DRAFT

Cleanup Action Plan

Jacobson Terminals

5350 30th Avenue NW
Seattle, Washington

Prepared for
Washington State Department of Ecology

May 25, 2016
17800-56

HARTCROWSER

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Prepared by
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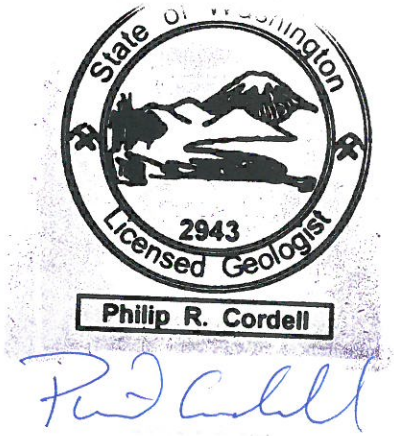

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ACRONYMS AND ABBREVIATIONS

ARARs	applicable or relevant and appropriate requirements
Aspect	Aspect Consulting
ASTs	aboveground storage tanks
bgs	below ground surface
CAP	cleanup action plan
CFR	Code of Federal Regulations
cis-DCE	Cis-1,2-dichloroethene
City	City of Seattle
COC	contaminant of concern
CSLs	cleanup screening levels
CSM	conceptual site model
CULs	cleanup levels
CWA	Clean Water Act
DCA	disproportionate cost analysis
DCAP	draft cleanup action plan
Ecology	Washington State Department of Ecology
EDR	engineering design report
GAC	granulated activated carbon
IA	interim action
Jacobson Draft IAWP	Jacobson Terminals Draft Interim Action Work Plan
Jacobson RI/FS	Jacobson Terminals Remedial Investigation and Feasibility Study
mg/kg	milligram per kilogram
MTCA	Model Toxics Control Act
NA	natural attenuation
NPDES	National Pollutant Discharge Elimination System
PAH	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
POC	point of compliance
PQL	practical quantitation limit
PRB	permeable reactive barrier
RAOs	remedial action objectives
RCW	Revised Code of Washington
SCO	sediment cleanup objective
Ship Canal	Lake Washington Ship Canal
Site	Jacobson Terminals Site
SMS	[Washington] Sediment Management Standards
TCE	trichloroethene
TEE	terrestrial ecological evaluation
TPH	total petroleum hydrocarbons
USACE	US Army Corps of Engineers
USTs	underground storage tanks
VCP	Voluntary Cleanup Program
VOCs	volatile organic compounds
WAC	Washington Administrative Code
ZVI	zero valence iron

1.0 EXECUTIVE SUMMARY

This report details the preferred cleanup alternative for remediation of the Jacobson Terminals Site (Site) at 5350 30th Avenue NW in Seattle, Washington (Figure 1). The primary objective is to detail the preferred cleanup action and summarize the remedial alternative evaluation process detailed in the "Jacobson Terminals Remedial Investigation and Feasibility Study" (Jacobson RI/FS; Hart Crowser 2016), which is the basis for this Draft Cleanup Action Plan (DCAP). The DCAP was prepared for the Washington State Department of Ecology (Ecology) according to the requirements of the Model Toxics Control Act (MTCA) Chapter 70.105D Revised Code of Washington (RCW) and its implementing regulations (Chapter 173-340 Washington Administrative Code [WAC]). A summary of this report is presented below. Please refer to the main text of this report for a detailed discussion of the Site history, cleanup goals, and process for selection of the preferred remedial alternative.

- The Site is located along the north shore of the Ship Canal adjacent to the Hiram M. Chittenden Locks in the City of Seattle. The property was used to operate a lumber mill from approximately 1890 to the 1930s. Beginning around 1940, the property was used for storage and loading/unloading from docked boats. The property has been used as a marine support facility and boat storage since Alan and Brian Jacobson purchased the property in 1975.

- Previous environmental characterization activities have been completed at the Site and surrounding properties by various consultants and Ecology beginning in the 1980s. A historical release of transformer oil on the northern portion of the Site created a plume of polychlorinated biphenyls (PCBs) and several chlorinated benzene compounds in soil and groundwater. This area of PCB contamination is known as the Interim Action (IA) area, located in the north-central portion of the Site (Figure 2). An interim remedial action has been developed, but not yet implemented, to remove the soil impacted by PCBs. A separate area of PCB- and petroleum-impacted soil was discovered in the alley separating the United States Army Corps of Engineers (USACE) property and the Site and an area of chlorinated ethene impacted soil and groundwater, originating from the upgradient Market Street Property, is located in the northern portion of the property. The Site has been enrolled in Ecology's Voluntary Cleanup Program (VCP) since 2001 under VCP number NW0611.

- In 2013 and extending into 2014, Ecology tasked Hart Crowser with completing a soil, groundwater, and sediment investigation to delineate PCB contamination in the northern portion of the Site in support of the planned IA. PCBs and chlorinated benzene concentrations in soil exceeded applicable screening criteria and extended further than previous investigations

estimated. Soil with PCB concentrations exceeding MTCA Method A unrestricted cleanup levels was largely delineated, but PCB concentrations in groundwater exceeding surface water protection levels were found in all the monitoring wells sampled, including compliance monitoring wells and existing deep wells.

- In 2014, Ecology tasked Hart Crowser with completing a feasibility study (RI) and feasibility study (FS) to assess soil and groundwater contamination in the upland portion of the Site, further evaluate sediment quality in the adjacent Lake Washington Ship Canal, develop remedial alternatives to address soil and groundwater contamination, and recommend the most appropriate alternative based on site chemical and physical conditions. The investigation identified four additional upland areas where PCB (and other contaminants of concern [COCs]) concentrations in soil and/or groundwater exceed MTCA Method A or Method B cleanup levels. Without additional information, it is assumed that this contamination is migrating to the Ship Canal.

- Five remedial alternatives were developed and evaluated in the Jacobson RI/FS to remove upland contamination and mitigate contaminant migration to the Ship Canal. The five alternatives included:

  - Alternative 1 – Natural Attenuation
  - Alternative 2 – Hot Spot Excavation
  - Alternative 3 – Treatment Wall Extension
  - Alternative 4 – Excavation of Soil Exceeding Remedial Action Objectives (RAOs)
  - Alternative 5 – Hot Spot Excavation and Treatment Wall Extension Contingency

- Following the above MTCA analysis and the disproportionate cost analysis (DCA) presented in the Jacobson RI/FS, Alternative 5 was identified as the preferred alternative for remedial action, pending public review and agency approval. Combined with the IA, this alternative will establish partial source control by removing identified sources of COCs, reduce contaminant mass migration to adjacent surface water and sediment, and achieve groundwater protectiveness at the conditional point of compliance (POC).

2.0 INTRODUCTION

This DCAP addresses cleanup of the Jacobson Terminals Site (Site) in Seattle, Washington (Figure 1). The DCAP was prepared for Ecology according to the requirements of the MTCA Chapter 70.105D RCW and its implementing regulations (Chapter 173-340 WAC).

The Jacobson Terminals facility has been enrolled in Ecology's VCP since 2001 under number NW0611. Aspect Consulting (Aspect) has been the owner's environmental consultant since 2003. The work for this report follows previous investigations and remedial actions conducted by Aspect and Hart Crowser at the Site beginning in 1996, and, since 2013, work conducted by Hart Crowser for Ecology, including

the Jacobson RI/FS (Hart Crowser 2016), which is the basis for this DCAP. Hart Crowser's work for this DCAP was conducted under contract with Ecology.

An IA has been developed (but not yet implemented) to remove soil impacted by PCBs in the north-central portion of the Site (Figure 2). Details of the IA can be found in "Jacobson Terminals Draft Interim Action Work Plan" (Jacobson Draft IAWP; Hart Crowser 2014a). Cleanup actions detailed in this report are intended to follow the IA and address soil and groundwater contamination present in other areas of the Site.

2.1 Elements of a Cleanup Action Plan

Elements of this DCAP address requirements of WAC 173-340-380, which include:

- A description of the planned cleanup action;
- Rationale for selecting the proposed alternative;
- A summary of other cleanup action alternatives evaluated in the RI/FS;
- Cleanup standards for the contaminants and media of concern;
- Description of institutional controls;
- Applicable state and federal laws;
- Preliminary determination of compliance with MTCA remedy selection criteria; and
- Types, levels, and amounts of contaminants remaining on site, and measures to prevent migration and contact.

Design and construction considerations for the proposed alternative will be further developed and evaluated in the engineering design report (EDR) and project design plans and specifications.

2.2 Report Organization

Specific discussion points pertinent to the MTCA criteria are presented in subsequent sections, which are organized as shown below.

Section 3.0 – Summary of Site Conditions. This section summarizes the historical uses of the property and its current land use. An overview of the results of the RI and other recent investigation work is also included. This information was used to develop the conceptual site model (CSM) also presented in this section.

Section 4.0 – Cleanup Standards. This section identifies RAOs and cleanup standards for the Site.

Section 5.0 – Remediation Alternatives Considered and Basis for Remedy Selection. Five remediation alternatives were evaluated in the RI/FS. This section describes the alternatives that were developed and the MTCA criteria used to evaluate the alternatives.

Section 6.0 – Selected Remediation Alternative. This section describes the selected remediation alternative which includes hot spot excavation and installation of a treatment wall or permeable reactive barrier.

Section 7.0 – Remediation Alternative Implementation, Costs, and Schedule. The work planned to implement the cleanup action and schedule are outlined in this section. This work includes preparation of the remedial design documentation, construction plans, and specifications.

Section 8.0 – References. Lists references cited in this report.

3.0 SUMMARY OF SITE CONDITIONS

The Jacobson Terminals facility is at 5350 30th Avenue NW in the Ballard district of Seattle (Figure 1). The Site's boundaries are the Lake Washington Ship Canal (Ship Canal) to the south and east, the Seaborn property to the east, the USACE property to the west, and the City of Seattle (City) property to the north.

The Site is located along the north shore of the Ship Canal and the topography is generally level. The northwest corner, which is used for parking, slopes toward the south and east and is approximately 5 feet above the elevation of the rest of the Site, at the approximate elevation of the City property and railroad tracks.

Fencing and gates control access to the Site, which is zoned industrial (IG1 U/65). Large boat storage racks are in the central and north-central areas of the Site. Small business offices/warehouses border the USACE property along the western Site boundary.

The USACE property contains offices, maintenance buildings, and a tourist facility for the Hiram M. Chittenden Locks, which are part of the Ship Canal. The Seaborn property is used for boat moorage and office space. The City property, formerly Burlington Northern Railroad right-of-way, contains active railroad tracks. Adjacent and north of the City property and railroad tracks, NW 54th Street runs east–west. Further north, upgradient of the Site, is the Market Street property, at 2801 NW Market Street, which consists of a climbing gym and other commercial businesses and eateries.

3.1 Site History

3.1.1 Jacobson Terminal Property

The Site is on a former estuarine tideflat. In the 1920s, the area was filled with wood waste, construction debris, and sand dredged from the Lake Washington Ship Canal. The property was used to operate a lumber mill from approximately 1890 to the 1930s. Beginning around 1940, the property was used for storage and loading/unloading from docked boats. Since Alan and Brian Jacobson

(partners in A&B Jacobson LLC) purchased the property in 1975, the property has been used as a marine support facility and boat storage.

3.1.2 Market Street Property

Approximately 14 interconnected buildings were constructed on the Market Street property between 1946 and 1955. Fuel tanks and shell casings were reportedly manufactured at the property before the factory operation switched to steel window frame manufacturing in the late 1940s. In 1955, the factory stopped producing steel frames and began producing aluminum window frames. This manufacturing process used extrusion presses, an anodizing circuit of 21 aboveground storage tanks (ASTs) constructed of steel or concrete, 10 underground storage tanks (USTs), a paint room, and an interior drainage system that included 24 floor drains, trench drains, and sumps.

From approximately 1948 to 1978, wastewater from the Market Street property was discharged directly to the Ship Canal; in later years, the wastewater was treated on the property and discharged to the King County Metro wastewater collection system. Wastewater discharge violations of the Metro permit regulations for pH and metal concentration exceedances are documented in the project file. In the late 1970s, the sewer pipes were inspected using video, and severe deterioration and disintegration of the pipes was observed. The former owner of the Market Street property reportedly replaced the pipes. Window manufacturing operations ceased at the Market Street property in 1989 (Hart Crowser 2000). Currently, the Market Street property is used primarily for commercial business.

3.2 Summary of Environmental Conditions

Numerous environmental investigations have taken place since the 1980s at the Site and surrounding properties. A summary of historical soil and groundwater data collected from the Site and surrounding wells is in “Jacobson Terminals Data Gaps Report” (Hart Crowser 2013), and recent environmental investigation activities are detailed in the Jacobson RI/FS (Hart Crowser 2016). On-site investigations and remedial activities are summarized below.

3.2.1 Historical Environmental Characterizations

Groundwater monitoring was first conducted to delineate a vinyl chloride plume identified at the upgradient Market Street property. Metals, low- and high-pH solutions, and solvents were also historically released on the Market Street property. The releases created localized exceedances of metals in soil and groundwater and an extensive groundwater plume of tetrachloroethene (PCE) and associated degradation products (primarily trichloroethene [TCE], cis-1,2-dichloroethene [cis-DCE], and vinyl chloride), as shown on Figure 2. Prior to 1999, when a treatment wall was installed along the boundary between the City property and the Site, the plume extended from the Market Street and City properties onto the USACE property and the Jacobson Terminals Site (Aspect 2004).

A separate area of soil impacted by chlorinated solvents, located on the City property downgradient of the Market Street treatment wall but upgradient of the Site, was identified as the likely source of chlorinated solvent impacts on the Site (Hart Crowser 2013). However, elevated concentrations of

chlorinated solvents found during RI activities in the northwest corner of the Site suggest there are still soil impacts downgradient of the Market Street treatment wall (Hart Crowser 2014a).

A historical release of transformer oil on the northern portion of the Site created a plume of PCBs and several chlorinated benzene compounds in groundwater. PCBs and chlorinated benzenes at concentrations exceeding cleanup levels (CULs; see Section 4.2) have been detected downgradient of where the presumed transformer oil release occurred, in soil samples up to 30 feet below ground surface (bgs). Ecology is currently planning an IA to remove contaminated soil in this area.

During construction activities in the early 1990s, a separate area of PCB- and petroleum-impacted soil was discovered in the alley along the west boundary of the Site (Hart Crowser 1997), directly adjacent to the USACE property (Figure 2).

3.2.2 Recent Environmental Investigations

Hart Crowser completed a soil, groundwater, and sediment investigation from 2013 to 2014. Soil results indicated that PCBs and chlorinated benzene at concentrations exceeding the applicable CULs extended further than previous investigations had estimated. Results of the 2013 to 2014 investigation are summarized in Jacobson Draft IAWP (Hart Crowser 2014a). In that document, the IA area is delineated based on the highest concentrations of PCBs on the site. The IA cleanup is not included in the scope of this report and is being planned separately.

