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Feasibility Study Addendum

B36 Area, Tacoma Metals Site
Tacoma, Washington

Table of Contents

List of Appendices

List of Tables

List of Figures

List of Acronyms

AOC	area of contamination
ARARs	applicable or relevant and appropriate requirements
bgs	below ground surface
CAP	cleanup action plan
COCs	chemicals of concern
cPAH	carcinogenic polynuclear aromatic hydrocarbon
DCA	disproportionate cost analysis
DNAPL	dense non-aqueous phase liquid
Ecology	Washington State Department of Ecology
FS	feasibility study
KJC	Kennedy/Jenks Consultants
MTCA	Model Toxics Control Act
MW	monitoring wells
PAHs	polynuclear aromatic hydrocarbons
POC	point of compliance
PRSC	Puyallup River Side Channel
RI	remedial investigation
sf	square feet
TEE	terrestrial ecological evaluation
TPH	total petroleum hydrocarbons
VOC	volatile organic compound
WAC	Washington Administrative Code

Executive Summary

The Washington State Department of Ecology (Ecology) has agreed to the development of a feasibility study (FS) addendum to supplement a remedial investigation (RI)/FS report for the Tacoma Metals Site (Site) produced by Kennedy/Jenks Consultants (KJC). International Paper Company (International Paper) prepared this FS addendum to develop and evaluate two additional cleanup action alternatives to compare with the excavation alternative selected for the B36 Area in the revised augmented RI/FS report (KJC 2014). The three cleanup action alternatives evaluated for the B36 area in this FS addendum include a revised excavation alternative, an *in situ* solidification alternative, and a multi-component alternative consisting of shallow soil excavation, fill placement, and paving with low-permeability asphalt. This FS addendum documents the evaluation of these alternatives in accordance with Washington State Model Toxics Control Act (MTCA) regulations.

The first section of the FS addendum provides a description of the Site (including the off-property parcels and their location); the exposure pathways and cleanup standards previously developed in the revised augmented RI/FS report (KJC 2014); and recent investigation results for the B36 Area, located on two of the off-property parcels. The second section presents the cleanup action goals, the quantity and location of environmental media requiring cleanup, and the development and description of the cleanup action alternatives that address the cleanup action goals for the B36 Area. The final section of this FS addendum provides the evaluation and comparison of the three cleanup action alternatives; the results of the disproportionate cost analysis (DCA) performed on those alternatives in accordance with Washington Administrative Code (WAC) 173-340-360(3)(e); and selection of the preferred cleanup action alternative for the B36 Area of the Site. *In situ solidification* is the selected preferred cleanup action alternative for the B36 Area, based on the investigation results, the cleanup goals, and this evaluation of cleanup action alternatives.

1 Introduction

The Washington State Department of Ecology (Ecology) has agreed to the development of a feasibility study (FS) addendum to supplement a remedial investigation (RI)/FS report for the Tacoma Metals Site (Site) produced by Kennedy/Jenks Consultants (KJC). International Paper Company (International Paper) prepared this FS addendum to develop and evaluate two additional cleanup action alternatives to compare with the excavation alternative selected for the B36 Area in the revised augmented RI/FS report (KJC 2014). This FS addendum documents the evaluation of these alternatives in accordance with Washington State Model Toxics Control Act (MTCA) regulations.

This section provides a brief description of the Tacoma Metals Site including the off-property parcels and their location, the exposure pathways and cleanup standards that were previously developed in the revised augmented remedial investigation/feasibility study (RI/FS) report (KJC 2014), and recent investigation results for the B36 Area, located on two of the off-property parcels.

1.1 Off-Property Parcel Locations and Descriptions

The Tacoma Metals Site (Site) is located at 1919 Portland Avenue in Tacoma, Washington, in an industrial-zoned area within the Tacoma Tideflats (refer to Figure 1-1). The Site is bounded to the northeast by the Puyallup River, to the southeast by the Lincoln Avenue Bridge, which crosses the Puyallup River, to the southwest by Portland Avenue, and to the northwest by the off-property parcels. The off-property parcels include the City of Tacoma right-of-way and two private (Simpson and JJ Port) properties. The City of Tacoma right-of-way is located immediately northwest of the Site, the Simpson property is located adjacent to and northwest of the City of Tacoma right-of-way, and the JJ Port property is located adjacent to and northwest of the Simpson property (Figure 1-1). The Tacoma Metals property measures approximately 5.9 acres. The three off-property parcels including the City of Tacoma right-of-way, the Simpson property, and the JJ Port property measure approximately 0.4, 0.6, and 0.7 acres, respectively. This FS addendum addresses the B36 Area, which is located primarily on the Simpson property and to a lesser extent on the JJ Port property (Figure 1-2).

