crest elevations are variable along the wave attenuator, and are defined to minimize the volume of construction material without diminishing the capability of the reef to protect the shoreline. Segmenting the reef allowed for maximum protection from wave energy, while minimizing the overall fill footprint of the structure. Breaks in the structure also will likely allow for better tidal circulation inside the reef (landward).

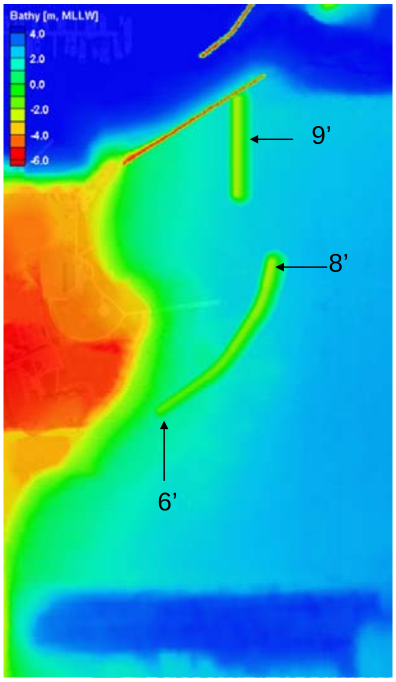


Figure 19. Optimized wave attenuator alternative

The optimized Wave Attenuator alternative was further evaluated by conducting wave modeling for different wave conditions and tide elevations. Figure 20 shows the modeling results example of a 25-year return period wave storm from the SE direction at MHHW elevation. In addition, the figure superimposes the existing conditions modeling results (b) for the same wave storm conditions.

The modeling results showed a significant reduction of wave heights along most of the Port Marine Area. Some wave energy still propagates to the project site through the opening between the North and South reefs, which would facilitate circulation of the area as opposed to one continuous reef. However, the amount of this wave energy is significantly less than for existing conditions and will limit erosive impact on the bottom and shoreline.

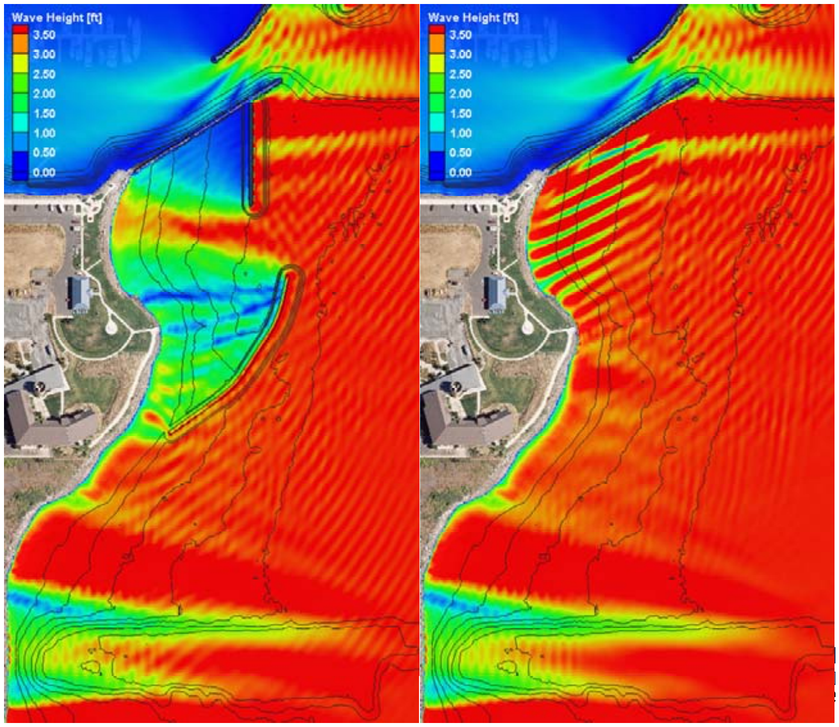


Figure 20. HWAVE modeling results for the optimized wave attenuator alternative (a) and existing conditions (b), 25-year return period storm, SE direction, MHHW

5. Shoreline Material and Bottom Sediment Mobility Analysis

5.1 Sediment Mobility Analysis Methodology

Shoreline and bottom sediment mobility analysis was conducted to determine the type and size of beach material (sediment) that can be used as cap material and to provide shore protection for Configurations 1 and 2. Two different criteria were used for cap material and shore protection material.

The analysis of cap material was conducted using a criterion of no sediment mobility (movement) during a 25-year storm event. This criterion should apply to all water surface elevations in the range from MHHW to MLLW (approximately elevation +8.5 to 0). The criterion of "no sediment mobility" was selected to assure no movement and no displacement of surface material that will be used as a cap for contaminated sediment or habitat, consistent with Palermo, et al. (1998).

The criterion of sediment stability for the purpose of shore protection is not as strict as for environmental capping purposes, and allows limited movement and displacement of sediment, assuming that this sediment remains within the general beach area. Movable sediment also effectively attenuates wave energy. Shore protection with movable sediment, however, requires maintaining an interface with a sufficient layer of thickness between wave shear and protected shoreline during a design storm event. One way to achieve this interface would be to use sediment that is a composition of movable and non-movable sediment. Movable sediment migrates up and down the beach slope during various storm conditions, dissipating wave energy and providing wave attenuation. Non-movable sediment armors the surface of the beach, forming the required stable interface during the design storm event.

Analysis and determination of non-movable sediment in a wave environment is relatively standard and consists of comparing wave-induced shear stresses to threshold shear stress of sediment movement. This procedure is used further to determine the size of cap material for contaminated sediment.

Analysis and determination of movable sediment is more complex and does not have one agreed upon approach, specifically for composition of beach sediment such as cobble/gravel/sand material. There are still theoretical uncertainties regarding sizing of sediment to be mobile, storm conditions corresponding to different sediment size mobility, area of migration for movable sediment, and other topics. A simple approach for computing movable sediment size is applied herein, based on the following assumptions:

- Composition of sediment for shore protection consists of two major components: non-movable and movable.
- A non-movable component is represented by the 10% (D_{90}) largest particle size, while a movable component is represented by the 50% (D_{50}), or median, particle size.
- The ratio of size of movable to size of non-movable sediment (D_{90}/D_{50}) is equal to 3:1. This ratio was obtained from a review of field data from various coarse gravel beaches in the Puget Sound area.

Based on these assumptions, the simplified approach included only determining the size of non-movable sediment (D_{90}) and, using ratio $D_{90}/D_{50} = 3.0$, estimating the size of movable sediment (D_{90}). A non-movable sediment size for shore protection was computed with the same procedure as discussed above for capping material. To further simplify the methodology, a storm event with a 25-year return period from the SE direction (the same criterion as for the cap material stability) was applied to determine the size of non-movable sediment for shore protection purposes.

5.2 Sediment Mobility Analysis for Configuration 1

Analysis and computations of sediment mobility for Configuration 1 was conducted for the Sill Alternative area at the Port and MJB Marine Areas separately. Figure 21 shows the plan view of Configuration 1 shore protection with two transects. Transect 1 was used as a representative shoreline cross-section for the Port Marine Area Sill Alternative, and Transect 2 was used as a representative shoreline cross-section for the MJB Marine Area Sill Alternative.