The 2014 IA investigation delineated the extent of PCB impacts exceeding MTCA Method A industrial CULs, but did not delineate concentrations exceeding screening levels protective of surface water. Soil with PCB concentrations exceeding MTCA Method A unrestricted CULs was largely delineated, except for near the northeast corner of the impacted area.

PCB concentrations in groundwater exceeding surface water protection levels were found in all the monitoring wells sampled, including compliance monitoring wells JT-12 and JT-6. Existing deep wells, screened approximately 25 to 30 feet bgs, also had low-level PCB impacts exceeding surface water protection levels. Arsenic concentrations in many of the wells also exceeded surface water protection levels.

The sediment investigation found PCB and arsenic impacts above Washington Sediment Management Standards (SMS) freshwater sediment cleanup objective (SCO) levels, but below cleanup screening levels (CSLs). One sediment sample contained concentrations of mercury that exceed the CSL.

The Jacobson RI/FS (Hart Crowser 2016) confirmed that the bulk of PCB and chlorinated benzene contaminant mass is likely located in and around the IA area; however, analytical results show PCB and other COC impacts to soil and/or groundwater in other areas of the Site. The widespread detections suggest impacts likely have regional sources and/or are residuals from legacy contamination (historical industrial activities at the Site and surrounding properties). Data gaps described in the RI/FS require additional characterization to determine whether the groundwater to surface water/sediment pathway is complete (e.g., contaminant concentrations exceeding surface water protection at the

point of compliance). Additionally, a vapor intrusion assessment should be completed following the IA (or sooner if the IA is delayed) to confirm that the exposure risk to indoor occupants is low.

Without additional information, it is assumed that upland groundwater contamination exceeding surface water screening levels is migrating to sediment and surface water in the Ship Canal, and building occupants may be at risk of inhaling volatile organic compounds (VOCs) associated with Site soil and groundwater. Pending collection of additional data, the RI/FS concluded that soil and groundwater remediation is needed to reduce contaminant levels to below screening criteria.

3.3 Conceptual Site Model

This section provides a conceptual understanding of the Site that is based on the results of historical research, subsurface investigations, and previous remedial actions. A CSM presents the links between contaminant sources, release mechanisms, exposure pathways and routes, and receptors to summarize the current understanding of the risk to human health and the environment. The CSM is the basis for developing technically feasible cleanup alternatives and selecting a final cleanup, and may be refined throughout the cleanup action process as additional information becomes available. Figure 3 presents the CSM graphically.

A historical release of transformer oil in the northwest portion of the Site resulted in introduction of PCBs and chlorinated benzenes to the identified IA area. The RI found that soil and groundwater in other areas of the Site are impacted by PCBs and other site COCs, indicating the presence of additional sources such as impacted fill materials.

Secondary release mechanisms include fugitive dust, plant uptake, infiltration and leaching to groundwater, and volatilization. Groundwater discharge can also potentially impact surface water. Potential exposure routes are ingestion, direct dermal contact, and inhalation.

Potential human receptors include workers inside the Site buildings, potential workers during future Site development, and utility workers. Terrestrial ecological receptors include plants and animals exposed to impacted media, as well as secondary food chain consumers such as birds and mammals.

A terrestrial ecological evaluation (TEE) was not completed for the Site because it qualifies for a TEE exemption according to requirements described in WAC 173-340-7491 since it is covered by asphalt, which creates a physical barrier between contaminated media and plants and wildlife. Institutional controls will need to be employed to maintain the asphalt. Implementing these controls will require a formal written agreement between the property owner and Ecology. Assuming the controls are implemented, a TEE will not be required for the Site.

3.3.1 Media of Concern

Soil, groundwater, and surface sediment have been identified as the affected media at the Site, because results of the environmental assessments to date show elevated concentrations of PCBs, total petroleum hydrocarbons (TPH), metals, and chlorinated benzenes and several other VOCs.

3.3.2 Contaminants of Concern

Table 1 presents the constituents that have been analyzed for and detected in soil, sediment, and groundwater. Constituents detected in at least one sample at a concentration greater than the applicable CUL are considered COCs for the associated media. Dioxins are considered potential COCs at the Site because previous investigations found that their concentrations exceeded the calculated MTCA Method B screening level (Hart Crowser 2014b); however, dioxin concentrations did not exceed local background soil dioxin concentrations reported in the Urban Seattle Area Soil Dioxin and [Polycyclic Aromatic Hydrocarbons] PAH Concentrations Initial Summary Report (Ecology 2011).

Table 1 – Contaminants of Concern

Contaminants of Concern	Soil[a]		Groundwater[b]		Sediment
	Less than MTCA Method B	Greater than MTCA Method B	Less than MTCA Method B	Greater than MTCA Method B	Above Ecology SMS SCO
Total PCBs	X[c]	X[c]	X	X	X
Diesel-range organics[d]	X	X	X	X	
Heavy oil[d]	X	X			
Arsenic[e]	X	X		X	X
Cadmium	X	X	X[f]		
Chromium[d]	X		X		X
Lead[d]	X	X	X		
Mercury	X	X			X
1,2,4-Trichlorobenzene	X	X	X[f]	X	
1,2-Dichlorobenzene	X	X	X		
1,3-Dichlorobenzene	X	X	X		
1,4-Dichlorobenzene	X	X	X[f]	X	
Benzene	X	X	X[d]	X[d]	
Chlorobenzene	X	X	X[f]		
1,1-Dichloroethene		X			
Tetrachloroethene	X	X	X		
Trichloroethene	X	X	X[f]		
Naphthalene	X	X	X[f]		
Vinyl chloride	X[c]	X[c]	X		
Dioxins TEQ		X[g]			

Notes:

a. Calculated using the Three-Phase Partitioning Model (MTCA equation 747-1), using the most conservative freshwater screening levels presented in this table, unless otherwise noted.

b. Compared with Clean Water Act S304 freshwater screening level for consumption of organisms, groundwater migration to surface water, unless otherwise noted.

c. The screening level for soil is lower than the method practical quantitation limit (PQL); by default, MTCA uses the PQL as the screening level.
d. Compared with MTCA Method A cleanup levels (soil/groundwater).
e. Compared with regional natural background concentration in soil for Puget Sound (Ecology 1994).
f. Compared with MTCA Method B carcinogen surface water screening level, standard formula value.
g. Dioxins in Site soil do not exceed the 90th percentile urban concentration reported in the Urban Seattle Area Soil Dioxin and PAH Concentrations Initial Summary Report (Ecology 2011).

3.3.3 Environmental Fate of COCs

The primary physical and chemical processes that can influence contaminant concentrations and migration are:

- Adsorption to soil;
- Leaching or dissolution into groundwater;
- Volatilization; and
- Biodegradation.

In general, when oil is released into the subsurface, it may travel through the unsaturated zone as free-phase product. The constituents can sorb onto soil particles and leach or dissolve into groundwater (when present) and migrate with groundwater flow. The constituents can also degrade over time through chemical or biological processes; however, the rate of natural attenuation (NA) for PCBs is relatively slow. Site NA for petroleum and volatile organics occurs at a faster rate. Volatile constituents evaporate and can migrate through the unsaturated zone as soil vapor. Some vapor may escape to the atmosphere or accumulate in enclosed spaces such as buildings. Contaminants associated with the historical placement of fill materials containing COCs such as lead or heavy oil are generally not mobile and will remain in the soil matrix.

3.3.4 Receptors

Potential receptors at the Site include humans and terrestrial and aquatic ecological receptors such as plants and animals exposed to impacted media and secondary food chain consumers such as birds and mammals.

3.3.5 Potential Exposure Pathways

For a contaminant to present a risk to human health and/or the environment, the pathway from the contaminant to the receptor must be complete. Exposure pathways comprise five elements: a source (such as a UST), a medium (such as soil), an exposure point (such as a business), an exposure route (ingestion, direct contact, or inhalation), and a receptor (such as workers or marine organisms). The main potential exposure media not currently mitigated at the Site are adjacent surface water and sediment into which dissolved contaminants could migrate, and air. The exposure routes could be ingestion, direct contact, or inhalation, and potential receptors could be utility workers. Several pathways are potentially complete only if Site or utility work includes digging in the soil or

groundwater. An overview of existing and potential exposure pathways is presented in the Site CSM on Figure 3. The potential exposure media and routes are summarized below.

3.3.5.1 Soil

Site soil contains elevated concentrations of PCBs, metals, chlorinated benzenes, and chlorinated ethenes. The Site is paved, so there is no exposure route directly from soil unless the pavement is removed. Workers digging in the soil for future development or utility work may be exposed to contaminants if they do not have adequate personal protective equipment or do not use safety procedures. Routes of exposure to contaminants in soil are incidental ingestion and direct contact.

3.3.5.2 Groundwater

All three potential exposure routes (incidental ingestion, direct dermal contact, and inhalation of vapors) exist for groundwater at the Site. For the incidental ingestion and direct contact routes, complete pathways would exist only if workers were digging in soil below the groundwater table. For the inhalation of vapors route, on-site and off-site utility workers could be exposed if VOCs dissolved in groundwater at the Site volatilized out of the liquid phase and migrated upward into unsaturated soil pore spaces. However, once the IA is complete, removal of source material will significantly reduce risk the inhalation risk.

3.3.5.3 Surface Water

Shallow groundwater beneath the Site migrates to the Ship Canal. There is a potential for dissolved contaminants to impact the aquatic environment.

3.3.5.4 Sediment

Metals and PCBs in sediment can impact the aquatic environment. These impacts can be ecological or associated with human consumption of aquatic organisms.

3.3.5.5 Soil Gas

Chlorinated benzenes, petroleum constituents, and chlorinated ethenes can volatilize in soil, potentially leading to gas-phase migration of the COCs to the surface. Impacts to indoor air within existing Jacobson Terminals buildings is possible, given the buildings' proximity to the IA area. Therefore, the inhalation exposure route may exist for utility workers. However, once the IA is complete, removal of source material will significantly reduce this risk.

3.3.5.6 Fugitive Dust

Fugitive dust will not be an exposure medium while the Site is paved. Fugitive dust could be a potential medium if the pavement is removed and workers dig in the soil.

3.3.5.7 Plant Uptake

The COC-impacted areas at the Site are predominantly paved or covered by building foundations. Plants are not grown for human consumption and this Site is paved within the impacted areas; therefore, plants are unlikely to be an exposure medium.

4.0 CLEANUP STANDARDS

The following sections identify RAOs and cleanup standards for the Site that were developed to address the applicable regulatory requirements for site cleanup. These requirements address conditions relative to potential human receptor impacts. Together, the RAOs and cleanup standards provide the framework for evaluating remediation alternatives, as summarized in Sections 5 and 6.

4.1 Remedial Action Objectives

The primary objective for the DCAP is to substantially eliminate, reduce, and/or control unacceptable risks to human health and the environment posed by site COCs to the greatest extent practicable.

4.2 Cleanup Standards

Cleanup standards include CULs and POCs as described in WAC-173-340-700 through WAC 173-340-760. CULs for soil, groundwater, and sediment are discussed below.

4.2.1 Soil

The Sites' location adjacent to the Ship Canal requires that contaminant concentrations in soil be protective of surface water (the Ship Canal) in accordance with WAC 173-34-747. Soil COC CULs were calculated using Ecology's Three-Phase Partitioning Model (WAC 173-340-747(4)). This model provides a conservative estimate for establishing soil COC concentrations that will not result in contamination of groundwater above an acceptable level. Surface water screening values, presented in Table 2, were used to compute soil CULs protective of the groundwater exposure pathway. For chemicals with no MTCA freshwater screening values, the MTCA Method A unrestricted or Method B direct contact CUL was used. For COCs that were not found in groundwater above surface water CULS, MTCA Method A unrestricted or C industrial direct contact CULs were used. To identify hot spot areas and define the extent of the IA area, PCB concentrations were also compared with the MTCA Method A unrestricted CUL of 1 milligram per kilogram (mg/kg).

4.2.2 Groundwater

In accordance with WAC 173-340-720 and 173-340-730, groundwater CULs are based on levels that provide surface freshwater protection since the Site is adjacent to the Ship Canal and groundwater discharges into the freshwater environment. Therefore, the most conservative freshwater screening levels for consumption of aquatic organisms (the federal Clean Water Act [CWA] Section 304, National Toxics Rule 40 Code of Federal Regulations [CFR] 131 or MTCA Method B surface water criteria, whichever is lower) were used for the CULs. For chemicals with no freshwater screening values, MTCA Method A CULs were used. Groundwater CULs are shown in Table 2.

4.2.3 Sediment

Sediment analytical results were compared with the Washington State freshwater SCO criteria and freshwater sediment CSLs as defined in WAC 173-204. Sediment screening levels are shown in Table 2.

Table 2 – Proposed Cleanup Levels

Contaminant of Concern	Soil Cleanup Level (mg/kg)[a]	Groundwater Cleanup Level (µg/L)[b]	Sediment Cleanup Level (mg/kg)[h]
Total PCBs[c]	0.0000787	0.000064	0.11
Diesel-range organics[d]	2,000	500	--
Heavy oil[d]	2,000	500	--
Arsenic	7[e]	0.098[c]	14
Cadmium	5.6	40.5[f]/5[d]	2.1
Chromium[d]	2,000	50	72
Lead[d]	250	15	360
Mercury	0.146	0.14	0.66
1,2,4-Trichlorobenzene	0.0056	2.03[f]	--
1,2-Dichlorobenzene	2.33	3,000	--
1,3-Dichlorobenzene	0.011	10	--
1,4-Dichlorobenzene	0.02	21[f]	--
Benzene	0.0064	5[f]	--
Chlorobenzene	0.434	800[f]	--
1,1-Dichloroethene	0.0011	3.2[g]	--
Tetrachloroethene	0.015	29	--
Trichloroethene	0.0023	7[f]	--
Naphthalene	6.56	4,710[f]	--
Vinyl chloride	0.0005[c]	1.6	--
Dioxins TEQ	0.049 (pg/g)[a]	--	--

Notes:

a. Calculated using the Three-Phase Partitioning Model (MTCA equation 747-1), using the most conservative freshwater screening levels presented in this table, unless otherwise noted.
b. Clean Water Act S304 freshwater screening level for consumption of organisms for groundwater migration to surface water pathway, unless otherwise noted.
c. The screening level for soil/groundwater is lower than the method PQL; MTCA defaults the screening level up to the PQL.
d. Compared with MTCA Method A CULs (soil/groundwater).
e. Compared with regional natural background concentration in soil for Puget Sound (Ecology 1994).
f. Compared with MTCA Method B, lowest carcinogen or non-carcinogen, surface water screening level, standard formula value.
g. Compared with National Toxics Rule 40 CFR 131 freshwater screening level for consumption of organisms based on groundwater migration to surface water.
h. Ecology SMS SCO screening level.