Historically, the Site and the off-property parcels have been used for industrial land uses including St. Paul & Tacoma Lumber mill facilities, a coke manufacturing plant, and a metals recycling facility. The St. Paul & Tacoma Lumber mill facilities extended from the northwestern portion of the Site to the northwestern property boundary of the JJ Port property including the Simpson property. Two above-ground storage tanks were located on the Simpson property with capacities of 102,000 and 450,000 gallons. Other facilities that were located on the Simpson property include an overhead crane, a rail spur, and elevated structures of unknown purpose that were identified in historical aerial photographs and site plans. A creosoting plant located in the northwest portion of the Tacoma Metals property (referred to as the Creosoting Plant Area) appears to have been constructed in the late 1900s to the early 1910s and appears to have been operational until the late 1920s to early 1930s. Coking operations occurred in the 1940's on the Tacoma Metals Property, including the Creosoting Plant Area. No structures are currently present on the Simpson property. Two buildings are located on the JJ Port property, and the area surrounding the buildings is used for parking vehicles and storing equipment.

The Simpson property has relatively level topography with an average elevation of approximately 10 feet above mean sea level. The elevation drops several feet immediately adjacent to the northwest property boundary. Therefore, the elevation of the JJ Port property is typically several feet lower than the elevation of the Simpson property. Soil materials encountered in the vicinity of the B36 Area have included sandy- and gravelly-fill materials (typically with varying quantities of wood, metal, or other debris), woody debris with and without matrix material (typically silt and sand), and native materials including sand, silt, and clay. The flow direction in shallow groundwater at the Site is influenced by tidal fluctuations in the Puyallup River and varies between high- and low-tide cycles. At low tide, the flow direction is generally toward the Puyallup River; and at high tide, the flow direction is generally toward the Site, away from the Puyallup River. The magnitude of the shallow groundwater gradient is greater during low-tide conditions than during high-tide conditions, resulting in an overall net gradient towards the Puyallup River. Depth to shallow groundwater varies with tidal levels. Saturated conditions are generally encountered at approximately 8 to10 feet below ground surface (bgs).

Over the years, several modifications have been made to the Puyallup River channel. The Puyallup River channel was modified by construction of an earthen levee by the U.S. Army Corps of Engineers in the late 1940s and 1950s. Prior to construction of the levee, the southwestern bank of the river adjoined the northeastern boundary of the Site. During construction of the levee, the course of the river was shifted to the northeast, and a portion of the former Puyallup River channel located adjacent to the Tacoma Metals Property and the off-property parcels was isolated from the main channel. The former channel area, referred to as the Puyallup River side channel (PRSC), was gradually filled over time primarily with wood-waste material.

The original levee remained intact until 2005, when the PRSC estuary habitat was constructed by the City of Tacoma. The wood-waste material that had accumulated in the former channel area was removed, and the original levee was breached to flood the former channel area. The course of the Puyallup River was not modified; portions of the original levee remained intact and were lowered to preserve the main channel, but an estuary habitat was created within the former channel area. A new levee was constructed immediately northeast of the Tacoma Metals Property and off-property parcels, between the Site and the PRSC.

1.2 RI/FS Report Exposure Pathways and Cleanup Standards

The conceptual site model was originally presented in the RI/FS report (KJC 2001), and was updated in the revised augmented RI/FS report (KJC 2014). Chemical migration pathways identified in the RI/FS report included vertical migration through the vadose zone to shallow groundwater, and horizontal migration in the shallow groundwater zone both towards and away from the Puyallup River due to tidal fluctuation. The augmented RI/FS report further evaluated the chemical migration pathways and concluded that the fine-grained unit appears to have acted as a barrier to downward migration of chemicals of concern (COCs) in the former Creosoting Plant Area and also appears to have influenced the lateral migration of COCs from the former Creosoting Plant Area towards the northeast and north. The COCs appear to be associated with dense non-aqueous phase liquid (DNAPL) observed in wood-waste fill and native soil materials as small globules, mainly at locations at or near the former Creosoting Plant Area. DNAPL is also present as thin stringers along the base of the wood-waste fill and along the upper surface of the fine-grained unit.

COCs do not appear to have migrated significantly beyond the northeastern site boundary, and impacts to shallow groundwater were not identified along the southwestern margin of the PRSC in the 2010/2011 PRSC investigation (KJC 2012). These findings indicate that the potential groundwater to surface water and groundwater to sediment chemical migration pathways are currently incomplete for the Site and are not likely to become complete in the future because creosote and coke were last used at the Site approximately 65 years ago.

Exposure pathways identified in the revised augmented RI/FS report applicable to the B36 Area include:

- Direct contact with soil and groundwater located at depths less than 15 feet bgs by workers performing subsurface construction
- Direct contact with soil located at depths less than 6 feet bgs by wildlife

Note that the groundwater ingestion pathway is incomplete because shallow groundwater is not a potable water source.