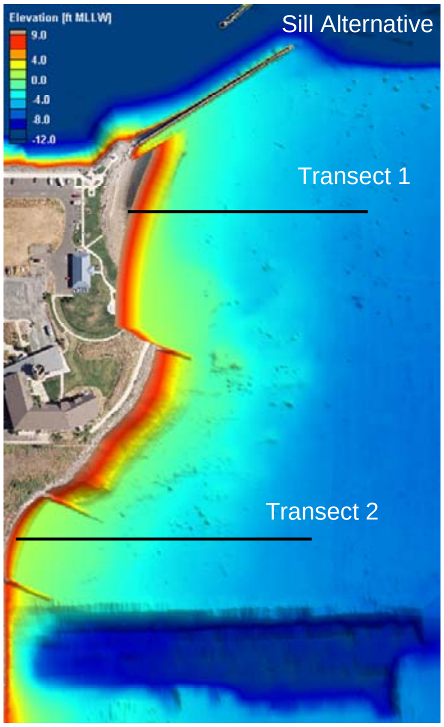


Figure 21. Location of transects for sediment stability analysis

Results of wave modeling for a 25-year storm from the SE at MHHW, MSL, and MLLW tide levels were applied to compute bottom velocities along the transects. Bottom wave orbital velocities were extracted from the numerical modeling results along Transects 1 and 2 from offshore to the location of wave breaking depth. This depth was different for each tide elevation. Landward from the breaking depth, bottom velocities were computed as swash velocities using methodology described by the Coastal Engineering Manual (USACE 2002). The results of computations of bottom velocities along Transect 1 for three tide elevations are shown in Figure 22.

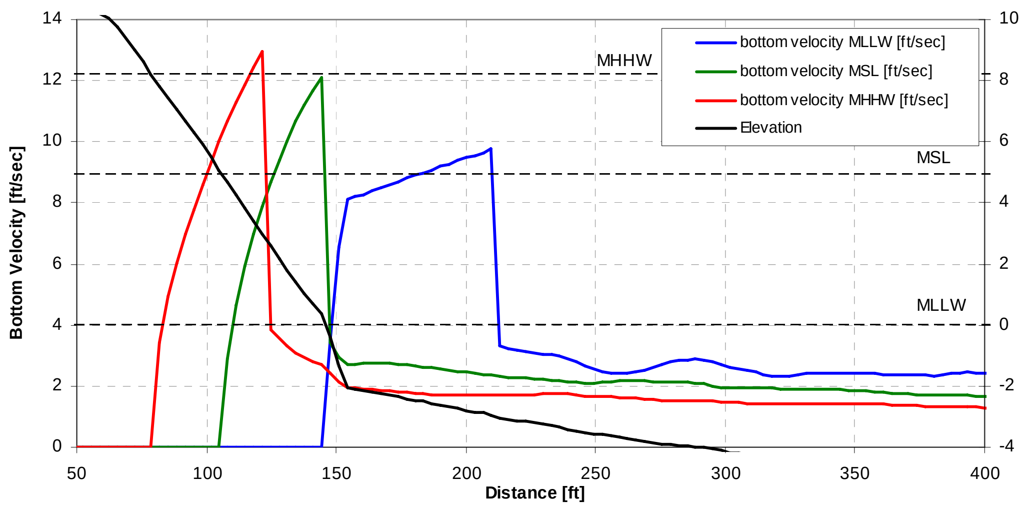


Figure 22. Bottom velocities along Transect 1 for three tide elevations, 25-year return period storm event

The black line on the figure represents the bottom profile along Transect 1. The figure shows that location and magnitude of peak velocities depends on tide elevation. During low tide, when breaking wave height is located farther offshore, peak bottom velocity is also displaced offshore.

The bottom velocities were used to compute shear stresses and compare the shear stresses derived from threshold velocity of sediment. Sediment with threshold velocity exceeding wave-generated shear stresses was considered to be stable for a 25-year return period storm event. These stable sediments for Transect 1 are plotted on Figure 23 for different tide elevations.

As expected, the figure shows that the location and size of stable material for the given storm event strongly depends on tide elevation. Therefore, computation of stable material was conducted for three different tide elevations. Computed stable sediments along Transect 1 for the entire range of tide elevations (for this particular storm event) are shown in Figure 24.

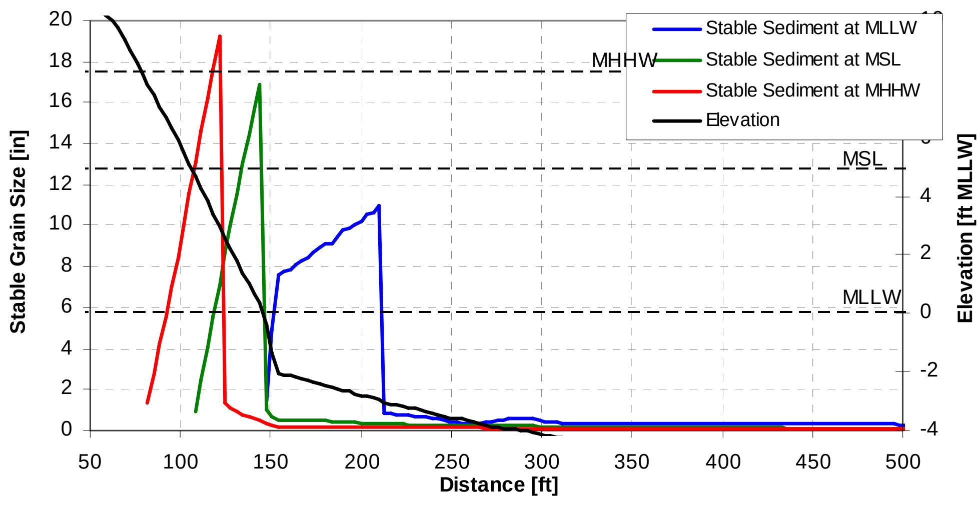


Figure 23. Stable sediment size along Transect 1 for three tide elevations, 25-year return period storm event from SE

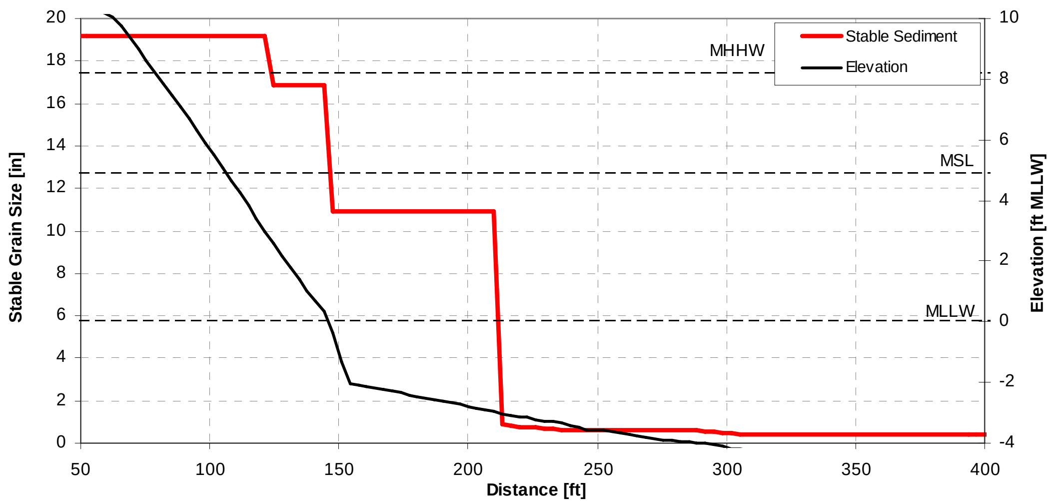


Figure 24. Combined stable sediment size along Transect 1 for the range of tide elevation from MLLW to MHHW, 25-year return period storm event from SE

The red line on the figure represents distribution of sediment sizes along transects that would be stable (non-movable) during a 25-year return period storm event from the SE for the entire range of tide elevation from MLLW to MHHW. This line was obtained from the envelopment of maximum particle sizes from Figure 20 above.