4.2.4 Point of Compliance

Soil. The soil CULs are based on protection of adjacent surface waters, so the POC will be established in the soil throughout the Site (WAC 173-340-740[6][b]). For soil COCs that have been shown to be not

present in Site groundwater at concentrations above applicable CULs, the POC will be the upper 15 feet, to protect receptors from direct contact exposure.

Groundwater. Because of the Site's proximity to the Ship Canal, groundwater discharging from the Site has the potential to impact surface water. As specified in WAC 173-340-720, the standard POC will be established throughout the Site from the uppermost level of the saturated zone extending vertically to the lowest depth that could potentially be affected. It is anticipated that it will not be practicable to meet CULs throughout the Site within a reasonable restoration timeframe, and therefore a conditional POC will be established at the groundwater–surface-water interface.

Sediment. For sediment cleanups, the standard POC is the biologically active zone (upper 10 centimeters), which for this Site is considered to also be the POC protective of human health (WAC 173-204-560(6)).

4.3 Applicable or Relevant and Appropriate Requirements

This section identifies potential applicable or relevant and appropriate requirements (ARARs) to be used in assessing and implementing remedial actions at the Site. The potential ARARs come from federal and state statutes, regulations, criteria, and guidelines. The types of potential ARARs evaluated for the Site were contaminant-, location-, and action-specific. Each type is summarized below and evaluated in Table 3.

In general, only the substantive requirements of ARARs are applied to MTCA cleanup sites being administered by Ecology (WAC 173-340-710[9][b]). Thus, cleanup actions under a formal agreement with Ecology are exempt from the administrative and procedural requirements specified in state and federal laws. This exemption also applies to permits or approvals required by local governments.

4.3.1 Contaminant-Specific ARARs

Contaminant-specific ARARs are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in establishment of numerical contaminant values that regulatory agencies generally recognize as allowable to protect human health and the environment. The cleanup levels presented in Section 4.2 specify the contaminant-specific ARARS for this Site.

4.3.2 Action-Specific ARARs

Action-specific ARARs are pertinent to particular remediation methods and technologies, and to actions conducted to support cleanup. Action-specific ARARs are requirements that may need to be satisfied during the performance of specific remedial actions because they prescribe how certain activities (e.g., treatment and disposal practices, media monitoring programs) must occur. Typically, action-specific ARARs are not fully defined until a preferred response action has been selected and the corresponding remedial action can be more completely refined. However, preliminary consideration of the range of potential action-specific ARARs may help focus the process of selecting a preferred remedial action alternative. A number of action-specific ARARS are identified in Table 3 and will be addressed in more detail in the EDR.

4.3.3 Location-Specific ARARs

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in a specific location. Some examples of special locations are floodplains, wetlands, historic sites, and sensitive ecosystems or habitats. Location specific ARARs for this project include the Shoreline Management Act of 1971 [RCW 90.58]. Compliance with this ARAR will be detailed in the EDR.

4.4 Definition of the Areas of Concern

The approximate extent of contamination is determined by considering soil and groundwater exceedances of the applicable MTCA criteria and the Site CSM. The estimated extents of contamination hot spots are shown on Figure 4. Sediment contamination in the area of the Ship Canal directly adjacent to the Site is considered an area of potential concern; however, the extent of contamination there has not been fully delineated and sediment toxicity testing indicates risk to aquatic organisms is relatively low. Therefore, sediment is not within the focus of this remedial alternative evaluation. Additionally, the main PCB plume (IA Area) in the north-central portion of the Site is addressed in the Jacobson Draft IAWP (Hart Crowser 2014a) and is excluded from discussion of hot spots in the following sections. Hot spots, which for the purposes of this report are defined as areas containing soil PCB concentrations exceeding 1 mg/kg, are listed below.

4.4.1 Hot Spot 1: JT-MW-07S

Soil samples collected during installation of monitoring well JT-MW-07S (located in the south portion of the Site) contained concentrations of diesel-range organics, lube oil, metals, and PCBs exceeding CULs. The near-surface soil was classified as characteristic dangerous waste as specified in WAC-173-303-100 because of elevated lead concentrations. The lead and PCB occurrences indicate an area of contamination separate from the IA area. Because of the hot spot's anomalous location relative to the IA area, its extent was estimated for remediation costing purposes; the estimate is based on field observations at the time of drilling, analytical data, and site constraints (i.e., the adjacent boat rack). Additional characterization is needed to delineate impacts in this area. For budgeting purposes, the extent of impacted soil around JT-MW-07S is assumed to be 1,900 square feet and the depth of impacted soil is assumed to be 10 feet. The total volume of soil requiring remediation is thus assumed to be 700 cubic yards.

4.4.2 Hot Spot 2: MW-4/JT-US-39

This hot spot area is along the Site's west boundary with the USACE property and an upgradient area that was previously remediated to address diesel- and PCB-impacted soil. Soil samples collected from boring JT-US-39 contained PCBs at a concentration exceeding the MTCA Method A unrestricted CUL and Site CULs. Groundwater samples from monitoring wells MW-4 and HC-MW-1 (directly east of JT-US-39) contained PCBs at concentrations exceeding CULs.

These PCB occurrences indicate another area of contamination, separate from the IA area. The extent of impacts around JT-US-39 has been estimated for remediation costing purposes based on field observations at the time of drilling, analytical data, and site constraints (i.e., the adjacent buildings).

Additional characterization is needed to delineate impacts in this area. The extent of impacted soil is assumed to be approximately 700 square feet and the depth of impacted soil is assumed to be 8 feet. The total volume of soil requiring remediation is thus assumed to be 200 cubic yards.

4.4.3 Hot Spot 3: JT-US-46

Soil samples from boring JT-US-46 contained PCBs at concentrations exceeding CULs. This boring is directly south of and adjacent to the IA area. It is unclear whether these results are associated with the IA area or these results indicate a separate PCB-impacted area. The boring is approximately 25 feet south of the IA area; the area around the boring is being treated as a separate area of concern. The impacted area around JT-US-46 has been estimated for remedial alternative costing purposes based on field observations at the time of drilling and analytical data. Additional characterization is needed to delineate impacts in this area. For costing purposes, the extent of impacted soil around JT-US-46 is assumed to be approximately 1,200 square feet and the depth of impacted soil is assumed to be 18 feet. The total volume of soil to be remediated is thus assumed to be 800 cubic yards.

4.4.4 Hot Spot 4: JT-US-53

Soil samples from boring JT-US-53 contained PCBs and vinyl chloride at concentrations exceeding CULs. Groundwater samples collected from the nearby wells also contained PCBs at concentrations exceeding CULs. Chlorinated solvent impacts in this area are likely residual contamination from the upgradient Market Street release.

The PCB occurrences indicate another area of contamination, separate from the IA area. Hart Crowser estimated the impacted area around JT-US-53 for remedial alternative costing purposes based on field observations at the time of drilling, analytical data from the boring and nearby monitoring wells, and site constraints (i.e., property boundaries and nearby utilities). Additional characterization is needed to delineate impacts in this area. For costing purposes, the extent of impacted soil around JT-US-53 is assumed to be approximately 1,300 square feet and the depth of impacted soil is assumed to be 8 feet. The total volume of soil to be remediated is thus assumed to be 300 cubic yards.

5.0 REMEDIATION ALTERNATIVES CONSIDERED AND BASIS FOR REMEDY SELECTION

Five remediation alternatives were evaluated in the Jacobson RI/FS. This section describes the alternatives that were developed and the MTCA criteria used to evaluate the alternatives.

5.1 Remediation Alternatives Evaluated

The options evaluated in the Jacobson RI/FS specifically included technologies considered to be capable of achieving the remedial action objectives, MTCA CULs, and other regulatory requirements. Five remediation alternatives applicable to impacted media at the Site were developed from these technologies. Implementation of all alternatives assumes completion of the planned PCB-removal IA. The components of the five remediation alternatives are summarized below and detailed in the Jacobson RI/FS.

5.1.1 Alternative 1 – (No Cleanup Action) Natural Attenuation with Institutional Controls and Compliance Monitoring

This alternative maintains the existing cap and treatment wall and relies on natural processes and restrictive covenants to limit exposure pathways. Under this alternative, the COCs would not be removed from or contained at the Site. Alternative 1 includes:

- Monitored NA;
- Institutional controls; and
- Compliance monitoring.

5.1.2 Alternative 2 – Hot Spot Excavation with Institutional Controls and Compliance Monitoring

This alternative removes impacted soil in the hot spot areas discussed in Section 4.4. Alternative 2 includes:

- Excavation and disposal of Hot Spots 1 through 4 (approximately 2,000 cubic yards of soil);
- Backfilling and Site restoration;
- Institutional controls; and
- Compliance monitoring.

5.1.3 Alternative 3 – Treatment Wall Extension with Institutional Controls and Compliance Monitoring

This alternative includes construction of a treatment wall to treat groundwater prior to discharging to the Ship Canal. Alternative 3 includes:

- Construction of treatment walls adjacent to the Ship Canal;
- Backfilling and Site restoration;
- Institutional controls; and
- Compliance monitoring.

5.1.4 Alternative 4 – Excavation of Soil Exceeding RAOs with Institutional Controls and Compliance Monitoring

This alternative includes Site-wide removal of suspected impacted soil. Alternative 4 includes:

- Excavation and disposal of 25,000 cubic yards of impacted soil,
- Backfilling and Site restoration,
- Institutional controls if contamination remains following removal (i.e., under buildings), and
- Compliance monitoring.

5.1.5 Alternative 5 – Hot Spot Excavation and Treatment Wall Installation with Institutional Controls and Compliance Monitoring

This alternative is a combination of both Alternatives 2 and 3. Alternative 5 includes:

- Excavation and disposal of Hot Spots 1 through 4 (approximately 2,000 cubic yards of soil);
- Contingency construction of treatment walls adjacent to the Ship Canal (if groundwater discharges are shown to be impacting the aquatic environment at unacceptable levels);
- Backfilling and Site restoration;
- Institutional controls; and
- Compliance monitoring.

5.2 Evaluation Process

Ecology identifies within the MTCA regulations (WAC 173-340-360) the criteria that should be used to evaluate remediation alternatives. The purpose of the evaluation is to identify the relative advantages and disadvantages of each alternative and thereby assist in the decision-making process. This process was used in the Jacobson RI/FS to identify the preferred alternative.

5.2.1 MTCA Evaluation Criteria

Key guiding requirements for evaluating remediation alternatives and remedial action selection for the Site are listed in the MTCA regulations. MTCA criteria consist of threshold requirements and other criteria listed in WAC 173-340-360(2), Minimum Requirements for Cleanup Actions, as listed in Table 4 and detailed in the Jacobson RI/FS (Hart Crowser 2016).

MTCA indicates a preference for permanent solutions to the maximum extent practicable based on a DCA. DCA criteria include protectiveness, permanence, and effectiveness over the long term, management of short-term risks, technical and administrative implementability, and consideration of public concerns. The benefits of the alternatives considered are balanced against relative costs for implementing each alternative. Remedies that can be implemented in a shorter time, based on potential environmental risks and effects on current site use and associated site and surrounding area resources, are also preferred. The third criterion, public concerns, is addressed during comment periods for the Jacobson RI/FS documents and in the written remedy selection decision and subsequent DCAP for remedy implementation. Table 5 presents the DCA evaluation from the Jacobson RI/FS.

The DCA is a test to determine whether incremental costs of a given alternative above those of a lower-cost option exceed the incremental degree of benefit achieved by the higher cost-alternative. The most practicable permanent solution is identified as the baseline cleanup action alternative for FS evaluation. The referenced section of MTCA further specifies that, where alternatives are equal in benefits, the least costly alternative will be selected provided that the MTCA threshold and other requirements are met.

5.2.2 Remediation Alternative Evaluation

Based on the evaluation of alternatives presented in Section 9 of the Jacobson RI/FS, the preferred remediation alternative is Alternative 5, which involves hot spot excavation and off-site disposal in a Subtitle C landfill facility (or Subtitle D depending on additional characterization); and a treatment wall construction contingency.

Remediation Alternative 5 most closely satisfies the threshold criteria and other MTCA requirements discussed in Section 5.2.1 and detailed in the Jacobson RI/FS Section 8. It would be protective of human health during activities not associated with construction and/or subsurface disturbance at the Site, and would provide long-term protection to adjacent surface waters; however, a treatability study would be required before implementation to assess its effectiveness.

The DCA, detailed in Section 9.3 of the RI/FS and summarized in Table 5, assessed whether the most practicable permanent solution will be used to the maximum extent practicable. To complete the evaluation, an alternative is identified as the baseline against which other alternatives are compared. Alternative 4 was assumed to be the most permanent practicable solution and was used as the baseline for this comparison.

Although Alternative 4 is the most permanent, Alternative 5 uses permanent solutions to the maximum extent practicable. Alternative 4 has significantly higher costs than Alternative 5 for minimal increase in protectiveness. Alternative 1 provides the least amount of permanence and protectiveness. Alternatives 2 and 3 were also determined to provide less permanence and protection when compared to Alternatives 4 and 5. Because it provides overall protection and permanence and costs less than Alternative 4, Alternative 5 is the preferred alternative.

Alternative 5 may present more short-term risks and challenges during implementation than would the other alternatives. Risks would be related to the off-site transport of contaminated soil, and challenges would include disruption to local businesses. However, using the DCA criteria to compare all five alternatives, Alternative 5 was found to be:

- Equally or more protective;
- Equally or more permanent; and
- Equally or more effective over the long term.

6.0 SELECTED REMEDIATION ALTERNATIVE

As discussed above, Alternative 5 was selected as the preferred cleanup action and includes hot spot excavation, disposal of contaminated materials, installation of a treatment wall or permeable reactive barrier (PRB), and institutional controls. However, if additional data is collected that shows that upland contaminants don't pose a risk to the Ship Canal, the treatment wall may not be required by Ecology. Hot spot excavation would target specific areas across the Site where COC concentrations exceeding MTCA Methods A or B CULs (which are generally higher than Site CULs) have been identified. The excavation locations are detailed in Section 4.4 and shown on Figure 4. The contingency PRB will treat groundwater flowing through the barrier before it flows into the Ship Canal. Groundwater flows at a natural gradient through these walls, which are typically constructed by excavating a trench and backfilling with a mixture of reactive materials and sand or a slurry. The reactive materials will be similar to those used in the existing 2003 treatment wall, zero valence iron (ZVI) and granulated activated carbon (GAC). The extent of the wall is shown on Figure 5. Selection of this cleanup action complies with WAC-340-360.