The preliminary cleanup standards listed in this section have not yet been approved by Washington State Department of Ecology (Ecology) as final cleanup standards for the Site. Final cleanup standards will be established in the cleanup action plan (CAP). However, Ecology expects that cleanup standards will be *"…initially established during the scoping of the remedial investigation and may be further refined during the remedial investigation and/or feasibility study"* per WAC 173-340-350(9)(a).

WAC 173-340-700(3) defines the term "cleanup standards" as follows:

"Cleanup standards shall consist of the following:

- Cleanup levels for hazardous substances present at the site
- The location where these cleanup levels must be met (point of compliance [POC])

- Other regulatory requirements that apply to the site because of the type of action and/or location of the site ('applicable state and federal laws')"

The revised augmented RI/FS report proposed cleanup levels for the Site (see Table 3 of that document) based on those originally identified in the initial RI/FS report (KJC 2001) and the findings of the Cleanup Level Evaluation (KJC 2007) and Terrestrial Ecological Evaluation (TEE) (KJC 2010). Soil cleanup levels for the Site assumed an industrial land use and are based on Model Toxics Control Act (MTCA) Method C values. If MTCA Method C values were not available, then the MTCA Method A values for industrial land use were used. The Cleanup Level Evaluation included a human health risk evaluation, which incorporated the findings of investigation activities performed since completion of the RI. The TEE included an assessment of potential exposure to wildlife including risk-based screening against the ecological indicator soil concentrations for protection of wildlife in MTCA Table 749-3 (KJC 2010).

Cleanup standards for groundwater in the revised augmented RI/FS report are based on protection of surface water in accordance with Washington Administrative Code (WAC) 173-340-730(1)(a) and WAC 13-340-720(8)(d)(i) because groundwater discharges to surface water adjacent to the Site and groundwater or surface water are not a current or potential sources of potable water.

Cleanup levels identified in the revised augmented RI/FS report are used as the preliminary soil cleanup levels for the B36 Area, and are included in Table 1-1. Preliminary soil cleanup levels are only included in Table 1-1 for the COCs identified at the B36 Area (see Section 1.3 for further information on identification of COCs at the Site), which includes those chemicals that exceeded the MTCA Method C values, the MTCA Method A values if no Method C value is available, or the protection of wildlife value for soils located at depths less than 6 feet bgs. Soil cleanup levels for protection of groundwater are not appropriate for the Site because groundwater is not a potential source of potable water and groundwater with concentrations exceeding surface water cleanup levels has not migrated to the PRSC in approximately 65 years since creosoting and coking operations ceased at the Site (see WAC 173-340-747(9)). Because of this very long timeframe, migration of COCs to surface water is also not expected to occur in the future. As presented in the forensic evaluation (Friedman & Bruya 2007), petroleum standards are not appropriate for the Site because hydrocarbon compounds detected in groundwater are from a pyrogenic (formed by heat), rather than a petrogenic (formed by rock), source. The conditional POC for site groundwater is located along the northeastern property boundary.

1.3 October 2014 B36 Area Investigation Results

During the initial RI, impacts to environmental media related to former site use as a metals recycling facility were evaluated and fully characterized. However, additional historical site uses including creosoting and coking operations were identified during the initial RI in the western portion of the Site. Impacts to environmental media related to polynuclear aromatic hydrocarbons (PAHs) were identified during the initial RI but not fully characterized. Therefore, a supplemental RI was performed between 2002 and 2011 to evaluate and characterize potential impacts to environmental media related to PAHs. The supplemental RI work area included the JJ Port and Simpson properties and the bank area adjacent to the PRSC. The supplemental RI was performed in phases, with each phase of work approved by Ecology prior to implementation.

During the supplemental RI, PAH-impacted soil was identified in one boring (B36) located on the Simpson property at depths less than 15 feet bgs. Based on this, additional investigation work was performed in the vicinity of boring B36 to determine the extent of impacts. During this additional investigation, 22 borings (B48 through B69) were drilled in early October 2014 (10/7/2014 and 10/8/2014), and an additional 11 borings (B70 through B80) were drilled in late October 2014 (10/30/14) [Figure 1-2]. Boring logs for these new boring locations are included in Appendix A. Between one and three soil samples were collected from each borehole by KJC, at depths ranging from 3.5 to 18 feet, and were analyzed for total petroleum hydrocarbons (TPH)-diesel, TPH-oil, and PAHs. In addition, samples from one borehole (B69) were analyzed for volatile organic compounds (VOCs). Analytical results for these new boreholes are included in Table 1-2. Analytical results for soil samples collected at the Simpson property in February 2006 and October 2007 as part of the supplemental RI, including samples collected from B36, are also included in Table 1-2 for completeness. Boring logs for these locations (B31 and B34 through B39) are also included in Appendix A.