Similar computations were conducted for Transect 2. The results of computations of stable sediment sizes for a 25-year storm event for the range of tide elevations is shown in Figure 25. As expected, the size of stable sediment at the MJB Marine Area is slightly smaller than at the Port Marine Area, due to a smaller effect from reflected waves.

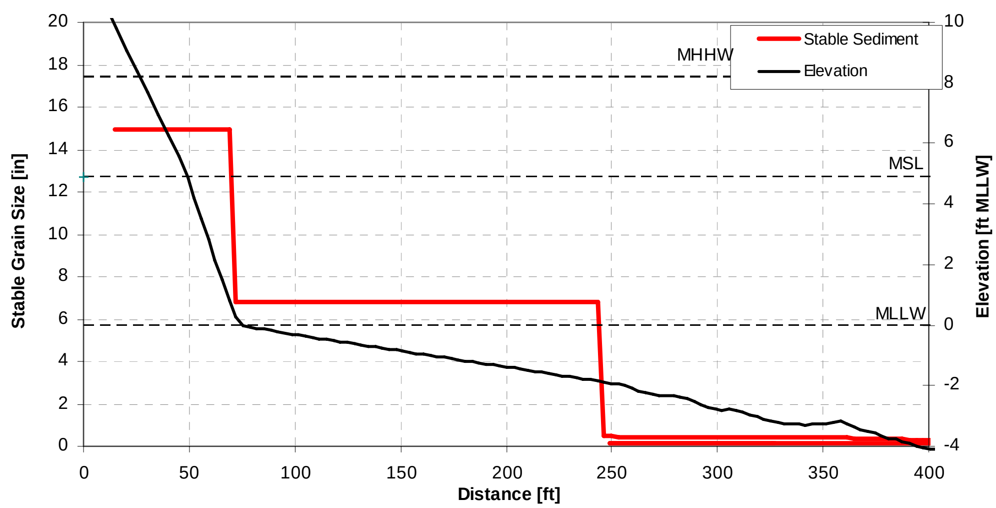


Figure 25. Combined stable (non-movable) sediment size along Transect 2 for the range of tide elevation from MLLW to MHHW, 25-year return period storm event from SE

As discussed above (See Section 4.1), computations of non-movable sediment size was conducted with dual purposes: determine the size of material for capping of contaminated sediment and determine a basis for estimating shore protection beach material. However, there is no source that provides uniform material (only one size) either for capping or shore protection purposes. For developing a gradation of capping material, in order to minimize risk of displacement, the computed non-movable sediment should correspond to the $D_{50\%}$ (or smaller) sediment size. When applying the results of computation to size of beach material for shore protection purposes, the sediment size on a graph would represent the D_{90} grain size. Using the assumption regarding converting sediment gradation from D_{90} to $D_{50\%}$, the distribution of beach sediment along Transects 1 and 2 (Sills at Port and MJB Marine Areas, respectively) is shown in Figure 26.

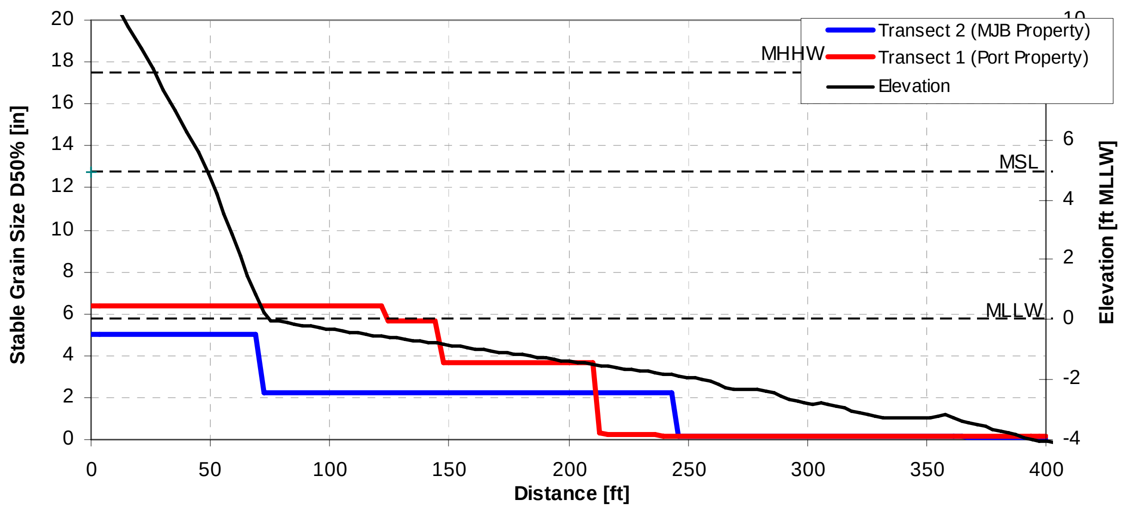


Figure 26. MJB Marine Area and Port Marine Area Sill Alternative recommended $D_{50\%}$ material for shore protection, 25-year return period storm event from SE

It is our understanding that the Port Marine Area Sill Alternative may require two types of material - cap material and beach material. It is also our understanding that the MJB Marine Area Sill Alternative would require only one type of material - beach material. Table 2 summarizes computations of stable sediment size relevant for capping purpose at the Port Marine Area and beach stabilization purpose at both the Port and MJB Marine Areas. The table also distinguishes sediment size for the upper beach material (above MLLW) and lower beach material (below MLLW).

Table 2, Sill Alternative, capping and beach material

	$D_{50\%}$ Cap Material Size, (in)	Upper Beach (above MLLW) $D_{50\%}$ Material Size, (in)	Lower Beach (below MLLW) $D_{50\%}$ Material Size, (in)
Port Marine Area Sill Alternative	19.2 (rock)	6.1 Cobbles	3.8-6.1 Cobbles
MJB Marine Area Sill Alternative	N/A	5.0 Cobbles	2.0 Gravel

Note: Material names follow size classification of the Unified Soil Classification System.

5.3 Sediment Mobility Analysis for Configuration 2

Analysis and computations of sediment mobility for Configuration 2 was conducted for the Wave Attenuator area only. The analysis and results of analysis of sediment mobility for the Sill Alternative at the MJB Marine Area is identical for both configurations: Configuration 1 and Configuration 2. Therefore, the results of stability analysis from Configuration 1 for the Sill Alternative at the MJB Marine Area (See Section 5.2) were applied there for Configuration 2. Analysis of sediment mobility for Configuration 2 was conducted along the representative cross-section at the Port Marine Area shoreline.

The full set of sediment mobility analysis similar to that described in Section 5.2 was applied for Wave Attenuator Transect A. Results of wave modeling for a 25-year storm event from the SE at MHHW, MSL, and MLLW tide elevations were used to compute bottom velocities. These bottom velocities were further used to compute shear stresses and determine non-movable sediment sizes. Non-movable sediment sizes were transformed to stable beach sediment using a relationship $D_{90}/D_{50\%} = 3.0$. Results of computations are shown on Figure 27.