6.1 Excavation of Hot Spots

Hot spot excavation would target specific areas across the Site where COC concentrations exceed the MTCA Method A or Method B CULs, as detailed in Section 4.4 and shown on Figure 4. Excavation of discrete source areas will provide a permanent and effective cleanup with manageable Site impacts. Further hot spot delineation should be completed to refine excavation boundaries.

Excavation would remove contaminated soil in Areas 1 through 4, which total an area of approximately 4,800 square feet (Figure 4). We estimate that the vertical extent of the excavation would be 10 feet bgs in Area 1, 8 feet bgs in Area 2, 18 feet bgs in Area 3, and 8 feet bgs in Area 4. The estimated total volume of soil to be excavated is approximately 2,000 cubic yards. The excavation areas will be offset from any permanent structures to avoid undermining foundation stability. If necessary, the areas will be dewatered by installing an extraction well and on-site groundwater storage or treatment system. Dewatering is included in the Alternative 5 cost estimate.

Alternative 5 does not directly address contamination that may be present underneath buildings. If confirmation sampling indicates residual contamination is present underneath buildings, institutional controls would be put in place to limit or eliminate COC exposure pathways in these areas. In addition, hot spot contamination may be present off site in Areas 2 and 4, on the City and USACE properties. Excavation in these areas may not fully remove the contaminant source. Compliance monitoring will be conducted at the limits of the excavations to determine whether the source areas have been removed or reduced.

6.2 Contingency Treatment Wall Installation

Without additional information, it is assumed that upland groundwater contamination exceeding surface water screening levels is migrating to sediment and surface water in the Ship Canal. Unless additional studies are completed to contradict this assumption, construction of a treatment wall (Figure 5) is needed to reduce contaminant levels to below CULS at the POC. The proposed PRBs will be designed to match the existing treatment walls, which were installed in 2003. The PRBs will degrade and sorb contaminants using ZVI and GAC, respectively. Groundwater flows along its natural gradient through the reactive materials and is treated after migration through the wall. ZVI is known to degrade chlorinated solvents and GAC has been shown to sorb metals and organics. Case studies demonstrating the effectiveness of ZVI to treat PCBs are limited; however, the IA area excavation, outlined in the Jacobson Draft IAWP (Hart Crowser 2014a), is expected to eliminate the main source area of upgradient PCBs. The existing and newly installed treatment walls will likely need to be regenerated every 20 years.

Additional aquifer testing will be needed to determine design specifications for the treatment wall. Installation of the treatment wall may alter groundwater flow along the shoreline. Specific design parameters and results of groundwater flow modeling will be detailed in the EDR.

6.3 Off-Site Disposal

Pending additional characterization, we have assumed that all excavated soil contaminated with PCBs, metals, chlorinated benzenes, or chlorinated ethenes from Hot Spot 1 will be disposed of in a Subtitle C landfill as hazardous waste. The nearest Subtitle C disposal facility is at the Chemical Waste Management Northwest facility in Arlington, Oregon, which is approximately 263 miles away from the site. Approximately 4,000 tons of impacted material will be excavated and disposed of in the Subtitle C landfill. Soil removed from Hot Spots 2, 3, and 4, as well as the treatment wall footprint, can likely be transported to a Subtitle D facility, but additional characterization will be needed to complete a waste profile.

Following hot spot excavation and verification soil sampling and analysis, the area will be backfilled with clean fill material, then restored as described below.

6.4 Site Restoration

After hot spot excavation, verification soil sampling and analysis, treatment wall installation (if necessary), and backfilling, Site restoration will be completed. Site restoration will include replacing utilities and monitoring wells, installing compliance monitoring wells, and repaving.

6.5 Stormwater Management

The excavation and treatment wall installation work will be conducted in accordance with the substantive provisions of the National Pollutant Discharge Elimination System (NPDES) requirements for stormwater discharges from construction areas to minimize erosion and to prevent enhanced sediment loading to surface water (the Ship Canal).

6.6 Compliance Monitoring

Compliance monitoring will be implemented in accordance with WAC 173-340-410 and include:

- **Protection monitoring** to confirm that human health and the environment are adequately protected during the construction period of the cleanup action;
- **Performance monitoring** to confirm that the cleanup action has attained cleanup standards and other performance standards; and
- **Confirmational monitoring** to confirm the long-term effectiveness of the cleanup action once performance standards have been achieved.

Protection monitoring elements, including dust monitoring during excavation, will be addressed in the health and safety plan that will be created for the project.

Soil samples will be collected and analyzed from the base and walls of the excavation to confirm that the target CULs have been achieved, or to document the concentration of COCs that remain on the Site. Related monitoring and documentation will include verifying the chemical quality of imported soil

used for backfilling, placement of the soil to match the pre-existing grade, and nominal compaction requirements, to be established during the design phase.

Confirmational monitoring is a component of compliance monitoring that is intended to demonstrate the long-term effectiveness of the cleanup action once CULs or other performance standards have been attained. Specific details for post-construction monitoring will be developed in a long-term monitoring plan after project plans and specifications are prepared in the design phase, which will conform to the general requirements in WAC 173-340-410.

6.7 Institutional Controls

As described in the MTCA regulations (WAC 173-340-440), institutional controls are intended to limit or prohibit activities that may interfere with the integrity of a cleanup action that would result in risk of exposure to contaminated soil at the Site. Institutional controls may include on-site features (such as fences), education (such as signage and public notices), legal mechanisms (such as land use restrictions, restrictive covenants, zoning designations, and building permit requirements), maintenance requirements for engineered controls (i.e., containment caps), and financial assurances.

The selected remedial action would include restricted land use and periodic performance review. The restricted land use would be in the form of an environmental covenant that must be recorded as part of the property deed to warn future owners of the condition of the Site and limit activities that may compromise the asphalt cap. The performance of the treatment wall would be reviewed and evaluated periodically.

6.8 Permitting and Planning Requirements

Required permits include:

- A stormwater control permit from the City for construction activities;
- A general NPDES permit for stormwater management;
- Construction permits from the Seattle Public Utilities Department and King County for water line and sewer rerouting and replacement;
- A grading permit from the City for pavement replacement after completion of remedial activities;
- A shoreline conditional use permit from King County for conducting construction activities within 200 feet of a shoreline; and
- Well abandonment and well construction permits from Ecology for abandonment of existing on-site monitoring wells and subsequent replacement.

7.0 REMEDIATION ALTERNATIVE IMPLEMENTATION, COSTS, AND SCHEDULE

Alternative 5 was identified as the preferred alternative for remedial action, pending public review and agency approval. Combined with the IA, this alternative will establish partial source control by removing identified sources of COCs. This alternative will reduce contaminant mass migration to adjacent surface water and sediment and achieve groundwater protectiveness at the conditional POC. Residual contamination will be capped by impervious surfaces to reduce human exposure.

The hot spot excavations will reduce toxicity permanently by removing soil in the most heavily impacted areas of the Site. While the treatment wall is in place, there is a low risk that residual contaminants will migrate to the Ship Canal, because groundwater will be treated *in situ* prior to discharge. Groundwater toxicity will be reduced through chemical and physical processes while the wall is in place and properly maintained.

We recommend additional site characterization before implementing the selected remedial action plan. Data gaps remain at the Site and collection of additional data to define the extent of the hot spots and further evaluate the groundwater to surface water pathway will help refine the scope and costs of the remedial action. If additional information is collected that demonstrates contaminant levels are below CULS at the POC, the treatment wall contingency will not be necessary.

The estimated cost for Alternative 5, using assumptions made in the Jacobson RI/FS, is approximately $6.73 million (−35 to +50 percent). A detailed cost estimate is provided in Table 6a for the conceptual remediation alternative. If it is determined that the treatment wall is not necessary, the cost of Alternative 5 would be approximately $1.97 million, as shown in Table 6b. Estimated costs will be further refined in the remedial design stage of the cleanup action.

Cleanup action implementation will be further developed in the EDR and project design documents. Ecology will provide public notice and an opportunity for the public to review and comment on the Jacobson RI/FS and this DCAP, as required under WAC 173-340-600. The detailed design phase to develop the EDR and project plans and specifications would occur after the public review process has been completed and public comments have been addressed. A schedule for the additional soil, groundwater, and sediment characterization and cleanup action implementation has not been determined.

8.0 REFERENCES

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Table 3 – Potential Applicable or Relevant and Appropriate Requirements

Authority	Resource	Implementing Laws/Regulations	ARAR?	Applicability
Contaminant-Specific ARARs				
State	Soil	Washington State Model Toxics Control Act [RCW 70.105D; Chapter 173-340 WAC]	Yes	The MTCA soil cleanup levels are applicable.
State	Groundwater	Washington State Model Toxics Control Act [RCW 70.105D; Chapter 173-340 WAC]	Yes	The MTCA groundwater cleanup levels are applicable.
State	Sediment	Washington State Model Toxics Control Act [RCW 70.105D; Chapter 173-204 WAC]	Yes	The SMS are applicable.
Action-Specific ARARs				
Federal/ State	Surface water	Federal Water Pollution Control Act--National Pollution Discharge Elimination System [CWA; 33 USC § 1342, Section 402] and Implementing Regulations Washington State Construction Stormwater General Permit [RCW 90.48]	Yes	The NPDES program establishes requirements for point source discharges, including stormwater runoff. These requirements would be applicable for any point source discharge of stormwater during construction or following cleanup.
Federal	Surface water	Federal Water Pollution Control Act--Water Quality Certification [CWA; 33 USC § 1341, Section 401] and Implementing Regulations	No	Section 401 of the CWA provides that applicants for a permit to conduct any activity involving potential discharges into waters or wetlands shall obtain certification from the state that discharges will comply with applicable water quality standards. No discharges are expected to waters or wetlands of the state.
State	Surface water	Hydraulic Code [RCW 77.55; Chapter 220-110 WAC]	No	The Hydraulic Code requires that any construction activity that uses, diverts, obstructs, or changes the bed or flow of state waters must be done under the terms of a Hydraulics Project Approval permit issued by the WDFW. These activities are not expected for the proposed alternatives.
Federal/ State	Solid waste	Transportation of Hazardous Materials [49 CFR Parts 105 to 177] [Chapter 446-50 WAC]	Yes	Transportation of hazardous waste or materials is required to meet state and federal requirements. This requirement is potentially applicable to alternatives that involve the off-site transport of impacted soil.
Federal/ State	Solid waste	Resource Conservation and Recovery Act [42 USC § 6901 et seq.], Subtitle C – Hazardous Waste Management [40 CFR Parts 260 to 279] Dangerous Waste Regulations [Chapter 173-303 WAC]	Yes	Subtitle C of RCRA pertains to the management of hazardous waste. Off-site disposal of impacted soil meeting hazardous waste criteria may require disposal at a Subtitle C landfill. These requirements are applicable to the remediation alternatives that involve off-site disposal of impacted soil.

Table 3 – Potential Applicable or Relevant and Appropriate Requirements

Authority	Resource	Implementing Laws/Regulations	ARAR?	Applicability
Federal	Solid waste	Resource Conservation and Recovery Act [42 USC § 6901 et seq.], Subtitle D – Managing Municipal and Solid Waste [40 CFR Parts 257 and 258]	Yes	Subtitle D of RCRA establishes a framework for management of non-hazardous solid waste. These regulations establish guidelines and criteria from which states develop solid waste regulations. These requirements are applicable to the remediation alternatives that involve off-site disposal of impacted soil.
State	Solid waste	Washington State Solid Waste Handling Standards [RCW 70.95; Chapter 173-350 WAC]	Yes	Washington State Solid Waste Handling Standards apply to facilities and activities that manage solid waste. The regulations set minimum functional performance standards for proper handling and disposal of solid waste; describe responsibilities of various entities; and stipulate requirements for solid waste handling facility location, design, construction, operation, and closure. These requirements are applicable to remediation alternatives that involve off-site disposal of impacted soil.
Federal/ State	Solid waste	Land Disposal Restrictions [40 CFR Part 268] [Chapter 173-303-140 WAC]	Yes	Best management practices for dangerous wastes are required to meet state and federal requirements. These requirements are applicable to the remediation alternatives that involve off-site disposal of soil classified as dangerous waste.
Federal	Air	Clean Air Act [42 USC § 7401 et seq.; 40 CFR Part 50]	Yes	The federal Clean Air Act creates a national framework designed to protect ambient air quality by limiting air emissions.
State	Air	Washington Clean Air Act and Implementing Regulations [Chapter 173-400-040(8) WAC]	Yes	These regulations require the owner or operator of a source of fugitive dust to take reasonable precautions to prevent fugitive dust from becoming airborne and to maintain and operate the source to minimize emissions. These regulations are applicable to all alternatives during construction.
State	Groundwater	Minimum Standards for Construction and Maintenance of Water Wells [RCW 18.104; Chapter 173-160 WAC]	Yes	Washington State has developed minimum standards for constructing water and monitoring wells, and for decommissioning wells. These regulations are applicable to all alternatives prior to construction.
Federal	Endangered species, critical habitats	Endangered Species Act [16 USC §§ 1531 - 1544] and Implementing Regulations	No	The ESA protects species of fish, wildlife, and plants that are listed as threatened or endangered with extinction. It also protects designated critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species, including consultation with resource agencies. No threatened or endangered species or habitat areas are expected to be impacted by the remediation alternatives.
State	Remedy construction	Washington Industrial Safety and Health Act [RCW 49.17; Chapter 296-24 WAC]	Yes	Site worker and visitor health and safety requirements established by the WISHA are to be met during implementation of the remedial action.
State/Local	Remedy construction	State Environmental Policy Act [43.21 RCW, Chapter 197-11 WAC]	Yes	A SEPA review is likely required for local permitting and pursuant to MTCA.
Local	Remedy construction	City of Seattle Ordinances	Yes	Appropriate substantive requirements are to be met for implementation of the remedial action (for example, Grading Code SMC 22.170).

Table 3 – Potential Applicable or Relevant and Appropriate Requirements

Authority	Resource	Implementing Laws/Regulations	ARAR?	Applicability
Location-Specific ARARs				
State	Public lands	Public Lands Management [RCW 79.02]	No	Activities on public lands are restricted, regulated, or proscribed. The remediation alternatives do not occur on public lands.
State	Aquatic lands	Aquatic Lands Management – Washington State [RCW 79.90; Chapter 332-30 WAC]	No	The Aquatic Lands Management law develops criteria for managing state-owned aquatic lands. Aquatic lands are to be managed to promote uses and protect resources as specified in the regulations. Remediation areas are not on aquatic lands.
Federal/ State	Historic areas	Archaeological and Historic Preservation Act [16 USC § 469, 470 et seq.; 36 CFR Parts 65 and 800] [RCW 24.34, 27.44, 27.48, and 27.53; Chapters 25-46 and 25-48 WAC]	No	Actions must be taken to preserve and recover significant artifacts, preserve historic and archaeological properties and resources, and minimize harm to national landmarks. There are no known historic or archaeological sites in the vicinity of the remediation areas.
State	Shorelines and surface water	Shoreline Management Act of 1971 [RCW 90.58] and Implementing Regulations	Yes	Actions are prohibited within 200 feet of shorelines of statewide significance unless permitted. Remediation alternatives occur within 200 feet of the Lake Washington Ship Canal.
State	Wetlands	Shoreline Management Act of 1971 [RCW 90.58] and Implementing Regulations	No	The construction or management of property in wetlands is required to minimize potential harm, avoid adverse effects, and preserve and enhance wetlands. The remediation alternatives do not occur within delineated wetlands.