During the October 2014 investigation events, AECOM collected split samples from the same soil sampling locations and depth intervals as KJC. To confirm KJC's analytical results, AECOM had a small subset of those split samples analyzed by ALS Environmental (ALS), located in Kelso, Washington in 2014. Dibenzofuran was included in ALS' reporting list, and dibenzofuran results are included in Table 1-2 for this subset of samples in addition to results for the other analytes reported by KJC's laboratory. During the development of this FS addendum, locations that had been previously sampled but not analyzed were identified for analysis to help further delineate treatment areas and volumes. In particular, PAH data were not available for some locations where TPH concentrations exceeded preliminary cleanup levels and at shallow soil sampling locations where deeper soil sampling locations exceeded preliminary cleanup levels. Therefore, AECOM performed additional analyses in 2015 on samples collected in October 2014 that had been stored frozen at ALS's laboratory. These analytical results are also provided in Table 1-2 and are flagged with "J" flags because they were analyzed outside of the recommended holding time. All ALS laboratory data were validated by AECOM chemists, and the data validation report is included as Appendix B. ALS laboratory reports are included as Appendix C.

Concentrations of carcinogenic PAHs (cPAHs) exceed the preliminary soil cleanup levels in the B36 Area at some locations (see Table 1-2). Although petroleum cleanup levels are not appropriate for the Site because hydrocarbon compounds detected at the Site are from a pyrogenic source as presented in the forensic evaluation (Friedman & Bruya 2007), they are indicative of the presence of cPAHs. Therefore, for locations where only TPH data is available, exceedances of the TPH MTCA Method A industrial soil cleanup levels are considered indicative of an exceedance of the cPAH cleanup level. The total area of soil located at depths less than 15 feet bgs with concentrations of TPH-diesel, TPH-oil, and/or cPAHs exceeding the preliminary soil cleanup levels is shown on Figure 1-3. Lithological information from the soil borings, along with the analytical results, was used to develop profiles for the area exceeding preliminary soil cleanup levels along two transects: AA-AA' and BB-BB'. Boring logs for all locations included in the two profiles are included in Appendix A, including B31 which is located in the City of Tacoma right-of-way. The locations of the two transects are shown on Figure 1-3, and the two profiles are shown on Figure 1-4.

Table 1-1. Preliminary Soil Cleanup Levels, B36 Area, Tacoma Metals Site

Chemicals of Concern	MTCA Method A Industrial Soil Cleanup Level (mg/kg)[a]	MTCA Method C Industrial Soil Cleanup Level (mg/kg)[a]	Protection of Wildlife (mg/kg)[b]	Preliminary Cleanup Levels (mg/kg)
TPH[c]				
Diesel	2,000	NA	6,000	2,000
Oil	2,000	NA	NA	2,000
Polynuclear Aromatic Hydrocarbons				
cPAHs[d]	2	18	12	12 (< 6 feet bgs) 18 (6 to 15 feet bgs)

Notes:
[a]Cleanup levels obtained from Ecology's CLARC database in March 2015. Only applies to soil located at depths less than 15 feet bgs.
[b]Direct contact for protection of wildlife based on the TEE (KJC 2010). Only applies to soil located at depths less than 6 feet bgs.
[c]Although petroleum cleanup levels are not appropriate for the Site because hydrocarbon compounds detected at the Site are from a pyrogenic source as presented in the forensic evaluation (Friedman & Bruya 2007), they are indicative of the presence of cPAHs.
[d]Benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, chrysene, benzo(k)fluoranthene, benzo(b)fluoranthene, benzo(a)anthracene, with the TTEC of these compounds compared to the cleanup level using the Toxicity Equivalency Factor methodology of WAC 173-340-708(8)(e) and values listed in Table 708-2 (MTCA 2007).

bgs - below ground surface
CLARC - Cleanup Levels and Risk Calculation
cPAH - carcinogenic polynuclear aromatic hydrocarbons
KJC - Kennedy/Jenks Consultants
mg/kg - micrograms per kilogram
MTCA - Model Toxics Control Act
NE - not established
TEE - terrestrial ecological evaluation
TPH - total petroleum hydrocarbons
TTEC - total toxic equivalent concentration
WAC - Washington Administrative Code