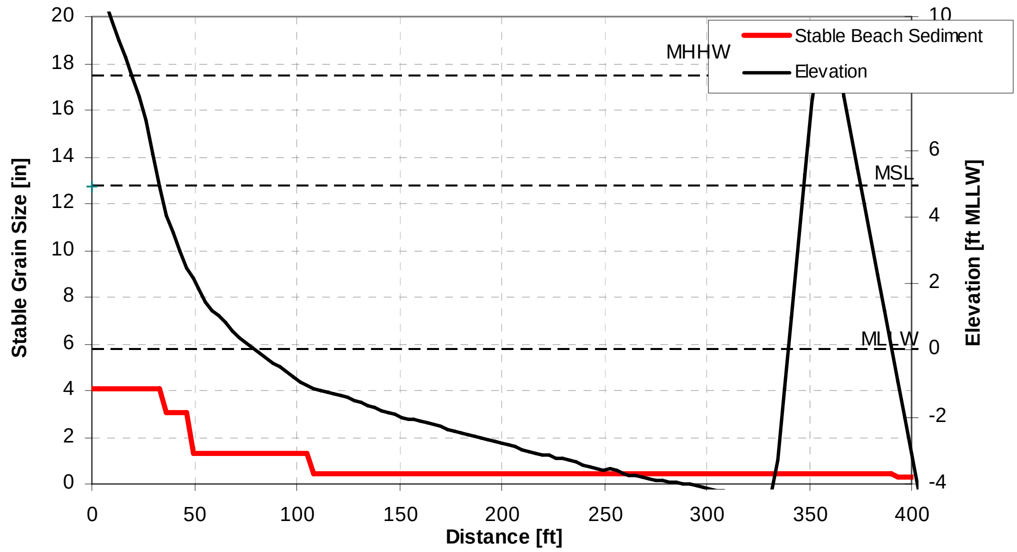


Figure 27. Combined stable sediment size along representative transect of Reef Habitat shoreline for the range of tide elevation from MLLW to MHHW, 25-year return period storm event from SE

The red line on the figure represents distribution of sediment sizes along transects that would be stable during a 25-year return period storm event from the SE for the entire range of tide elevation from MLLW to MHHW. The black line on the figure shows the bottom profile and wave attenuator (offshore) configuration. Note that only a small area of the beach (less than 50 ft) would require coarse gravel material. The remaining parts of the beach would be stable with small gravel-sandy material.

Table 3 summarizes computed stable sediment size relevant for beach stabilization purposes at both the Port and MJB Marine Areas for Configuration 2.

Table 3, Stable sediment for Configuration 2 Wave Attenuator and Sill Alternative at MJB

	Upper Beach (above MLLW) $D_{50\%}$ Material Size, (in)	Lower Beach (below MLLW) $D_{50\%}$ Material Size, (in)
Wave Attenuator Alternative	1.0-4.0 Gravel-Cobble	<1.0 Sand-Gravel
MJB Marine Area Sill Alternative	5.0 Cobble	2.0 Gravel

3. References

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APPENDIX B
CLEANUP ACTION ALTERNATIVE COST ESTIMATES – PORT UPLANDS AREA

TABLE B-1
COST ESTIMATE - CLEANUP ACTION ALTERNATIVE PUA-1
PORT UPLANDS AREA
FORMER SCOTT PAPER COMPANY MILL SITE

ITEM No.	DESCRIPTION	PLAN QUANT	UNIT	UNIT PRICE	AMOUNT (2008$)	NOTE
	Mobilization and Site Preparation					
1	Mobilization/Site Controls/Demobilization	1	LS	$165,000.00	$165,000	Basis: Average of three CSM bids.
	Subtotal				**$165,000**	
	Demolition					
4	Asphalt demolition and disposal	2,778	SY	$11.80	$32,800	Includes all asphalt surfaces ~25000 SF, 6" thick
5	Concrete demolition and disposal	700	CY	$149.00	$104,300	Includes concrete pads, foundations, and sidewalks
6	Demolish/Rebuild Park Building	1	LS	$410,000.00	$410,000	Includes $50,000 for demolition and $200/SF for 1800 SF
	Subtotal				**$547,100**	
	Soil Removal, Backfill, and Pavement Restoration					
7	Installation of Sheet Pile Wall	1,000	LF	$636.00	$636,000	Assume temporary sheet pile along shoreline and adjacent to buildings in area of contaminated soil. Average depth of 40 feet. Unit cost of $15.9/SF from 2005 Means Site Construction 02250-400-1300
8	Excavation Dewatering	1	LS	$200,000.00	$200,000	Pump, Temporary Storage, and Disposal. Dewatering required for excavations deeper than 10' bgs.
9a	Excavate Soil (0'-6' bgs)	1,344	CY	$10.00	$13,400	Total of all soil excavated. Assume 20% expansion above in-place volume. Cost includes excavation and stockpile. Unit cost for all upland excavation based on average of three CSM bids.
9b	Excavate Soil (0'-10' bgs)	22,058	CY	$10.00	$220,600	
9c	Excavate Soil (0'-12' bgs)	9,144	CY	$10.00	$91,400	
9d	Excavate Soil (0'-15' bgs)	34,179	CY	$10.00	$341,800	
10	Contaminated Soil (non-haz) Transport and Disposal at approved off-site facility	53,380	TON	$56.00	$2,989,300	50% of all soil excavated. Assume 1.6 ton/CY. Cost includes loading and hauling. Unit cost from Waste management (Missy Boone).
11	On-site Stabilization for Lead Soil failing TCLP, with transport and disposal as non-haz contaminated soil	33,630	TON	$86.00	$2,892,100	30% of all soil excavated. Assume 1.6 ton/CY plus 5% expansion from stabilization. Cost includes stabilization (ART Engineering) and loading and hauling (WM non-haz).
12	Stockpile, Place and Compact Clean Excavated Soil	21,352	TON	$8.00	$170,800	20% of all soil excavated. Assume 1.6 ton/CY. Cost includes stockpiling, filling, and compaction. Unit cost based on average of three CSM bids.
13	Purchase, Place and Compact General Backfill Material	63,431	TON	$13.00	$824,600	Assume 1.6 ton/CY. Assume tonnage equal to that of off-site disposal soil. Cost includes purchase, filling and compaction. Unit cost based on average of three CSM bids.
14	Purchase, Place and Compact Rock Backfill Material	11,393	CY	$35.00	$398,800	Assume backfill of rock in bottom 5-foot interval of area excavated to 15' bgs. Unit cost based on average of three CSM bids.
15	Purchase and Place Topsoil	2,343	CY	$28.00	$65,600	Assume placement of topsoil across 50 percent of excavation areas at a thickness of 1'. Unit cost based on average of three CSM bids.
	Subtotal				**$8,844,400**	
	Surface Restoration					

TABLE B-1
COST ESTIMATE - CLEANUP ACTION ALTERNATIVE PUA-1
PORT UPLANDS AREA
FORMER SCOTT PAPER COMPANY MILL SITE

ITEM No.	DESCRIPTION	PLAN QUANT	UNIT	UNIT PRICE	AMOUNT (2008$)	NOTE
16	Hydroseed grass areas	3	acre	$2,400.00	$6,500	Unit cost based on average of three CSM bids.
17	Pavement Restoration, including base	2,778	SY	$40.00	$111,100	Includes all asphalt surfaces ~25000 SF x 6" thick, Unit cost based on average of 3 CSM bids.
	Subtotal				**$117,600**	
	Utility Alteration and Replacement					
18	Remove, Bypass, and/or Replace utilities in project area	1	LS	$100,000.00	$100,000	
	Subtotal				**$100,000**	
	Groundwater Monitoring					
19	Install network of 8 groundwater monitoring wells	8	Ea	$2,500.00	$20,000	
20	Perform 4 quarterly monitoring events, monitor for TPH and metals only	4	Ea	$3,872.00	$15,500	
	Subtotal				**$35,500**	
	Site Survey					
21	Post-Construction (As-Built) Surveys	1	LS	$25,000.00	$25,000	
	Subtotal				**$25,000**	
	Contractor Overhead (Based on total of Tasks 1-22)	10.00%	%		$983,460	
	Sales Tax	7.9%	%		$854,627	Sales Tax applied to sum of construction items 1-22 and construction overhead.
	Total Purchase and Installation Cost				**$11,672,687**	
	Construction Management and Field Monitoring	6.0%	%		$700,361	
Construction Total					**$12,373,048**	
	Contingency (Concept design level)	30.0%	%		$3,711,914	
Construction Total with Contingency					**$16,084,962**	
	Design and Permitting	8.0%	%		$1,286,797	
	Port Internal Costs	6.0%	%		$965,098	
OVERALL PROJECT TOTAL COSTS					**$18,336,857**	