Notes:
ARAR = applicable or relevant and appropriate requirements
CFR = Code of Federal Regulations
CWA = Clean Water Act
ESA = Endangered Species Act
MTCA = Model Toxics Control Act
NPDES = National Pollution Discharge Elimination System
RCRA = Resource Conservation and Recovery Act
RCW == Revised Code of Washington
SEPA = State Environmental Policy Act
SMC = Seattle Municipal Code
SMS = Sediment Management Standards
USC = United States Code
WAC = Washington Administrative Code
WDFW = Washington State Department of Fish and Wildlife
WISHA = Washington Industrial Safety and Health Act

Table 4 – Remediation Alternatives Evaluation

Selection Criteria	Alternative 1: Interim Action, Natural Attenuation with Institutional Controls, and Compliance Monitoring	Alternative 2: Interim Action, Hot Spot Excavation with Institutional Controls, and Compliance Monitoring	Alternative 3: Interim Action, Treatment Wall with Institutional Controls, and Compliance Monitoring	Alternative 4: Interim Action, Excavation of Soil Exceeding CULs with Institutional Controls, and Compliance Monitoring	Alternative 5: Interim Action, Hot Spot Excavation with Institutional Controls, and Compliance Monitoring, and Treatment Wall Construction Contingency
Threshold Requirements: WAC 173-340-360(2)(a)					
Protect Human Health and the Environment	Protective of human health. Ecological protectiveness unknown. Assuming IA is completed and property remains capped with impervious surfaces, human exposure is reduced. Additional data are needed to assess whether contamination located away from IA area is impacting adjacent surface water and sediment.	Protective of human health. Ecological protectiveness unknown. Assuming IA is completed and property remains capped with impervious surfaces, removal of contaminated hot spot material eliminates direct-contact risk to human receptors in, but residual contamination likely remains beneath impervious cap. Additional data are needed to assess whether contamination located away from IA area is impacting adjacent surface water and sediment.	Protective. Removal of contaminated material in interim action area and reduces contaminant mass migration to adjacent surface water and sediment, reducing potential risk to ecological receptors. Residual contamination at interim action area and hot spot contamination capped with impervious surfaces and human exposure reduced. Protective of ecological health in adjacent surface water while treatment wall in place.	Protective. Removal of all accessible contaminated material eliminates direct-contact risk to human receptors and greatly reduces risk of migration to ecological receptors in adjacent surface water. Any residual contamination below buildings would be capped by impervious surfaces. Inaccessible soil exceeding cleanup levels may remain in the AOC and leaching of contaminants may impact the adjacent surface water body.	Protective. Removal of contaminated material, reduces contaminant mass migration to adjacent surface water and sediment, and reduces potential risk to ecological receptors. Residual contamination capped by impervious surfaces and human exposure reduced. Protective of ecological health in adjacent surface water while treatment wall in place.
Comply with Cleanup Standards	Unknown. Impacts to hot spot soil, groundwater, and sediment would remain after interim action and natural attenuation is not expected within a reasonable time frame. It is not known whether groundwater contamination is impacting adjacent surface water or whether capping can contain contaminants.	Unknown. Impacts to soil (residual), groundwater, and sediment would likely remain even after interim action and hot spot removal, and natural attenuation is not expected within a reasonable time frame. It is not known whether groundwater contamination is impacting adjacent surface water or whether capping can contain groundwater contaminants.	Complies. Upland soil exceeding cleanup levels that remain after interim action would be contained by pavement cap. Treatment wall would treat groundwater contamination, eliminating migration to the Ship Canal. Cleanup actions that involve containment can be deemed to meet cleanup standards if requirements set out in WAC 173-340-740(6)(f) are met.	Likely complies. Following removal, no accessible contaminated soil exceeding cleanup levels would remain in the AOC. Material left in place above cleanup levels will be contained by capping although it may still be in contact with groundwater.	Complies. Residual upland soil exceeding cleanup levels would be contained by pavement cap. Treatment wall would treat groundwater contamination, eliminating migration to the Ship Canal. Cleanup actions that involve containment can be deemed to meet cleanup standards if requirements set out in WAC 173-340-740(6)(f) are met.
Comply with Applicable State and Federal Laws	Unknown. ARARs are judged to be attainable and do not affect the alternative selection process (see Table 3).	Complies. ARARs are judged to be attainable and do not affect the alternative selection process (see Table 3).	Complies. ARARs are judged to be attainable and do not affect the alternative selection process (see Table 3).	Complies. ARARs are judged to be attainable and do not affect the alternative selection process (see Table 3).	Complies. ARARs are judged to be attainable and do not affect the alternative selection process (see Table 3).
Provide for Compliance Monitoring	Provides for compliance monitoring in accordance with WAC 173-340-410 as described in Section 7.2.1.	Provides for compliance monitoring in accordance with WAC 173-340-410 as described in Section 7.2.2.	Provides for compliance monitoring in accordance with WAC 173-340-410 as described in Section 7.2.3.	Provides for compliance monitoring in accordance with WAC 173-340-410 as described in Section 7.2.4.	Provides for compliance monitoring in accordance with WAC 173-340-410 as described in Section 7.2.5.
Other Requirements: WAC 173-340-360(2)(b)					
Use Permanent Solutions to the Maximum Extent Practicable	Does not use permanent solutions to the extent provided by other alternatives (see Table 5).	Uses permanent solutions, but leaves residual contamination. Alternative 2 is less permanent than Alternatives 4 and 5 (see Table 5).	Provides more permanence than Alternative 1, but requires ongoing O&M. However, it does not use permanent solutions to the extent provided in Alternatives 2, 4, and 5 (see Table 5).	Uses permanent solutions, However, inaccessible soil exceeding cleanup levels may remain in the AOC and leaching of contaminants may impact the adjacent surface water body. Although this alternative provides the most permanent solution, it is not practicable (see Table 5).	Uses permanent solutions to the extent provided in Alternatives 2 and 3, but is less permanent than Alternative 4 (see Table 5).

Table 4 – Remediation Alternatives Evaluation

Selection Criteria	Alternative 1: Interim Action, Natural Attenuation with Institutional Controls, and Compliance Monitoring	Alternative 2: Interim Action, Hot Spot Excavation with Institutional Controls, and Compliance Monitoring	Alternative 3: Interim Action, Treatment Wall with Institutional Controls, and Compliance Monitoring	Alternative 4: Interim Action, Excavation of Soil Exceeding CULs with Institutional Controls, and Compliance Monitoring	Alternative 5: Interim Action, Hot Spot Excavation with Institutional Controls, and Compliance Monitoring, and Treatment Wall Construction Contingency
Provide for a Reasonable Restoration Time Frame	Provides a reasonable restoration time frame to mitigate direct-contact exposure risk to human receptors. However, contaminated soil and groundwater will remain in the AOC and could migrate to the adjacent surface water body. Natural attenuation processes are not expected to occur within a reasonable time frame.	Provides a reasonable restoration time frame to mitigate direct-contact exposure risk to human receptors. However, soil exceeding cleanup levels will likely remain in the AOC and leaching of contaminants may impact the adjacent surface water body. The work could be completed within one construction season.	Provides a reasonable restoration time frame to mitigate exposure risk to receptors. The work could be completed within one construction season.	Provides a reasonable restoration time frame to mitigate exposure risk to receptors. The work could be completed within one construction season.	Provides a reasonable restoration time frame to mitigate exposure risk to receptors. The work could be completed within one construction season.
Consider Public Concerns	This criterion will be addressed during the public comment period for the RI/FS and Draft Cleanup Action Plan.				
Action-Specific Requirements: WAC 173-340-360(2)(c) through (h)					
Groundwater Cleanup Actions, WAC 173-340-360(2)(c)	Does not currently comply. There is only one well near the point of compliance away from the IA area containing PCBs above CULs. Additional data are needed to assess COC concentrations at the point of compliance.	Unknown. Areas of contamination will still exist away from the interim action area and hot spots. Additional data are needed to assess COC concentrations at the point of compliance.	Complies. Groundwater COC concentrations will be reduced due to interim action area removal, and impacts from residual contamination and hot spot areas will likely be reduced by the treatment wall to below CULs at the point of compliance.	Likely complies. Groundwater COC concentrations will likely be reduced by source removal to below CULs at the point of compliance.	Complies. Groundwater COC concentrations will likely be reduced by source removal and the treatment wall to below CULs at the point of compliance.
Cleanup Actions for Soil at Current or Potential Future Residential Areas and for Soil at Schools and Child Care Centers, WAC 173-340-360(2)(d)	Not applicable. The site is not in a residential area.				
Institutional Controls, WAC 173-340-360(2)(e)	Does not currently comply. Alternative 1 relies on institutional controls and monitoring to maintain the existing treatment wall and asphalt cap, which would comply once additional investigation provides evidence for incomplete contaminant transport pathway to adjacent aquatic environment.	Complies. Alternative 2 will require institutional controls depending on the amount of contaminated soil remaining in other areas of the site and beneath buildings; it does not rely primarily on institutional controls and monitoring.	Complies. Alternative 3 will require institutional controls; it does not rely primarily on institutional controls and monitoring.	Alternative 4 may require institutional controls depending on the amount of contaminated soil remaining beneath buildings; it does not rely primarily on institutional controls and monitoring.	Complies. Alternative 5 will require institutional controls depending on the amount of contaminated soil remaining in other areas of the site and beneath buildings; it does not rely primarily on institutional controls and monitoring.
Releases and Migration, WAC 173-340-360(2)(f)	Does not currently comply. Reduces infiltration and releases with existing asphalt cap, but does not address potential contaminant migration from the AOCs. Need to provide evidence of incomplete transport pathway to adjacent aquatic environment.	Does not currently comply. Alternative 2 minimizes releases and migration with existing asphalt cap and removal of contaminated material, but does not address potential migration of residual COCs to the Ship Canal.	Complies. Alternative 3 prevents releases and migration of COCs by maintaining the existing asphalt cap and construction of a treatment wall adjacent to the Ship Canal.	Likely complies. Alternative 4 minimizes releases and migration of COCs by removing accessible contaminated material and capping remaining contaminated material.	Complies. Alternative 5 prevents releases and migration by removing contaminated material and construction of a treatment wall adjacent to the Ship Canal.

Table 4 – Remediation Alternatives Evaluation

Selection Criteria	Alternative 1: Interim Action, Natural Attenuation with Institutional Controls, and Compliance Monitoring	Alternative 2: Interim Action, Hot Spot Excavation with Institutional Controls, and Compliance Monitoring	Alternative 3: Interim Action, Treatment Wall with Institutional Controls, and Compliance Monitoring	Alternative 4: Interim Action, Excavation of Soil Exceeding CULs with Institutional Controls, and Compliance Monitoring	Alternative 5: Interim Action, Hot Spot Excavation with Institutional Controls, and Compliance Monitoring, and Treatment Wall Construction Contingency
Dilution and Dispersion, WAC 173-340-360(2)(g)	Complies due to removal of interim action hot spot. Alternative 1 does not solely rely on dilution and dispersion.	Complies. Alternative 2 does not rely on dilution and dispersion.	Complies. Alternative 3 does not rely on dilution and dispersion.	Complies. Alternative 4 does not rely on dilution and dispersion.	Complies. Alternative 5 does not rely on dilution and dispersion.
Remediation Levels, WAC 173-340-360(2)(h)	Not applicable. The alternatives do not involve remediation levels.				

Table 5 – Disproportionate Cost Analysis

DCA Criterion	Alternative 1: Interim Action, Natural Attenuation with Institutional Controls, and Compliance Monitoring	Alternative 2: Interim Action, Hot Spot Excavation with Institutional Controls, and Compliance Monitoring	Alternative 3: Interim Action, Treatment Wall with Institutional Controls, and Compliance Monitoring	Alternative 4: Interim Action, Excavation of Soil Exceeding CULs with Institutional Controls, and Compliance Monitoring	Alternative 5: Interim Action, Hot Spot Excavation, Treatment Wall with Institutional Controls, and Compliance Monitoring
Protectiveness	Assuming the interim action is completed, partial source control reduces human exposure to contamination in soil and groundwater through institutional controls prohibiting disturbance of subsurface capped with impervious surfaces. May not be protective of ecological health in adjacent surface water, additional data necessary to evaluate this potential. Deed restriction required indefinitely for current/future tenants.	Assuming the interim action is completed, removes most of the known contaminant mass. Residual contamination capped by impervious surfaces, which reduces human exposure. Unknown ecological protectiveness because of residual impacts under buildings or beyond interim action area and hot spot boundaries. Additional data necessary to evaluate potential impacts to adjacent aquatic environment.	Assuming the interim action is completed, reduces contaminant mass migration to adjacent surface water and sediment. Residual contamination around interim action areas and hot spots capped by impervious surfaces. Human exposure reduced. Protective of ecological health in adjacent surface water while treatment wall is in place.	Assuming the interim action is completed, removes all accessible contaminant mass in soil and groundwater immediately. Residual contaminants, if present beneath permanent structures, may be capped by impervious surfaces. Human exposure removed except for potential exposure to residual impacts. Alternative 4 is the most protective of the five alternatives.	Assuming the interim action is completed, removes most of the known contaminant mass. Residual contamination capped by impervious surfaces. Human exposure is reduced. Reduces contaminant mass migration to adjacent surface water and sediment. While treatment wall is in place, protectiveness is achieved for groundwater downgradient of the treatment wall.
Permanence	Provides permanent reduction in volume of contaminated material through interim action removal. Risk of contaminant migration from residual contamination within and outside of Interim Action Area.. Groundwater quality would be monitored and the treatment wall may need to be maintained for many years.	Provides permanent reduction in volume of contaminated material through interim action removal and excavation of contaminant hot spot areas. Risk of contaminant migration due to residual contamination. Groundwater quality would be monitored and the treatment wall may need to be maintained for many years.	Provides permanent reduction in volume of contaminated material through interim action removal. Low risk of contaminant mobility because there would be in situ treatment before groundwater discharge into the Ship Canal. In situ treatment of groundwater will significantly reduce potential groundwater toxicity through chemical and physical processes while the treatment wall is in place and properly maintained.	Very low risk of mobility of residual contaminants. Provides permanent reduction in volume of contaminated material through excavation. Does not address contamination under existing structures.	Low risk of contaminant mobility because there would be in situ treatment before groundwater discharge into the Ship Canal. In situ treatment of groundwater will significantly reduce potential groundwater toxicity through chemical and physical processes while the treatment wall is in place and properly maintained. Provides permanent reduction in volume of contaminated material through excavation of contaminant hot spot areas.
Cost	$427,000	$1,910,000	$5,490,000	$14,800,000	$1,910,000 (w/o wall) $6,730,000 (w/ wall)
Effectiveness over the Long Term	Possibly effective for the interim action area contamination. Off-site disposal in an engineered, lined, and monitored facility. Landfills are a proven technology and are expected to be effective over the long term. Not effective at treating PCBs and metals in hot spot areas. Potentially not effective at treating diesel impacts.	Permanently remediates interim action area and contaminant hot spots where accessible, but residual contaminant mass will likely remain. Off-site disposal in an engineered, lined, and monitored facility. Landfills are a proven technology and are expected to be effective over the long term.	Remediates groundwater while treatment wall is in place and maintained. Does not directly reduce contaminant mass in source areas. Requires O&M to maintain long-term effectiveness.	Permanently remediates soil and removes potential groundwater contaminant source area. Off-site disposal in an engineered, lined, and monitored facility that is expected to be effective over the long term.	Remediates contaminant hot spots where accessible, but residual contaminant mass is likely to remain. Disposes contaminated soil off site in an engineered, lined, and monitored facility. Treatment wall remediates groundwater while in place, but requires O&M to maintain long-term effectiveness.
Management of Short-Term Risks	Moderate short-term risks associated with interim action area waste	Moderate short-term risks associated with waste excavation, over-the-road	Moderate short-term risks associated with waste excavation during treatment	Moderate to high short-term risks associated with waste excavation,	Moderate short-term risks associated with waste excavation, over-the-road