Table 1-2. Soil Analytical Results for B36 Area, Tacoma Metals Site

Sample ID:	MTCA Cleanup Level		Protection of Wildlife[8]	B34			B35			B36			B37			B38			B39		
Depth (feet bgs):				7-8	18-19	30-31	6-7	32-33	39-40	8-10	23-24	31-32	5-6	14-15	21-22	5-6	14.5-15.5	22.5-23.5	5.5-6.5	10-11	21-22
Date Sampled:	Method A	Method C	(<6 ft bgs)	Feb-2006	Feb-2006	Feb-2006	Feb-2006	Feb-2006	Feb-2006	Feb-2006	Feb-2006	Feb-2006	Oct-2007	Oct-2007	Oct-2007	Oct-2007	Oct-2007	Oct-2007	Oct-2007	Oct-2007	Oct-2007
TPH (mg/kg)																					
Diesel	2,000	NE	6,000	58.6 [6]	13.7 U	18.5 [7]	19.5 [6]	18.6 [7]	16.4 [7]	1,060 [7]	**14,900** [7]	**8,830** [7]	50 U	50 U	50 U	50 U	50 U	50 U	120	50 U	200
Oil	2,000	NE	NE	305	34.3 U	31.1 U	138	29.5 U	29.2 U	1,690	3,100 U	1,210 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U	250 U
PAHs (mg/kg)																					
1-Methylnaphthalene	NE	4,530	NE	0.118 U	0.0140 U	0.282	0.148 U	1.02	0.363	7.59 U	819	501	NR	NR	NR	NR	NR	NR	NR	NR	NR
2-Methylnaphthalene	NE	14,000	NE	0.118 U	0.0140 U	0.0127 U	0.148 U	0.890	0.170	7.59 U	25.1 U	88.2	NR	NR	NR	NR	NR	NR	NR	NR	NR
Acenaphthene	NE	210,000	NE	0.118 U	0.188	0.589	0.148 U	1.34	1.00	16.9	1,600	1,490	0.01 U	0.080	0.032	0.01 U	0.10	0.41	0.51	1.1	0.41
Acenaphthylene	NE	NE	NE	0.118 U	0.0140 U	0.0127 U	0.0385 J	0.0588 U	0.0600 U	7.59 U	25.1 U	22.1 J	0.01 U	0.01 U	0.01 U	0.011	0.01 U	0.01 U	0.12	0.01 U	0.11
Anthracene	NE	1,050,000	NE	0.118 U	0.0140 U	0.354	0.860 J	0.163	0.132	20.0	417	2,540	0.01 U	0.01 U	0.01 U	0.040	0.033	0.015	0.61	0.47	2.6
Benzo[a]anthracene[1]	NE	NA[1]	NE	0.448	0.0217	0.0284	0.332	0.0588 U	0.0600 U	71.7	403	296	0.01 U	0.01 U	0.01 U	0.18	0.01 U	0.01 U	0.99	0.019	6.7
Benzo[a]pyrene[1]	2	NA[1]	NE	0.491	0.0158	0.0102 J	0.755	0.0588 U	0.0600 U	88.8	271	151	0.01 U	0.01 U	0.01 U	0.24	0.01 U	0.01 U	1.3	0.01 U	4.2
Benzo[b]fluoranthene[1]	NE	NA[1]	NE	0.474	0.0217	0.00491 J	0.752	0.0588 U	0.0600 U	73.2	215	145	0.018	0.01 U	0.01 U	0.33	0.01 U	0.01 U	2.0	0.01 U	5.0
Benzo[g,h,i]perylene	NE	NE	NE	0.244	0.00814 J	0.0127 U	0.513	0.0588 U	0.0600 U	26.0	60.3	50.4	0.013	0.01 U	0.01 U	0.095	0.01 U	0.01 U	0.83	0.01 U	1.5
Benzo[k]fluoranthene[1]	NE	NA[1]	NE	0.481	0.0225	0.00169 J	0.631	0.0588 U	0.0600 U	78.0	245	135	0.01 U	0.01 U	0.01 U	0.13	0.01 U	0.01 U	0.62	0.01 U	1.9
Chrysene[1]	NE	NA[1]	NE	0.519	0.0300	0.0154	0.993	0.0588 U	0.0600 U	114	281	507	0.016	0.01 U	0.01 U	0.27	0.01 U	0.01 U	1.7	0.012	9.4
Dibenzo[a,h]anthracene[1]	NE	NA[1]	NE	0.229	0.0154	0.0127 U	0.343	0.0588 U	0.0600 U	22.1	58.3	97.7	0.01 U	0.01 U	0.01 U	0.022	0.01 U	0.01 U	0.24	0.01 U	0.58
Dibenzofuran	NE	3,500	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	NE	140,000	NE	1.120	0.0369	0.534	0.247	0.241	0.291	103	1,690	1,560	0.016	0.01 U	0.01 U	0.21	0.049	0.017	1.2	1.3	18
Fluorene	NE	140,000	NE	0.118 U	0.0297	0.569	0.148 U	1.08	0.725	7.59 U	1,290	1,570	0.01 U	0.01 U	0.01 U	0.01 U	0.089	0.01 U	0.39	1.3	0.40
Indeno[1,2,3-cd]pyrene[1]	NE	NA[1]	NE	0.330	0.0215	0.0127 U	0.550	0.0588 U	0.0600 U	31.7	82.7	101	0.011	0.01 U	0.01 U	0.12	0.01 U	0.01 U	1.0	0.01 U	1.9
Naphthalene	5	70,000	NE	0.118 U	0.00992 J	0.0539	0.0504 J	1.93	0.658	1.62 J	204	296	0.020	0.01 U	0.01 U	0.015	0.01 U	0.01 U	1.8	0.24	0.01 U
Phenanthrene	NE	NE	NE	0.401	0.0221	1.020	0.122 J	1.47	1.08	19.1	3650	4050	0.011	0.01 U	0.01 U	0.034	0.13	0.060	1.3	1.90	2.1
Pyrene	NE	105,000	NE	0.671	0.0293	0.328	0.274	0.105	0.122	136	1,550	1,150	0.016	0.01 U	0.01 U	0.44	0.027	0.028	1.1	0.770	15
TTEC[1]	2	18	12	0.692	0.0264	0.0139	1.03	0.0588 U	0.0600 U	**118**	**374**	**234**	0.00306	0.01 U	0.01 U	0.321	0.01 U	0.01 U	1.8	0.0020	5.9
VOCs (mg/kg)																					
Benzene	0.03	2,400	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	6	350,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methyl tert-butyl ether	0.1	73,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	7	280,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Xylenes	9	700,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