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TABLE B-2
COST ESTIMATE - CLEANUP ACTION ALTERNATIVE PUA-2
PORT UPLANDS AREA
FORMER SCOTT PAPER COMPANY MILL SITE

ITEM No.	DESCRIPTION	PLAN QUANT	UNIT	UNIT PRICE	AMOUNT (2008$)	NOTE
	Mobilization and Site Preparation					
1	Mobilization/Site Controls/Demobilization	1	LS	$165,000.00	$165,000	Basis: Average of three CSM bids.
	Subtotal				**$165,000**	
	Demolition					
4	Asphalt demolition and disposal	1,111	SY	$11.80	$13,100	Includes all asphalt surfaces ~10000 SF x 6" thick
5	Concrete demolition and disposal	100	CY	$149.00	$14,900	Includes concrete pads, foundations, and sidewalks
6	Demolish/Rebuild Park Building	1	LS	$410,000.00	$410,000	Includes $50,000 for demolition and $200/SF for 1800 SF
	Subtotal				**$438,000**	
	Soil Removal, Backfill, and Pavement Restoration					
7	Installation of Sheet Pile Wall	1,000	LF	$477.00	$477,000	Assume temporary sheet pile along shoreline and adjacent to buildings in area of contaminated soil. Average depth of 30 feet.
8	Excavation Dewatering	1	LS	$100,000.00	$100,000	Pump, Temporary Storage, and Disposal. Dewatering required for excavations deeper than 10' bgs.
9a	Excavate Soil (0'-6' bgs)	2,233	CY	$10.00	$22,300	Total of all soil excavated. Assume 20% expansion above in-place volume. Cost includes excavation and stockpile. Unit cost for all upland excavation based on average of three CSM bids.
9b	Excavate Soil (0'-10' bgs)	13,677	CY	$10.00	$136,800	
9c	Excavate Soil (0'-12' bgs)	8,881	CY	$10.00	$88,800	
9d	Excavate Soil (0'-15' bgs)	19,573	CY	$10.00	$195,700	
10	Contaminated Soil (non-haz) Transport and Disposal at approved off-site facility	28,393	TON	$56.00	$1,590,000	40% of all soil excavated. Assume 1.6 ton/CY. Cost includes loading and hauling. Unit cost from Waste management (Missy Boone).
11	On-site Stabilization for Lead Soil failing TCLP, with transport and disposal as non-haz contaminated soil	21,234	TON	$86.00	$1,826,100	30% of all soil excavated. Assume 1.6 ton/CY plus 5% expansion from stabilization. Cost includes stabilization (ART Engineering) and loading and hauling (WM non-haz).
12	Stockpile, Place and Compact Clean Excavated Soil	21,295	TON	$8.00	$170,400	30% of all soil excavated. Assume 1.6 ton/CY. Cost includes stockpiling, filling, and compaction. Unit cost based on average of three CSM bids.
13	Purchase, Place and Compact General Backfill Material	36,726	TON	$13.00	$477,400	Assume 1.6 ton/CY. Assume tonnage equal to that of off-site disposal soil minus rock backfill and topsoil. Cost includes purchase, filling and compaction. Unit cost based on average of three CSM bids.
14	Purchase, Place and Compact Rock Backfill Material	6,524	CY	$35.00	$228,300	Assume backfill of rock in bottom 5-foot interval of area excavated to 15' bgs. Unit cost based on average of three CSM bids.
15	Purchase and Place Topsoil	1,577	CY	$28.00	$44,200	Assume placement of topsoil across 50 percent of excavation areas at a thickness of 1'. Unit cost based on average of three CSM bids.
	Subtotal				**$5,357,000**	
	Surface Restoration					

TABLE B-2
COST ESTIMATE - CLEANUP ACTION ALTERNATIVE PUA-2
PORT UPLANDS AREA
FORMER SCOTT PAPER COMPANY MILL SITE

ITEM No.	DESCRIPTION	PLAN QUANT	UNIT	UNIT PRICE	AMOUNT (2008$)	NOTE
16	Hydroseed grass areas	3	acre	$2,400.00	$6,500	
17	Pavement Restoration, including base	1,111	SY	$40.00	$44,400	Includes all asphalt surfaces ~10000 SF x 6" thick
	Subtotal				**$50,900**	
	Utility Alteration and Replacement					
18	Remove, Bypass, and/or Replace utilities in project area	1	LS	$75,000.00	$75,000	
	Subtotal				**$75,000**	
	Groundwater Monitoring					
19	Install network of 8 groundwater monitoring wells	8	Ea	$2,500.00	$20,000	
20	Perform 4 quarterly monitoring events, monitor for TPH and metals only	4	Ea	$3,872.00	$15,500	
	Subtotal				**$35,500**	
	Site Survey					
21	Post-Construction (As-Built) Surveys	1	LS	$25,000.00	$25,000	
	Subtotal				**$25,000**	
	Contractor Overhead (Based on total of Tasks 1-22)	10.00%	%		$614,640	
	Sales Tax	7.9%	%		$534,122	Sales Tax applied to sum of construction items 1-22 and construction overhead.
	Total Purchase and Installation Cost				**$7,295,162**	
	Construction Management and Field Monitoring	6.0%	%		$437,710	
Construction Total					**$7,732,872**	
	Contingency (Concept design level)	30.0%	%		$2,319,862	
Construction Total with Contingency					**$10,052,733**	
	Design and Permitting	8.0%	%		$804,219	
	Port Internal Costs	6.0%	%		$603,164	
OVERALL PROJECT TOTAL COSTS					**$11,460,116**	

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TABLE B-3
COST ESTIMATE - CLEANUP ACTION ALTERNATIVE PUA-3
PORT UPLANDS AREA
FORMER SCOTT PAPER COMPANY MILL SITE