Table 5 – Disproportionate Cost Analysis

	excavation, over-the-road transport to landfill, and construction impacts to local businesses. Low short-term risks associated with implementing institutional controls.	transport to landfill, and construction impacts to local businesses. Low short-term risks associated with implementing institutional controls.	wall installation, over-the-road transport to landfill, and construction impact to local businesses.	over-the-road transport to landfill, and construction impact to local businesses. High short-term risk associated with large scale and long duration.	transport to landfill, and construction impact to local businesses. Increased complexity would result in more impacts to local businesses.
Technical and Administrative Implementability	Implementable. Uses typical construction practices and equipment for the interim action removal. Impacts to businesses on site would be moderate. Requires additional investigation to determine potential impact to adjacent surface water. Requires administrative structure, permits, institutional controls, and environmental covenant.	Implementable. Uses typical construction practices and equipment for source control. Impacts to businesses on site would be moderate. Requires additional investigation to determine potential impact to adjacent surface water. Requires additional characterization to delineate extent of hot spots. Requires permits, institutional controls, and environmental covenant.	Implementable. Uses typical construction practices and equipment, as well as treatment material handling. Construction impacts to businesses on site would be significant. Requires future maintenance, permitting, and additional characterization for design. Requires permits, institutional controls, and environmental covenant.	Implementable. Uses typical construction practices and equipment, although extensively impacts businesses on site, likely requiring closure of the facility for an extended period of time and rerouting of public sewer line. Requires permits and environmental covenant.	Implementable. Uses typical construction practices and equipment, as well as treatment material handling. Requires additional characterization to delineate impacts and future maintenance and permitting. Requires permits, institutional controls, and environmental covenants.
Consideration of Public Concerns	This criterion will be addressed during the public comment period for the RI/FS and Draft Cleanup Action Plan.				

Table 6a – Remediation Alternative 5 Estimated Costs (w/o Treatment Wall)

Location:	Jacobson Terminals Seattle, WA
Phase:	Feasibility Study (-35% to +50%)
Base Year:	2014
Date:	February 2016

Description: Cost estimate for variant of Alternative 5 that excludes installation of a treatment wall. This variant of Alternative 5 includes soil hot spot excavation, institutional controls, and compliance monitoring for 20 years.

CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Site Preparation					
Submittals/implementation plans	1	LS	$ 25,000	$ 25,000	Pre- and post-construction contractor submittals, work plan, HASP, etc. Based on similar project experience.
Mobilization/demobilization	1	LS	$ 10,156	$ 10,156	RACER 2013.
Remove pavement	1	LS	$ 9,332	$ 9,332	RACER 2013.
Remove underground utilities	1	LS	$ 1,392	$ 1,392	RACER 2013.
Well abandonment	1	LS	$ 5,544	$ 5,544	2 wells. RACER 2013.
TESC measures	1	LS	$ 10,000	$ 10,000	Engineer's estimate.
Subtotal				**$ 61,424**	
Excavation and Disposal					
Dewatering, treatment, sewer discharge	1	LS	$ 73,372	$ 73,372	RACER 2013 and King Co. 2014 discharge rates.
Excavation, loading, backfilling	1	LS	$ 158,450	$ 158,450	RACER 2013.
Transportation, disposal	2,968	TON	$ 200	$ 593,689	Disposal at Subtitle C landfill. Waste Management 2/21/2014 quote. See Table A-7 in RIFS.
Performance sampling and analysis	1	LS	$ 6,124	$ 6,124	See Table A-7 in RIFS.
Add backfill soil amendment	724	SF	$ 2.78	$ 2,013	Add amendment to enhance in situ bioremediation. Based on similar project experience.
Subtotal				**$ 833,648**	
Site Restoration					
Restore underground utilities	1	LS	$ 7,121	$ 7,121	RACER 2013.
Repave excavated areas	1	LS	$ 15,975	$ 15,975	RACER 2013.
Replace monitoring wells	1	LS	$ 9,074	$ 9,074	2 wells, 20-ft depth, 10-ft screen. RACER 2013.
Install compliance monitoring wells	1	LS	$ 10,378	$ 10,378	2 wells, 30-ft depth, 10-ft screen. RACER 2013.
Subtotal				**$ 42,548**	
Contingency	30%	--	--	**$ 281,286**	Scope and bid contingency. Percentage of capital costs.
Professional/Technical Services					
Project management	9%	--	--	$ 109,702	Percentage of capital cost + contingency. EPA 540-R-00-002.
Remedial design	12%	--	--	$ 146,269	Percentage of capital cost + contingency. EPA 540-R-00-002.
Construction management	10%	--	--	$ 121,891	Percentage of capital cost + contingency. EPA 540-R-00-002.
Subtotal				**$ 377,861**	
Institutional Controls					
Institutional controls plan	1	LS	$ 4,788	$ 4,788	See Table A-7 in RIFS.
Restrictive covenant	1	LS	$ 6,716	$ 6,716	RACER 2013.
Subtotal				**$ 11,504**	
TOTAL CAPITAL COST				**$ 1,608,272**	

ANNUAL O&M COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Monitoring					
Compliance monitoring	1	YR	$ 1,923	$ 1,923	See Table A-7 in RIFS.
Laboratory analysis	1	YR	$ 2,130	$ 2,130	See Table A-7 in RIFS.
Subtotal				**$ 4,053**	
Contingency	15%	--	--	**$ 608**	Scope and bid contingency. Percentage of annual costs.
Professional/Technical Services					
Project management	15%	--	--	$ 699	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Technical support	20%	--	--	$ 932	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Reporting	1	EA	$ 5,148	$ 5,148	Compliance and MNA performance monitoring. See Table A-7 in RIFS.
Subtotal				**$ 6,779**	
Institutional Controls					
Site database maintenance	1	YR	$ 3,732	$ 3,732	See Table A-7 in RIFS.
Subtotal				**$ 3,732**	
TOTAL ANNUAL O&M COST				**$ 15,172**	

Table 6a – Remediation Alternative 5 Estimated Costs (w/o Treatment Wall)

Location: Jacobson Terminals, Seattle, WA
Phase: Feasibility Study (-35% to +50%)
Base Year: 2014
Date: February 2016

Description: Cost estimate for variant of Alternative 5 that excludes installation of a treatment wall. This variant of Alternative 5 includes soil hot spot excavation, institutional controls, and compliance monitoring for 20 years.

PERIODIC COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Professional/Technical Services					
5-year reviews & reporting	1	EA	$ 5,000	$ 5,000	Years 5, 10, 15, 20. Engineer's estimate.
Subtotal				**$ 5,000**	
Institutional Controls					
Restrictive covenant update	1	EA	$ 4,922	$ 4,922	Years 5, 10, 15, 20. See Table A-7 in RIFS.
Subtotal				**$ 4,922**	

PRESENT VALUE ANALYSIS

Discount rate 1.2%
Total years 20

COST TYPE	YEAR	TOTAL COST	TOTAL ANNUAL COST	DISCOUNT FACTOR	NET PRESENT VALUE	NOTES
Capital	0	$ 1,608,272	$ 1,608,272	1.000	$ 1,608,272	
Annual O&M	1 - 20	$ 303,430	$ 15,172	17.687	$ 268,343	
Periodic	5	$ 9,922	$ 9,922	0.942	$ 9,348	
Periodic	10	$ 9,922	$ 9,922	0.888	$ 8,807	
Periodic	15	$ 9,922	$ 9,922	0.836	$ 8,297	
Periodic	20	$ 9,922	$ 9,922	0.788	$ 7,816	
		$ 1,951,391			$ 1,910,882	

TOTAL NET PRESENT VALUE OF ALTERNATIVE 5 w/o PRB **$ 1,910,000**

Notes:
Cost estimate does not include sales tax.
Present value analysis uses a 20-year discount rate of 1.2 percent (www.whitehouse.gov/omb/circulars_a094/a94_appx-c).

Table 6b – Remediation Alternative 5 Estimated Costs (w/ Treatment Wall)

Location:	Jacobson Terminals Seattle, WA
Phase:	Feasibility Study (-35% to +50%)
Base Year:	2014
Date:	February 2016

Description: Alternative 5 includes soil hot spot excavation and in situ groundwater treatment using a permeable reactive/sorptive barrier, institutional controls, and compliance monitoring for 20 years. The barrier would contain zero-valent iron (ZVI) to break down dissolved contaminant mass and granular activated carbon (GAC) to adsorb contaminants that are not amenable to treatment with ZVI.

CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Site Preparation					
Submittals/implementation plans	1	LS	$ 30,000	$ 30,000	Pre- and post-construction contractor submittals, work plan, HASP, etc. Based on similar project experience.
Mobilization/demobilization	1	LS	$ 20,313	$ 20,313	RACER 2013. For two separate events.
Remove pavement	1	LS	$ 11,579	$ 11,579	RACER 2013.
Remove underground utilities	1	LS	$ 1,392	$ 1,392	RACER 2013.
Well abandonment	1	LS	$ 5,544	$ 5,544	2 wells. RACER 2013.
TESC measures	1	LS	$ 10,000	$ 10,000	Engineer's estimate.
Subtotal				**$ 78,828**	
Excavation and Disposal					
Dewatering, treatment, sewer discharge	1	LS	$ 127,806	$ 127,806	RACER 2013 and King Co. 2014 discharge rates. Includes management of water from PRB installation.
Excavation, loading, backfilling	1	LS	$ 158,450	$ 158,450	RACER 2013.
Transportation, disposal	2,968	TON	$ 200	$ 593,689	Disposal at Subtitle C landfill. Waste Management 2/21/2014 quote. See Table A-7 in RIFS.
Performance sampling and analysis	1	LS	$ 6,124	$ 6,124	See Table A-7 in RIFS.
Add backfill soil amendment	724	SF	$ 2.78	$ 2,013	Add amendment to enhance in situ bioremediation. Based on similar project experience.
Subtotal				**$ 888,082**	
Permeable Reactive Barrier Installation					
Barrier earthwork	1	LS	$ 410,288	$ 410,288	RACER 2013.
Loading, transportation, disposal	1,047	TON	$ 200	$ 209,440	Disposal at Subtitle C landfill. Waste Management 2/21/2014 quote. See Table A-7 in RIFS.
Barrier material import, placement	1	LS	$ 1,058,925	$ 1,058,925	ZVI, GAC, sand, fill. RACER 2013.
Subtotal				**$ 1,678,652**	
Site Restoration					
Restore underground utilities	1	LS	$ 7,121	$ 7,121	RACER 2013.
Repave excavated areas	1	LS	$ 23,945	$ 23,945	RACER 2013.
Replace monitoring wells	1	LS	$ 9,074	$ 9,074	2 wells, 20-ft depth, 10-ft screen. RACER 2013.
Install compliance monitoring wells	1	LS	$ 15,965	$ 15,965	4 wells, 30-ft depth, 10-ft screen. RACER 2013.
Subtotal				**$ 56,105**	
Contingency	30%	--	--	**$ 810,500**	Scope and bid contingency. Percentage of capital costs.
Professional/Technical Services					
Project management	5%	--	--	$ 175,608	Percentage of capital cost + contingency. EPA 540-R-00-002.
Remedial design	8%	--	--	$ 280,973	Percentage of capital cost + contingency. EPA 540-R-00-002.
Construction management	6%	--	--	$ 210,730	Percentage of capital cost + contingency. EPA 540-R-00-002.
Subtotal				**$ 667,312**	
Institutional Controls					
Institutional controls plan	1	LS	$ 4,788	$ 4,788	See Table A-7 in RIFS.
Restrictive covenant	1	LS	$ 6,716	$ 6,716	RACER 2013.
Subtotal				**$ 11,504**	
TOTAL CAPITAL COST				**$ 4,190,984**	

ANNUAL O&M COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Monitoring					
Performance monitoring	1	YR	$ 2,425	$ 2,425	See Table A-7 in RIFS.
Compliance monitoring	1	YR	$ 3,615	$ 3,615	See Table A-7 in RIFS.
Laboratory analysis	1	YR	$ 7,100	$ 7,100	See Table A-7 in RIFS.
Subtotal				**$ 13,140**	
Contingency	15%	--	--	**$ 1,971**	Scope and bid contingency. Percentage of annual costs.
Professional/Technical Services					
Project management	15%	--	--	$ 2,267	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Technical support	20%	--	--	$ 3,022	Percentage of O&M costs + contingency. EPA 540-R-00-002.
Reporting	1	EA	$ 5,148	$ 5,148	Compliance and MNA performance monitoring. See Table A-7 in RIFS.
Subtotal				**$ 10,437**	

Table 6b – Remediation Alternative 5 Estimated Costs (w/ Treatment Wall)

Location:	Jacobson Terminals Seattle, WA
Phase:	Feasibility Study (-35% to +50%)
Base Year:	2014
Date:	February 2016

Description: Alternative 5 includes soil hot spot excavation and in situ groundwater treatment using a permeable reactive/sorptive barrier, institutional controls, and compliance monitoring for 20 years. The barrier would contain zero-valent iron (ZVI) to break down dissolved contaminant mass and granular activated carbon (GAC) to adsorb contaminants that are not amenable to treatment with ZVI.