Bold indicates the detected analyte exceeds MTCA Method C, MTCA Method A if no MTCA Method C is available, or the protection of wildlife cleanup level for soil located at less than 6 ft bgs.

Model Toxics Control Act (MTCA) Cleanup Regulation, WAC 173-340. MTCA Method A, B, and C soil values are from Ecology website CLARC tables downloaded October 2014 (https://fortress.wa.gov/ecy/clarc/CLARCDataTables.aspx).

[1] Carcinogenic PAH (cPAH) cleanup levels under MTCA are based on the calculated total toxicity of the mixture using the Toxicity Equivalency Methodology in WAC 173-340-708(8).
The mixture of cPAHs shall be considered a single hazardous substance and compared to the applicable MTCA Method B or C cleanup levels for benzo(a)pyrene.
TTEC was calculated using only results reported as detected.

[2] Sample contains diesel range organics that appear to be mineral spirits or kerosene

[3] Sample appears to be weathered creosote

[4] Sample appears to be creosote

[5] DUP-B100 is a field duplicate of sample B56

[6] Results in the diesel organics range are primarily due to overlap from heavy oil range.

[7] The sample chromatographic pattern does not resemble the fuel standard used for quantitation.

[8] Direct contact for protection of wildlife based on the TEE (Kennedy/Jenks Consultants 2010). Only applies to soil located at depths less than 6 feet bgs.

[9] Result reported from sample collected by AECOM and analyzed by ALS Environmental located in Kelso, Washington.

[10] Result reported from sample collected by AECOM and analyzed outside hold time by ALS Environmental located in Kelso, Washington.

[11] The soil recovery in this boring was between 2 to 3 feet per 5 feet of boring depth. Therefore, sample depth intervals are estimated. Although the sample collection interval was logged as 5 to 7 feet bgs, after further review of field logs and field notes it is more likely that this sample was actually collected between 5 and 8 feet bgs.

-- Not analyzed
bgs - below ground surface
J - estimated result
NA - not applicable
NE - not established
NR - not reported
PAHs - polynuclear aromatic hydrocarbons
TPH - total petroleum hydrocarbons
TTEC - Total Toxic Equivalent Concentration (sum of cPAH concentrations multiplied by their respective toxicity equivalency factors [TEFs] per WAC 173-340-708(8)(e))
U - Compound was analyzed for but not detected above the reporting limit shown.
VOC - volatile organic compound

Table 1-2. Soil Analytical Results for B36 Area, Tacoma Metals Site (Continued)