ITEM No.	DESCRIPTION	PLAN QUANT	UNIT	UNIT PRICE	AMOUNT (2008$)	NOTE
	Mobilization and Site Preparation					
1	Mobilization/Site Controls/Demobilization	1	LS	$80,000.00	$80,000	
	Subtotal				**$80,000**	
	Demolition					
4	Asphalt demolition and disposal	833	SY	$11.80	$9,800	Includes all asphalt surfaces ~7500 SF x 6" thick
5	Concrete demolition and disposal	20	CY	$149.00	$3,000	Includes concrete pads, foundations, and sidewalks
6	Demolish/Rebuild Park Building	1	LS	$410,000.00	$410,000	Includes $50,000 for demolition and $200/SF for 1800 SF
	Subtotal				**$422,800**	
	Soil Removal, Backfill, and Pavement Restoration					
7	Installation of Sheet Pile Wall	100	LF	$477.00	$47,700	Assume temporary sheet pile along adjacent to buildings in area of contaminated soil. Average depth of 30 feet.
8	Excavation Dewatering	1	LS	$50,000.00	$50,000	Pump, Temporary Storage, and Disposal. Dewatering required for excavations deeper than 10' bgs.
9a	Excavate Soil (0'-6' bgs)	5,938	CY	$10.00	$59,400	Total of all soil excavated. Assume 20% expansion above in-place volume. Cost includes excavation and stockpile. Unit cost for all upland excavation based on average of three CSM bids.
9b	Excavate Soil (0'-10' bgs)	1,028	CY	$10.00	$10,300	
9c	Excavate Soil (0'-12' bgs)	8,881	CY	$10.00	$88,800	
9d	Excavate Soil (0'-15' bgs)	1,551	CY	$10.00	$15,500	
10	Contaminated Soil (non-haz) Transport and Disposal at approved off-site facility	16,702	TON	$56.00	$935,300	60% of all soil excavated. Assume 1.6 ton/CY. Cost includes loading and hauling. Unit cost from Waste management (Missy Boone).
11	On-site Stabilization for Lead Soil failing TCLP, with transport and disposal as non-haz contaminated soil	5,776	TON	$86.00	$496,700	30% of all soil excavated. Assume 1.6 ton/CY plus 5% expansion from stabilization. Cost includes stabilization (ART Engineering) and loading and hauling (WM non-haz).
12	Stockpile, Place and Compact Clean Excavated Soil	2,784	TON	$8.00	$22,300	10% of all soil excavated. Assume 1.6 ton/CY. Cost includes stockpiling, filling, and compaction. Unit cost based on average of three CSM bids.
13	Purchase, Place and Compact General Backfill Material	22,936	TON	$13.00	$298,200	Assume 1.6 ton/CY. Assume tonnage equal to that of off-site disposal soil minus rock backfill and topsoil. Cost includes purchase, filling and compaction. Unit cost based on average of three CSM bids.
14	Purchase, Place and Compact Rock Backfill Material	517	CY	$35.00	$18,100	Assume backfill of rock in bottom 5-foot interval of area excavated to 15' bgs. Unit cost based on average of three CSM bids.
15	Purchase and Place Topsoil	807	CY	$28.00	$22,600	Assume placement of topsoil across 50 percent of excavation areas at a thickness of 1'. Unit cost based on average of three CSM bids.
	Subtotal				**$2,064,900**	
	Surface Restoration					
16	Hydroseed grass areas	3	acre	$2,400.00	$6,500	

TABLE B-3
COST ESTIMATE - CLEANUP ACTION ALTERNATIVE PUA-3
PORT UPLANDS AREA
FORMER SCOTT PAPER COMPANY MILL SITE

ITEM No.	DESCRIPTION	PLAN QUANT	UNIT	UNIT PRICE	AMOUNT (2008$)	NOTE
17	Pavement Restoration, including base	833	SY	$40.00	$33,300	Includes all asphalt surfaces ~7500 SF x 6" thick
	Subtotal				**$39,800**	
	Utility Alteration and Replacement					
18	Remove, Bypass, and/or Replace utilities in project area	1	LS	$50,000.00	$50,000	
	Subtotal				**$50,000**	
	Groundwater Monitoring					
19	Install network of 8 groundwater monitoring wells	8	Ea	$2,500.00	$20,000	
20	Perform 4 quarterly monitoring events, monitor for TPH and metals only	4	Ea	$3,872.00	$15,500	
	Subtotal				**$35,500**	
	Site Survey					
21	Post-Construction (As-Built) Surveys	1	LS	$25,000.00	$25,000	
	Subtotal				**$25,000**	
	Contractor Overhead (Based on total of Tasks 1-22)	10.00%	%		$271,800	
	Sales Tax	7.9%	%		$236,194	Sales Tax applied to sum of construction items 1-22 and construction overhead.
	Total Purchase and Installation Cost				**$3,225,994**	
	Construction Management and Field Monitoring	6.0%	%		$193,560	
Construction Total					**$3,419,554**	
	Contingency (Concept design level)	30.0%	%		$1,025,866	
Construction Total with Contingency					**$4,445,420**	
	Design and Permitting	8.0%	%		$355,634	
	Port Internal Costs	6.0%	%		$266,725	
OVERALL PROJECT TOTAL COSTS					**$5,067,779**	

TABLE B-4
COST ESTIMATE - CLEANUP ACTION ALTERNATIVE PUA-
PORT UPLANDS AREA
FORMER SCOTT PAPER COMPANY MILL SITE

ITEM No.	DESCRIPTION	PLAN QUANT	UNIT	UNIT PRICE	AMOUNT (2008$)	NOTE
	Mobilization and Site Preparation					
1	Mobilization/Site Controls/Demobilization	1	LS	$165,000.00	$165,000	Basis: Average of three CSM bids.
	Subtotal				**$165,000**	
	Demolition					
4	Asphalt demolition and disposal	1,111	SY	$11.80	$13,100	Includes all asphalt surfaces ~10000 SF x 6" thick
5	Concrete demolition and disposal	100	CY	$149.00	$14,900	Includes concrete pads, foundations, and sidewalks
6	Demolish/Rebuild Park Building	1	LS	$410,000.00	$410,000	Includes $50,000 for demolition and $200/SF for 1800 SF
	Subtotal				**$438,000**	
	Soil Removal, Backfill, and Pavement Restoration					
7	Installation of Sheet Pile Wall	1,000	LF	$477.00	$477,000	Assume temporary sheet pile along shoreline and adjacent to buildings in area of contaminated soil. Average depth of 30 feet.
8	Excavation Dewatering	1	LS	$75,000.00	$75,000	Pump, Temporary Storage, and Disposal. Dewatering required for excavations deeper than 10' bgs.
9a	Excavate Soil (0'-6' bgs)	2,233	CY	$10.00	$22,300	Total of all soil excavated. Assume 20% expansion above in-place volume. Cost includes excavation and stockpile. Unit cost for all upland excavation based on average of three CSM bids.
9b	Excavate Soil (0'-10' bgs)	20,887	CY	$10.00	$208,900	
9c	Excavate Soil (0'-12' bgs)	8,881	CY	$10.00	$88,800	
9d	Excavate Soil (0'-15' bgs)	1,551	CY	$10.00	$15,500	
10	Contaminated Soil (non-haz) Transport and Disposal at approved off-site facility	21,473	TON	$56.00	$1,202,500	40% of all soil excavated. Assume 1.6 ton/CY. Cost includes loading and hauling. Unit cost from Waste management (Missy Boone).
11	On-site Stabilization for Lead Soil failing TCLP, with transport and disposal as non-haz contaminated soil	15,784	TON	$86.00	$1,357,500	30% of all soil excavated. Assume 1.6 ton/CY plus 5% expansion from stabilization. Cost includes stabilization (ART Engineering) and loading and hauling (WM non-haz).
12	Stockpile, Place and Compact Clean Excavated Soil	16,105	TON	$8.00	$128,800	30% of all soil excavated. Assume 1.6 ton/CY. Cost includes stockpiling, filling, and compaction. Unit cost based on average of three CSM bids.
13	Purchase, Place and Compact General Backfill Material	34,548	TON	$13.00	$449,100	Assume 1.6 ton/CY. Assume tonnage equal to that of off-site disposal soil minus rock backfill and topsoil. Cost includes purchase, filling and compaction. Unit cost based on average of three CSM bids.
14	Purchase, Place and Compact Rock Backfill Material	517	CY	$35.00	$18,100	Assume backfill of rock in bottom 5-foot interval of area excavated to 15' bgs. Unit cost based on average of three CSM bids.
15	Purchase and Place Topsoil	1,377	CY	$28.00	$38,600	Assume placement of topsoil across 50 percent of excavation areas at a thickness of 1'. Unit cost based on average of three CSM bids.
	Subtotal				**$4,082,100**	
	Surface Restoration					