Institutional Controls					
Site database maintenance	1	YR	$ 3,732	$ 3,732	See Table A-7 in RIFS.
Subtotal				**$ 3,732**	
TOTAL ANNUAL O&M COST				**$ 29,280**	

PERIODIC COSTS

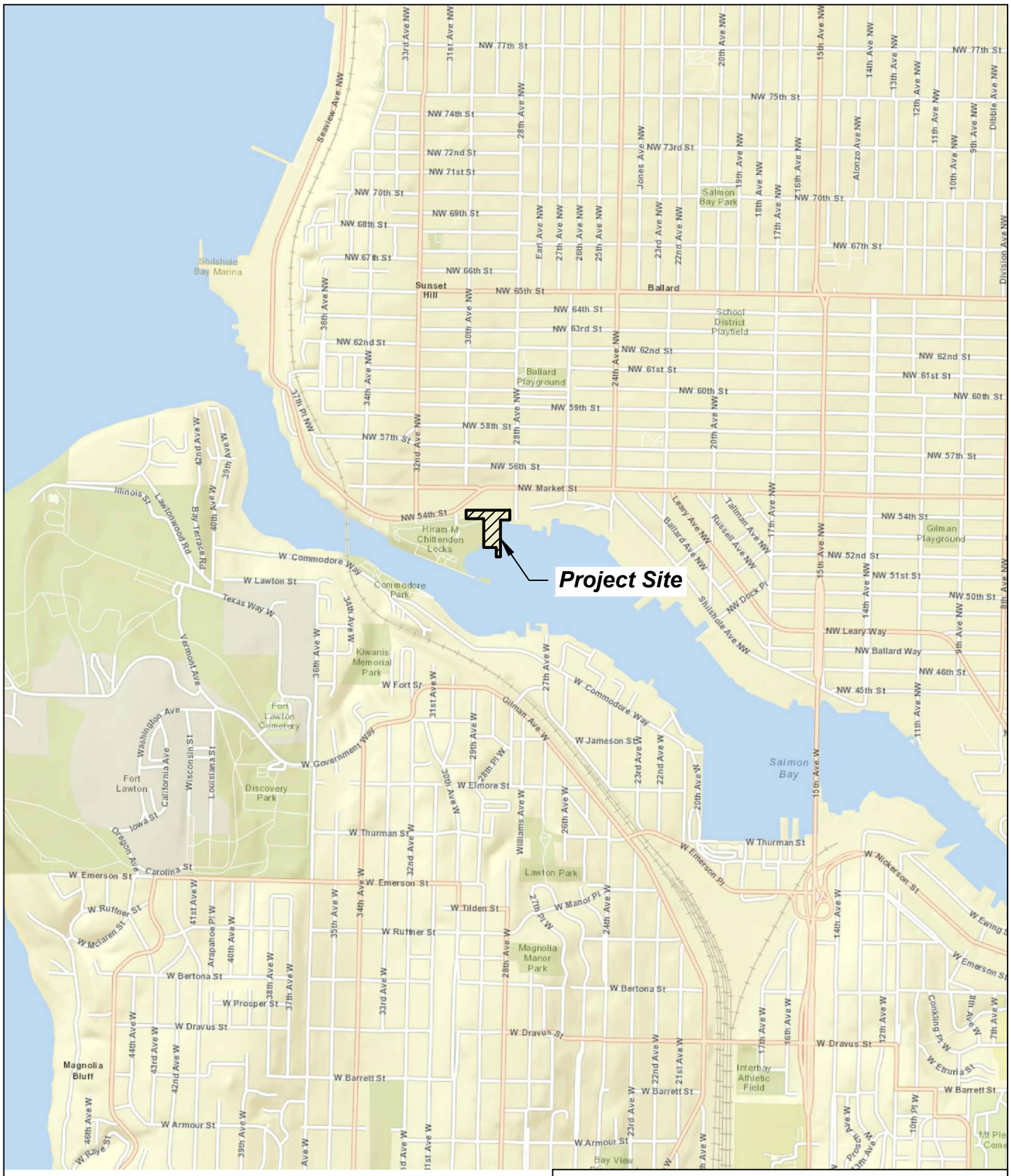
DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	NOTES
Permeable Reactive Barrier Maintenance					
Replace treatment media	1	EA	$ 1,892,408	$ 1,892,408	Year 20. Derived from capital costs above.
Contingency	20%	--	--	$ 378,482	
Project management	4%	--	--	$ 90,836	
Design	2%	--	--	$ 45,418	
Construction management	5%	--	--	$ 113,544	
Subtotal				**$ 2,520,687**	
Professional/Technical Services					
5-year reviews & reporting	1	EA	$ 5,000	$ 5,000	Years 5, 10, 15, 20. Engineer's estimate.
Subtotal				**$ 5,000**	
Institutional Controls					
Restrictive covenant update	1	EA	$ 4,922	$ 4,922	Years 5, 10, 15, 20. See Table A-7 in RIFS.
Subtotal				**$ 4,922**	

PRESENT VALUE ANALYSIS

Discount rate 1.2%
Total years 20

COST TYPE	YEAR	TOTAL COST	TOTAL ANNUAL COST	DISCOUNT FACTOR	NET PRESENT VALUE	NOTES
Capital	0	$ 4,190,984	$ 4,190,984	1.000	$ 4,190,984	
Annual O&M	1 - 20	$ 585,597	$ 29,280	17.687	$ 517,881	
Periodic	5	$ 9,922	$ 9,922	0.942	$ 9,348	
Periodic	10	$ 9,922	$ 9,922	0.888	$ 8,807	
Periodic	15	$ 9,922	$ 9,922	0.836	$ 8,297	
Periodic	20	$ 2,530,609	$ 2,530,609	0.788	$ 1,993,493	
		$ 7,336,956			$ 6,728,809	
TOTAL NET PRESENT VALUE OF ALTERNATIVE 5					**$ 6,730,000**	

Notes:
Cost estimate does not include sales tax.
Present value analysis uses a 20-year discount rate of 1.2 percent (www.whitehouse.gov/omb/circulars_a094/a94_appx-c).



Source: Base map prepared from ArcGIS Online, 2013.

0 2000 4000

Approximate Scale in Feet

N

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Vicinity Map

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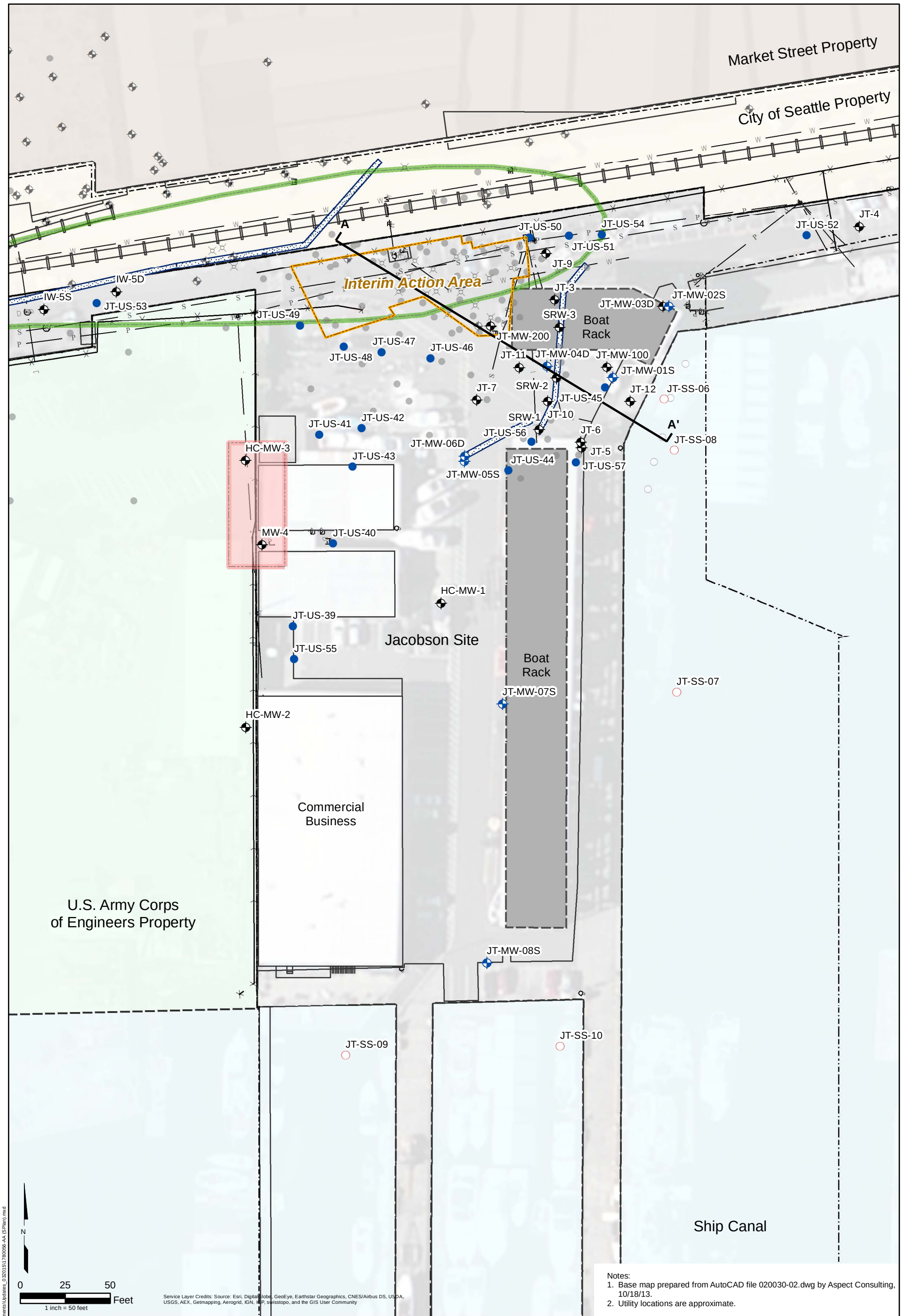
Figure
1

EAL 09/28/15 1780056-005 (VMap).dwg



Notes:
1. Base map prepared from AutoCAD file 020030-02.dwg by Aspect Consulting, 10/18/13.
2. Utility locations are approximate.

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Site Plan and RI Sampling Locations

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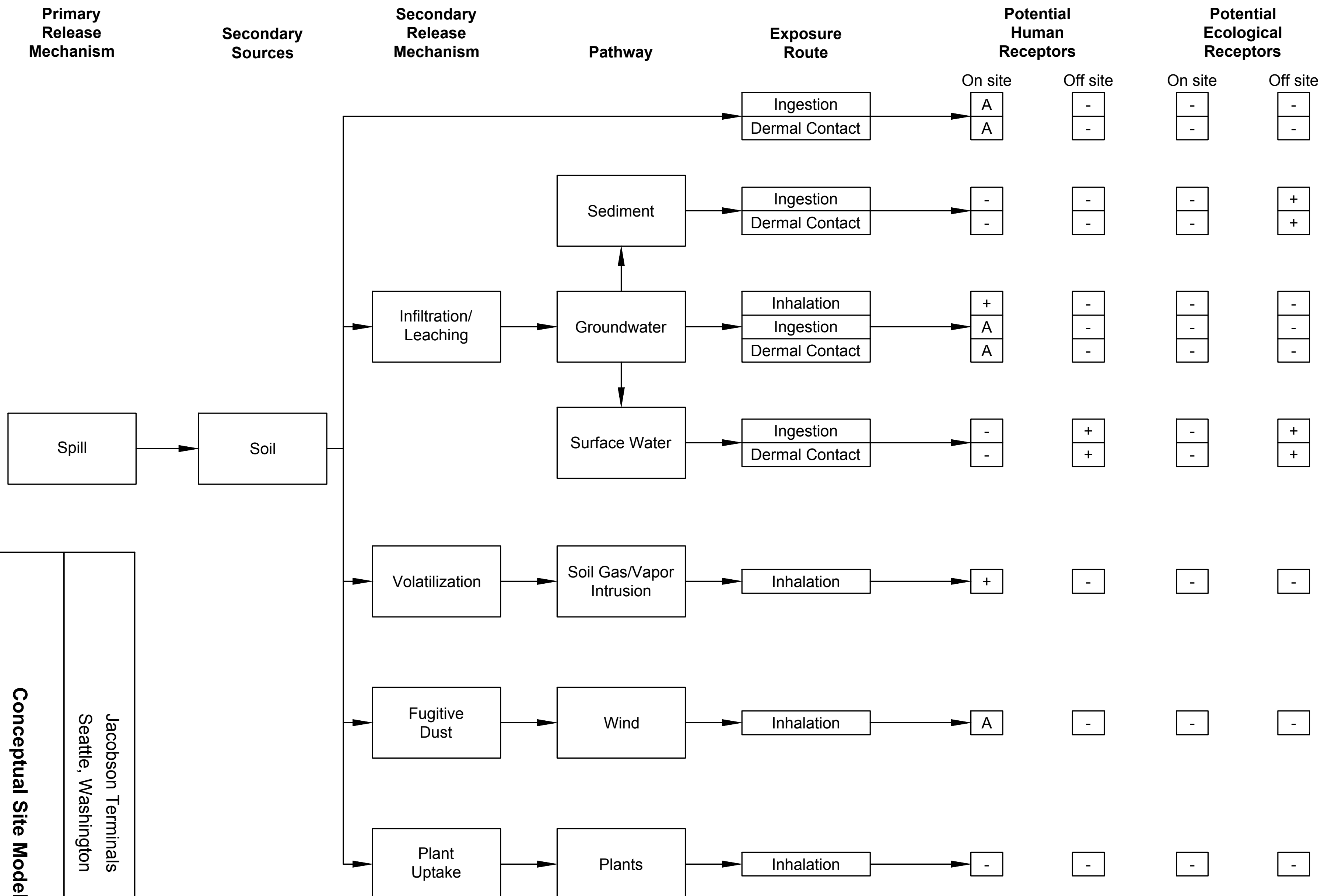
Figure
2

L:\Notebook\17800\56_Jacobson Terminal Property RI-FS\GIS\Documents\Updates_032015\17800S6-AA (SPlan).mxd