Sample ID:	MTCA Cleanup Level		Protection of Wildlife[8]	B48		B49		B50			B51		B52	B53	B54	B55			B56		DUP-B100[5]
Depth (feet bgs):				4.5-7	7-9	7	8-10	4-5	7-8	8-9	3.5-5	8.5-10	3.5-5	4-5	6-7	4-5	7.5-9	10-12	7-8.5	13-14	7-8.5
Date Sampled:	Method A	Method C	(<6 ft bgs)	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14	10/7/14
TPH (mg/kg)																					
Diesel	2,000	NE	6,000	97.9 [2]	22.3 [3]	160 J[10]	**31,800** [4]	10 U	1,150 [4]	104	182 [2]	58.9 [3]	10 U	497	33 [2]	20 U	419 [3]	661 [3]	266 [3]	156 [3]	227 [3]
Oil	2,000	NE	NE	164	166 [3]	2,000 J[10]	**40,600** [4]	199	949 [4]	50 U	354	73.2 [3]	50 U	**2,640**	236	286	750 [3]	631 [3]	1,560 [3]	184 [3]	954 [3]
PAHs (mg/kg)																					
1-Methylnaphthalene	NE	4,530	NE	0.109	0.139	0.096 J[10]	45.3	0.043 J[10]	20.1	0.408	0.077	0.147	0.033 U	0.540	0.033 U	0.016 J[10]	1.04	3.94	2.14	0.663	4.46
2-Methylnaphthalene	NE	14,000	NE	0.102	0.246	0.18 J[10]	62.2	0.069 J[10]	21.1	0.223	0.095	0.033 U	0.033 U	1.05	0.033 U	0.024 J[10]	0.821	2.87	1.93	0.410	3.64
Acenaphthene	NE	210,000	NE	0.086	0.237	0.074 J[10]	122	0.031 J[10]	51.9	1.55	0.165	0.401	0.033 U	0.851	0.059	0.010 J[10]	4.69	9.25	4.29	1.30	17.8
Acenaphthylene	NE	NE	NE	0.033 U	0.262	0.11 J[10]	2.58	0.026 J[10]	0.478	0.033 U	0.033 U	0.033 U	0.033 U	3.86	0.033 U	0.006 J[10]	1.72	0.587	0.497	0.087	0.476
Anthracene	NE	1,050,000	NE	0.456	1.18	0.96 J[10]	256	0.082 J[10]	53.8	0.124	0.227	0.080	0.033 U	6.38	0.154	0.011 J[10]	9.89	31.2	20.3	1.33	30.6
Benzo[a]anthracene[1]	NE	NA[1]	NE	0.123	3.98	1.1 J[10]	348	0.15 J[10]	43.8	0.121	0.348	0.129	0.033 U	15.4	0.181	0.033 J[10]	8.91	10.4	97.4	1.87	46.2
Benzo[a]pyrene[1]	2	NA[1]	NE	0.154	6.60	2.7 J[10]	284	0.30 J[10]	34.4	0.147	0.263	0.117	0.033 U	36.6	0.261	0.044 J[10]	19.4	10.8	18.8	2.22	46.0
Benzo[b]fluoranthene[1]	NE	NA[1]	NE	0.258	6.82	3.7 J[10]	366	0.44 J[10]	36.6	0.187	0.409	0.137	0.033 U	40.5	0.389	0.067 J[10]	26.9	12.3	18.6	2.34	58.0
Benzo[g,h,i]perylene	NE	NE	NE	0.033 U	1.76	1.3 J[10]	66.4	0.23 J[10]	14.9	0.042	0.106	0.033 U	0.033 U	12.1	0.164	0.028 J[10]	6.78	2.84	2.14	0.472	12.8
Benzo[k]fluoranthene[1]	NE	NA[1]	NE	0.081	2.60	0.78 J[10]	90.0	0.14 J[10]	14.0	0.072	0.158	0.058	0.033 U	10.5	0.119	0.021 J[10]	6.69	3.76	45.4	0.706	19.4
Chrysene[1]	NE	NA[1]	NE	0.200	8.26	4.0 J[10]	770	0.48 J[10]	62.8	0.186	0.499	0.146	0.033 U	31.4	0.327	0.075 J[10]	13.9	22.8	55.7	2.63	116
Dibenzo[a,h]anthracene[1]	NE	NA[1]	NE	0.108	0.714	0.43 J[10]	34.1	0.073 J[10]	6.29	0.033 U	0.033 U	0.033 U	0.033 U	4.57	0.053	0.0080 J[10]	0.433	1.07	13.0	0.201	6.84
Dibenzofuran	NE	3,500	NE	--	--	0.13 J[10]	13 [9]	0.033 J[10]	--	--	--	--	--	--	--	0.015 J[10]	--	--	--	--	--
Fluoranthene	NE	140,000	NE	0.783	3.45	0.92 J[10]	755	0.29 J[10]	91.9	0.338	1.03	0.317	0.033 U	16.0	0.217	0.067 J[10]	24.9	26.1	28.6	4.77	46.9
Fluorene	NE	140,000	NE	0.089	0.265	0.074 J[10]	83.9	0.025 J[10]	32.3	0.730	0.135	0.238	0.033 U	0.884	0.033 U	0.0089 J[10]	4.45	10.6	13.7	1.27	13.7
Indeno[1,2,3-cd]pyrene[1]	NE	NA[1]	NE	0.033 U	2.53	1.5 J[10]	95.4	0.22 J[10]	19.5	0.068	0.164	0.033 U	0.033 U	15.5	0.196	0.028 J[10]	8.81	3.67	6.65	0.678	18.4
Naphthalene	5	70,000	NE	0.262	0.719	0.33 J[10]	132	0.10 J[10]	28.3	0.624	0.213	0.151	0.033 U	1.56	0.101	0.039 J[10]	1.39	4.63	0.548	1.34	0.895
Phenanthrene	NE	NE	NE	0.731	2.12	0.63 J[10]	359	0.14 J[10]	131	0.480	0.694	0.204	0.033 U	2.67	0.226	0.063 J[10]	22.8	33.1	18.9	2.89	54.9
Pyrene	NE	105,000	NE	0.358	2.72	1.5 J[10]	648	0.44 J[10]	88.3	0.187	2.10	0.175	0.033 U	23.8	0.528	0.083 J[10]	18.4	16.7	30.1	1.72	50.5
TTEC[1]	2	18	12	0.213	8.35	3.5 J[10]	**385**	0.41 J[10]	**47.0**	0.194	0.376	0.151	0.033 U	**45.6**	0.358	0.060 J[10]	**24.7**	14.1	**37.5**	2.83	**62.0**
VOCs (mg/kg)																					
Benzene	0.03	2,400	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	6	350,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methyl tert-butyl ether	0.1	73,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	7	280,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Xylenes	9	700,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