TABLE B-4
COST ESTIMATE - CLEANUP ACTION ALTERNATIVE PUA-
PORT UPLANDS AREA
FORMER SCOTT PAPER COMPANY MILL SITE

ITEM No.	DESCRIPTION	PLAN QUANT	UNIT	UNIT PRICE	AMOUNT (2008$)	NOTE
16	Hydroseed grass areas	3	acre	$2,400.00	$6,500	
17	Pavement Restoration, including base	1,111	SY	$40.00	$44,400	Includes all asphalt surfaces ~10000 SF x 6" thick
	Subtotal				**$50,900**	
	Utility Alteration and Replacement					
18	Remove, Bypass, and/or Replace utilities in project area	1	LS	$75,000.00	$75,000	
	Subtotal				**$75,000**	
	Groundwater Monitoring					
19	Install network of 8 groundwater monitoring wells	8	Ea	$2,500.00	$20,000	
20	Perform 4 quarterly monitoring events, monitor for TPH and metals only	4	Ea	$3,872.00	$15,500	
	Subtotal				**$35,500**	
	Site Survey					
21	Post-Construction (As-Built) Surveys	1	LS	$25,000.00	$25,000	
	Subtotal				**$25,000**	
	Contractor Overhead (Based on total of Tasks 1-22)	10.00%	%		$487,150	
	Sales Tax	7.9%	%		$423,333	Sales Tax applied to sum of construction items 1-22 and construction overhead.
	Total Purchase and Installation Cost				**$5,781,983**	
	Construction Management and Field Monitoring	6.0%	%		$346,919	
Construction Total					**$6,128,902**	
	Contingency (Concept design level)	30.0%	%		$1,838,671	
Construction Total with Contingency					**$7,967,573**	
	Design and Permitting	8.0%	%		$637,406	
	Port Internal Costs	6.0%	%		$478,054	
OVERALL PROJECT TOTAL COSTS					**$9,083,033**	

APPENDIX C
CLEANUP ACTION ALTERNATIVE COST ESTIMATES – MJB NORTH AREA

DRAFT FINAL

TABLE C-1
COST ESTIMATE - CLEANUP ACTION ALTERNATIVES
MJB NORTH AREA
FORMER SCOTT PAPER COMPANY MILL SITE

INITIAL COSTS				ALTERNATIVE MJB-1		ALTERNATIVE MJB-2		ALTERNATIVE MJB-3	
CONTRACTOR		Unit	Unit Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
1	**Mobilization/Demobilization**								
	Mobilization/Demobilization	lump sum		1	$150,000	1	$125,000	1	$125,000
2	**Health and Safety**								
	Equipment	month	$1,030	4	$4,120	4.33	$4,460	3	$3,090
	PPE, Level D	day	$25	65	$1,625	80	$2,000	55	$1,375
	PPE, Level C	day	$75	13	$975	7	$525	4	$300
3	**Site Preparation**								
	Utility Locates	hour	$85	8	$680	8	$680	8	$680
	Site Security	linear foot	$4.00	2,150	$8,600	2,150	$8,600	2,150	$8,600
	Temporary Facilities	month	$2,347	4	$9,388	4.33	$10,163	3	$7,041
	Erosion Control	linear foot	$1	700	$700	700	$700	700	$700
	Storm water Management	day	$500	78	$39,000	87	$43,500	59	$29,500
	Concrete Demolition	square foot	$2.65	2,240	$5,936	2,240	$5,936	2,240	$5,936
	Concrete Disposal	CY	$27	166	$4,480	166	$4,480	166	$4,480
4	**Surveying**								
	Surveying	day	$1,500	2	$3,000	2	$3,000	2	$3,000
5	**Excavate and Dispose Soils (Remaining Upland Areas)**								
	Abandon Monitoring Wells	ea	$450	7	$3,150	7	$3,150	7	$3,150
	Excavation	ton	$5	14,630	$73,150	8,436	$42,180	7,106	$35,530
	Waste Transportation/Disposal (non-hazardous)	ton	$56	14,250	$800,494	8,170	$458,950	6,840	$384,237
	Waste Transportation/Disposal (hazardous)	ton	$214	380	$81,320	266	$56,924	266	$56,924
	Shallow Confirmation Sampling	ea	$232	299	$69,219	154	$35,651	141	$32,642
	Deep Confirmation Sampling	ea	$564	40	$22,560	34	$19,176	34	$19,176
	Backfill Excavated Areas	ton	$15	14,630	$219,450	8,436	$126,540	7,106	$106,590
6	**Mixing Soils (Remaining Upland Areas)**								
	Bioassay Sampling	ea	$800	0	$0	4	$3,200	0	$0
	Excavation	ton	$5	0	$0	8,550	$42,750	0	$0
	Precharacterization and Sidewall Sampling	ea	$162	0	$0	40	$6,460	0	$0
	Mix	LCY	$2.34	0	$0	5,400	$12,636	0	$0
	Confirmation Sampling	ea	$162	0	$0	5	$808	0	$0
	Spread and compact	BCY	$3.68	0	$0	4,500	$16,560	0	$0
7	**Geotextile**								
	Geotextile, 12 0z/sy geotextile/drainage fabric, 130 mil	square yard	$1.50	0	$0	3,835	$5,753	3,835	$5,753
	Grading	square yard	$0.52	0	$0	3,835	$1,994	3,835	$1,994
8	**Asphalt Cover (Remaining Upland Areas)**								
	Bioassay Sampling	ea	$800	0	$0	0	$0	6	$4,800
	Sampling of Areal Extent	ea	$162	0	$0	0	$0	36	$5,814
	Grading	square yard	$3.4	0	$0	0	$0	4,333	$14,907
	Asphalt Paving (6" stone base, 3" binder, 1" top)	square foot	$4.00	0	$0	0	$0	39,000	$156,000
9	**Excavate and Dispose soils (Shoreline Buffer Zone)**								
	Excavation	ton	$5	28,310	$141,550	12,540	$62,700	12,540	$62,700
	Waste Transportation/Disposal (non-hazardous)	ton	$56.18	24,510	$1,376,849	11,020	$619,049	11,020	$619,049
	Waste Transportation/Disposal (hazardous)	ton	$214	3,800	$813,200	1,520	$325,280	1,520	$325,280
	Shallow Confirmation Sampling	ea	$232	122	$28,243	122	$28,243	122	$28,243
	Deep Confirmation Sampling	ea	$564	296	$166,944	296	$166,944	296	$166,944
	Backfill Excavated Areas	ton	$15	28,310	$424,650	12,540	$188,100	12,540	$188,100
10	**Groundwater Monitoring Well Installation, Repair, and Sampling**								
	Install MW: Sched 40 PVC, 2"-diam. 15' depth	ea	$2,500	0	$0	4	$10,000	4	$10,000
	IDW	drum	$150	0	$0	6	$900	6	$900
	Groundwater Sampling and Reporting	round	$4,580	0	$0	4	$18,320	4	$18,320
11	**Pedestrian Walkway**								
	Grading	square yard	$3.44	3,394	$11,677	3,394	$11,677	3,394	$11,677
	Subgrade	square yard	$4.42	2,037	$9,002	2,037	$9,002	2,037	$9,002
	Asphalt Pavement (2")	square yard	$8.95	2,037	$18,228	2,037	$18,228	2,037	$18,228
	Riparian Planting	LS	$81,000	1	$81,000	1	$81,000	1	$81,000
12	**Erosion Control**								
	Hydroseed	acre	$2,500	8.4	$21,000	8.4	$21,000	7.5	$18,762
Subtotal					**$4,590,190**		**$2,602,217**		**$2,575,422**
	Sales Tax	**7.9%**			**$362,620**		**$205,580**		**$203,460**
Subtotal					**$4,952,810**		**$2,807,797**		**$2,778,882**
	Contingency			**40%**	**$1,981,120**	**30%**	**$842,340**	**25%**	**$694,720**
Subtotal, Contractor					**$6,933,900**		**$3,650,100**		**$3,473,600**
PROFESSIONAL TECHNICAL SERVICES									
	Permitting	LS	1		$50,000		$40,000		$40,000
	Engineering design costs	%	8%		$554,710		$292,010		$277,890
	Construction Management	%	6%		$416,030		$219,010		$208,420
	Project Management	%	5%		$346,700		$182,510		$173,680
Subtotal, Professional Services					**$1,367,440**		**$733,530**		**$699,990**
TOTAL INITIAL COST					**$8,301,300**		**$4,383,600**		**$4,173,600**