+ Potentially complete pathway

\- Incomplete pathway

A Pathway potentially complete when digging in soil or groundwater

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Conceptual Site Model

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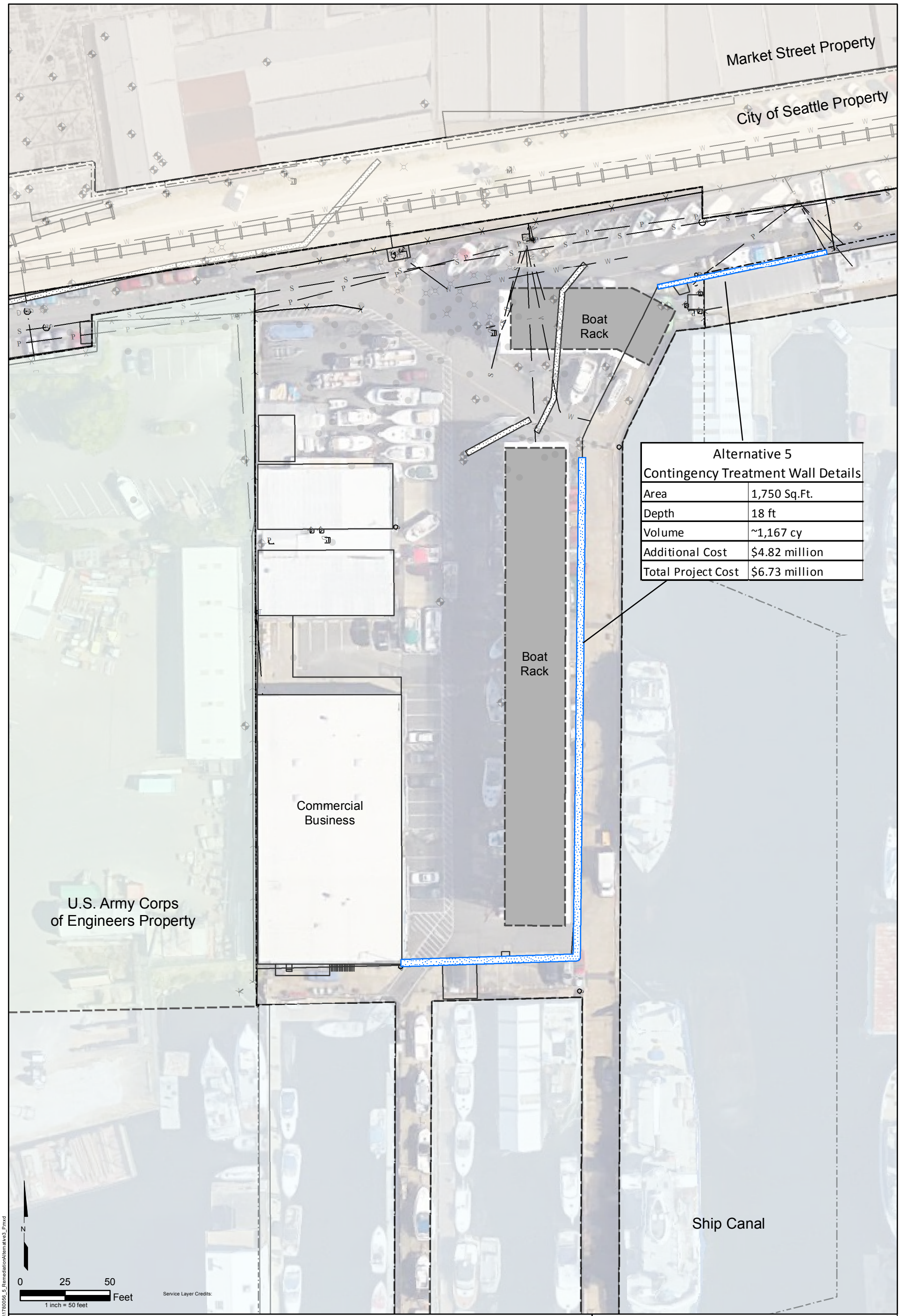
Figure **3**



Proposed Treatment Wall

- Fence Line
- Property Boundary
- Utility Line
- Water Line
- Sanitary Sewer Line
- Overhead Power
- Historical Soil Boring
- Historical Sediment Sample
- Injection Well
- Existing Monitoring Wells

Notes:
1. Base map prepared from AutoCAD file 020030-02.dwg by Aspect Consulting, 10/08/13.
2. Utility locations are approximate.

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Alternative 5 – Treatment Wall Area

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Figure **5**

L:\Notebooks\17800056_Jacobson Terminal Property RI-FS\GIS\docs\17800056_5_RemediationAlternative3_P.mxd

Market Street Property

City of Seattle Property

Area 4:
JT-US-53
8ft. | 296 cy

Interim Action Area

Area 3:
JT-US-46
18ft. | 766 cy

Boat Rack

Area 2:
MW-4/JT-US-39
8ft. | 214 cy

Area 1:
JT-MW-07S
10ft. | 701 cy

Alternative 5 Excavation Area Details	
Area	4,800 Sq.Ft.
Depth	8 to 18 ft
Volume	~2,000 cy
Estimated Cost	$1.91 million

Commercial Business

Boat Rack

U.S. Army Corps of Engineers Property

Ship Canal

N

0 25 50 Feet

1 inch = 50 feet

Service Layer Credits:

Contamination Hot Spots

Area 4:
JT-US-53
8ft. | 296 cy

Hot Spot ID

Excavation Depth

Excavation Volume

Fence Line
Property Boundary
Utility Line
Water Line
Sanitary Sewer Line
Overhead Power
Historical Soil Boring
Historical Sediment Sample
Injection Well
Existing Monitoring Wells

Notes:
1. Base map prepared from AutoCAD file 020030-02.dwg by Aspect Consulting, 10/08/13.
2. Utility locations are approximate.

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Alternative 5 – Hot Spot Excavation Areas

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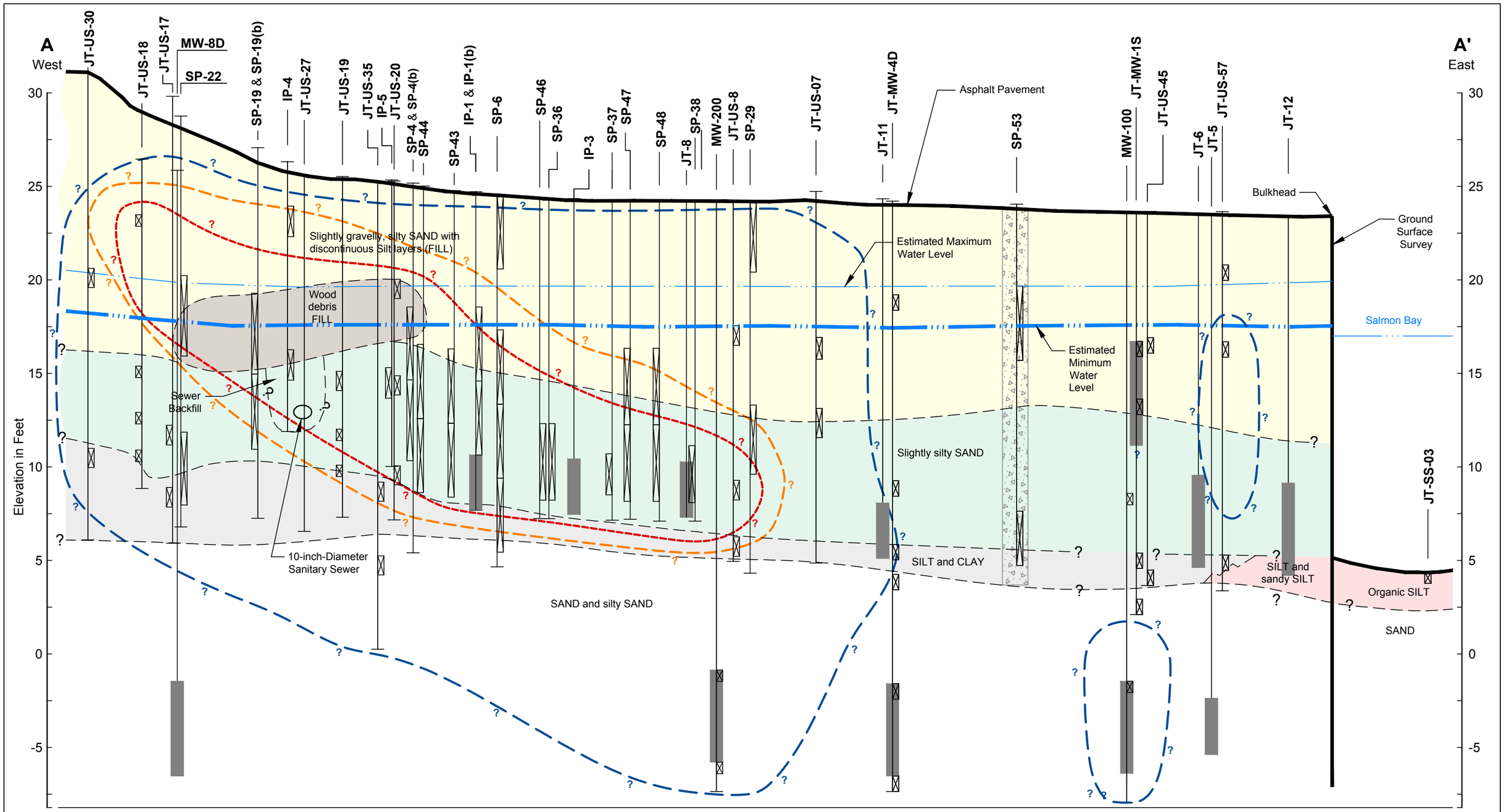
Figure
4

L:\Notebooks\17800056_Jacobson Terminal Property RI-FS\GIS\docs\17800056_4_ContaminationHotSpots_P.mxd



MW-8D Selected Exploration

Sample

Screened Interval

? Approximate Area of PCB Concentrations above Method A Industrial Cleanup (10 mg/kg)

? Approximate Area of PCB Concentrations above Method A Unrestricted Cleanup Level (1 mg/kg)

? Approximate Area of PCB Concentrations above Method B Surface Water Protection Screening Level (0.000079 mg/kg) and PQL

ZVI/GAC Groundwater Treatment Wall

? — — — Geologic Contact (Approximate)

Horizontal Scale in Feet
0 15 30
0 5 10
Vertical Scale in Feet
Vertical Exaggeration x 3

Notes:

1. Contacts between soil units are based on interpolation between borings and represent our interpretation of subsurface conditions based on currently available data.
2. Cross section developed from AutoCAD files provided by Aspect, dated 12/2005.
3. Elevation shown in City of Seattle vertical datum.

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Generalized Geologic Cross Section A-A'

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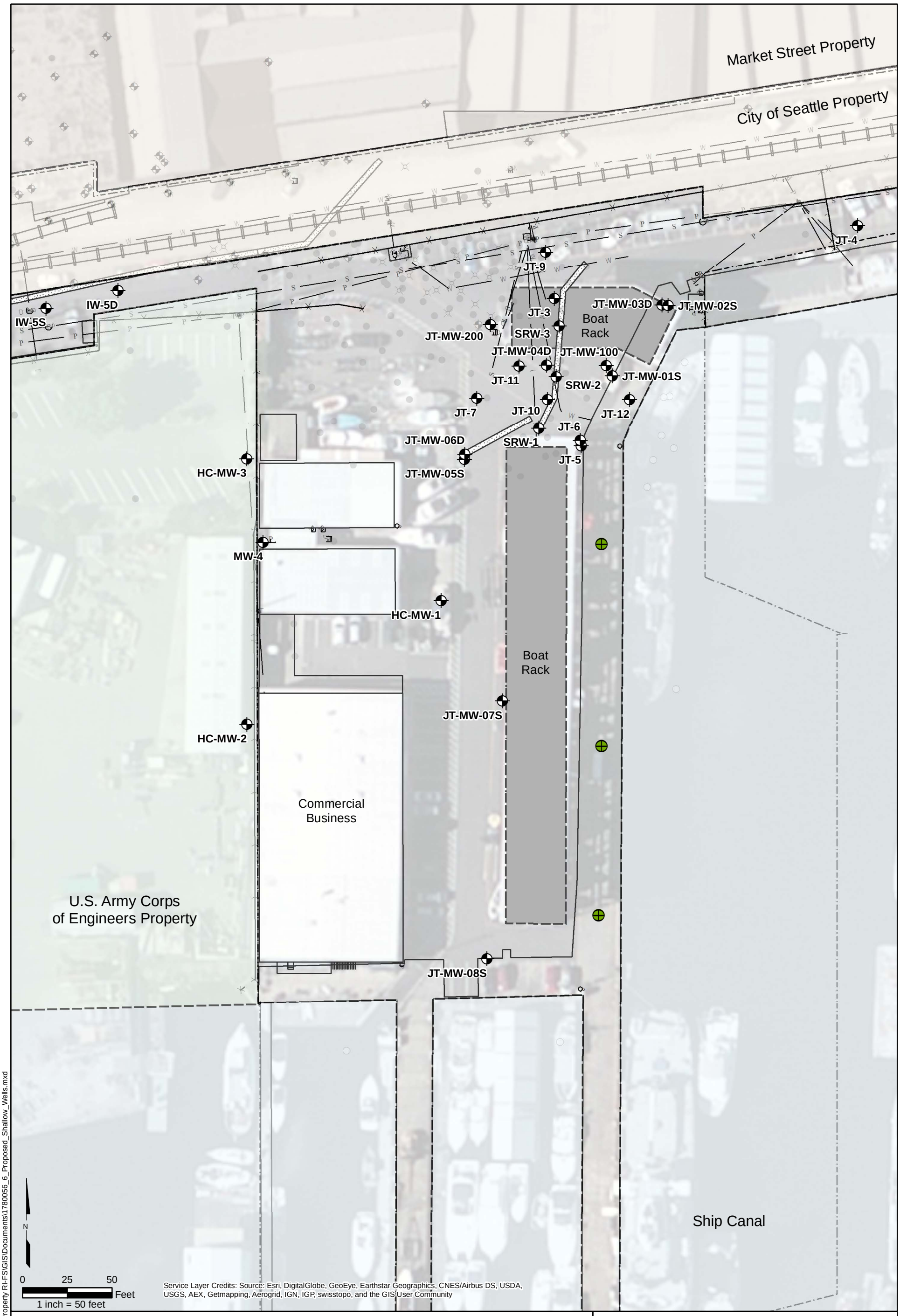
Figure 6

EAL 09/28/15 1780056-001 (XSec).dwg



LEGEND

- Monitoring Well
- Proposed Shallow Monitoring Well
- Fence Line
- Property Boundary
- Utility Line
- Water Line
- Sanitary Sewer Line
- Overhead Power
- Historical Soil Boring
- Historical Sediment Sample
- Injection Well
- Existing Monitoring Wells

Notes:
1. Base map prepared from AutoCAD file 020030-02.dwg by Aspect Consulting, 10/18/13.
2. Utility locations are approximate.
3. Elevations shown in City of Seattle datum.

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Proposed Shallow Groundwater Monitoring Wells

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Figure **7**

L:\Notebooks\17800056_Jacobson Terminal Property RI-FS\GIS\Documents\17800056_6_Proposed_Shallow_Wells.mxd