Notes:
1. 2007 Dollars.
2. Costs are +50% -30%.
3. 40 hour work week; 22 days/month
4. Level C PPE.
5. Waste disposal approximately 15% hazardous and 85% non-hazardous waste.
6. Soil 1 bank cubic yard = 1.9 tons
7. Soil, 1 BCY = 1.20 LCY
8. Concrete/Asphalt 1 cubic yard = 2 tons
9. Backfill costs assume delivered and placed.

APPENDIX D

CLEANUP ACTION ALTERNATIVE COST ESTIMATES – MARINE AREA

TABLE D-1
COST ESTIMATE - CLEANUP ACTION ALTERNATIVE M-1
MARINE AREA
FORMER SCOTT PAPER COMPANY MILL SITE

August 1, 2008 Opinion of Probable Construction Cost - Alternative M-1				
Item	Qty.	Unit	Unit Cost	Subtotal
1.Demolition & Clearing				
Remove Wood Piling	40	EA	$550.00	$ 22,000
Clear and Grub Vegetation	20,000	SF	$0.60	$ 12,000
Misc. Demolition	1	LS	$10,000.00	$ 10,000
Subtotal Demolition & Clearing				$ 44,000
2. Temporary Facilities				
Temp. Const. Fencing-Upland Project Limits	1,100	LF	$6.60	$ 7,260
Temp. Const. Entrance	1	LS	$1,500.00	$ 1,500
Temp. Shoring	0	SF	$40.00	$ -
Subtotal Temporary Facilities				$ 8,760
3. In-Water Work - MHHW and lower				
3a - Dredging				
Dredging and Upland Disposal (25% of volume)	8,550	CY	$100.00	$ 855,000
Dredging and Open Water Disposal - Non-Dispersive Site	25,650	CY	$30.00	$ 769,500
Post-dredge backfill - Beneficial Reuse Source (e.g. Swinomish Channel or Curtis Wharf)	24,100	CY	$20.00	$ 482,000
Post-dredge residuals cover - Beneficial Reuse Source (e.g. Swinomish Channel or Curtis Wharf)	8,800	CY	$20.00	$ 176,000
Subtotal Dredging and Disposal/Reuse				$ 2,282,500
3b - Capping				
Rock Rip-Rap Drift Sill - MJB Property	600	CY	$100.00	$ 60,000
Wave Attenuator Rock	11,200	CY	$100.00	$ 1,120,000
Purchase and Place Rock Armor Layer (d50 = 0.9 ft) - Upland Source	2,400	CY	$100.00	$ 240,000
Purchase and Place Sandy Gravel (d50 = 1.5 inches) - Upland Source	7,800	CY	$30.00	$ 234,000
Eel Grass Replacement	0.20	ACRE	$50,000.00	$ 10,084
Subtotal Shoreline Protection				$ 1,664,084
4. Paths and Docks				
Dock Floating	1,300	SF	$100.00	$ 130,000
Subtotal Paths and Docks				$ 130,000
			Subtotal Construction	$ 4,129,000
			Mobilization	$ 150,000
			Subtotal	$ 4,279,000
			Contingency (30%)	$ 1,284,000
			Subtotal (Construction Cost Amount)	$ 5,563,000
			Sales Tax (7.9%)	$ 439,000
			Permitting (LS)	$ 150,000
			Design (8%)	$ 445,000
			Project Management (5%)	$ 278,000
			Construction Management (6%)	$ 334,000
			Long Term Monitoring - Bathymetric Surveys (LS)	$ 75,000
			Total*	$ 7,284,000

In providing opinions of probable construction cost, the Client understands that the Consultant (Anchor Environmental L.L.C.) has no control over the cost or availability of labor, equipment or materials, or over market condition or the Contractor's methods

TABLE D-2
COST ESTIMATE - CLEANUP ACTION ALTERNATIVE M-2
MARINE AREA
FORMER SCOTT PAPER COMPANY MILL SITE

August 1, 2008 Opinion of Probable Construction Cost - Alternative M-2				
Item	Qty.	Unit	Unit Cost	Subtotal
1.Demolition & Clearing				
Remove Wood Piling	40	EA	$550.00	$ 22,000
Clear and Grub Vegetation	20,000	SF	$0.60	$ 12,000
Misc. Demolition	1	LS	$10,000.00	$ 10,000
Subtotal Demolition & Clearing				$ 44,000
2. Temporary Facilities				
Temp. Const. Fencing-Upland Project Limits	1,100	LF	$6.60	$ 7,260
Temp. Const. Entrance	1	LS	$1,500.00	$ 1,500
Temp. Shoring	0	SF	$40.00	$ -
Subtotal Temporary Facilities				$ 8,760
3. In-Water Work - MHHW and lower				
3a - Dredging				
Dredging and Upland Disposal (25% of volume)	5,575	CY	$100.00	$ 557,500
Dredging and Open Water Disposal - Non-Dispersive Site	16,725	CY	$30.00	$ 501,750
Post-dredge backfill - Beneficial Reuse Source (e.g. Swinomish Channel or Curtis Wharf)	11,500	CY	$20.00	$ 230,000
Post-dredge residuals cover - Beneficial Reuse Source (e.g. Swinomish Channel or Curtis Wharf)	9,900	CY	$20.00	$ 198,000
Subtotal Dredging and Disposal/Reuse				$ 1,487,250
3b - Capping				
Rock Rip-Rap Drift Sill - MJB Property	600	CY	$100.00	$ 60,000
Wave Attenuator Rock	11,200	CY	$100.00	$ 1,120,000
Purchase and Place Rock Armor Layer (d50 = 0.9 ft) - Upland Source	2,400	CY	$100.00	$ 240,000
Purchase and Place Sandy Gravel Gravel (d50 = 1.5 inches) - Upland Source	8,400	CY	$30.00	$ 252,000
Eel Grass Replacement	0.20	ACRE	$50,000.00	$ 10,084
Subtotal Shoreline Protection				$ 1,682,084
4. Paths and Docks				
Dock Floating	1,300	SF	$100.00	$ 130,000
Subtotal Paths and Docks				$ 130,000
			Subtotal Construction	$ 3,352,000
			Mobilization	$ 150,000
			Subtotal	$ 3,502,000
			Contingency (30%)	$ 1,051,000
			Subtotal (Construction Cost Amount)	$ 4,553,000
			Sales Tax (7.9%)	$ 360,000
			Permitting (LS)	$ 150,000
			Design (8%)	$ 364,000
			Project Management (5%)	$ 228,000
			Construction Management (6%)	$ 273,000
			Long Term Monitoring - Bathymetric Surveys (LS)	$ 75,000
			Total*	$ 6,003,000

In providing opinions of probable construction cost, the Client understands that the Consultant (Anchor Environmental L.L.C.) has no control over the cost or availability of labor, equipment or materials, or over market condition or the Contractor's methods