Bold indicates the detected analyte exceeds MTCA Method C, MTCA Method A if no MTCA Method C is available, or the protection of wildlife cleanup level for soil located at less than 6 ft bgs.
Model Toxics Control Act (MTCA) Cleanup Regulation, WAC 173-340. MTCA Method A, B, and C soil values are from Ecology website CLARC tables downloaded October 2014 (https://fortress.wa.gov/ecy/clarc/CLARCDataTables.aspx).

[1] Carcinogenic PAH (cPAH) cleanup levels under MTCA are based on the calculated total toxicity of the mixture using the Toxicity Equivalency Methodology in WAC 173-340-708(8).
The mixture of cPAHs shall be considered a single hazardous substance and compared to the applicable MTCA Method B or C cleanup levels for benzo(a)pyrene.
TTEC was calculated using only results reported as detected.

[2] Sample contains diesel range organics that appear to be mineral spirits or kerosene

[3] Sample appears to be weathered creosote

[4] Sample appears to be creosote

[5] DUP-B100 is a field duplicate of sample B56

[6] Results in the diesel organics range are primarily due to overlap from heavy oil range.

[7] The sample chromatographic pattern does not resemble the fuel standard used for quantitation.

[8] Direct contact for protection of wildlife based on the TEE (Kennedy/Jenks Consultants 2010). Only applies to soil located at depths less than 6 feet bgs.

[9] Result reported from sample collected by AECOM and analyzed by ALS Environmental located in Kelso, Washington.

[10] Result reported from sample collected by AECOM and analyzed outside hold time by ALS Environmental located in Kelso, Washington.

[11] The soil recovery in this boring was between 2 to 3 feet per 5 feet of boring depth. Therefore, sample depth intervals are estimated. Although the sample collection interval was logged as 5 to 7 feet bgs, after further review of field logs and field notes it is more likely that this sample was actually collected between 5 and 8 feet bgs.

-- Not analyzed
bgs - below ground surface
J - estimated result
NA - not applicable
NE - not established
NR - not reported
PAHs - polynuclear aromatic hydrocarbons
TPH - total petroleum hydrocarbons
TTEC - Total Toxic Equivalent Concentration (sum of cPAH concentrations multiplied by their respective toxicity equivalency factors [TEFs] per WAC 173-340-708(8)(e))
U - Compound was analyzed for but not detected above the reporting limit shown.
VOC - volatile organic compound

Table 1-2. Soil Analytical Results for B36 Area, Tacoma Metals Site (Continued)

Sample ID:	MTCA Cleanup Level		Protection of Wildlife[8]	B57		B58		B59	B60		B61		B62		B63		B64		B65		
Depth (feet bgs):				7.5-8.5	9-12	4-5	7.5-8.5	4.5-5.5	4.5-5	9-15	7-8	13-14	4-5	8-9	4-5	10.5-11.5	7.5-8.5	14-15	3.5-4.5	8-9	17-18
Date Sampled:	Method A	Method C	(<6 ft bgs)	10/7/14	10/7/14	10/7/14	10/7/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14
TPH (mg/kg)																					
Diesel	2,000	NE	6,000	**4,440** [3]	**13,200** [4]	687 [3]	920 [3]	10 U	385	**2,910** [3]	443 [3]	17.8 [3]	10 U	44.4	24.6	94.6 [3]	325 [3]	58.5 [3]	137	358 [3]	57.6 [4]
Oil	2,000	NE	NE	**20,200** [3]	**3,510** [4]	**3,030** [3]	1,460 [3]	65.2	857	1,330 [3]	823 [3]	18.0 [3]	90	199	50 U	50.3 [3]	847 [3]	19.2 [3]	910	456 [3]	25.8 [4]
PAHs (mg/kg)																					
1-Methylnaphthalene	NE	4,530	NE	9.60	866	3.1 J[10]	12.7	0.033 U	0.270	35.2	6.82	0.069	--	0.099	--	0.205	4.70	1.40	0.303	4.24	2.17
2-Methylnaphthalene	NE	14,000	NE	13.5	1,320	3.4 J[10]	30.4	0.033 U	0.341	6.78	1.11	0.033 U	--	0.033 U	--	0.052	2.82	1.35	0.507	1.88	2.69
Acenaphthene	NE	210,000	NE	22.3	810	13 J[10]	36.1	0.033 U	0.597	109	8.76	0.380	--	0.376	--	1.97	4.46	2.22	0.469	5.59	2.89
Acenaphthylene	NE	NE	NE	10.3	7.07	3.9 J[10]	3.15	0.033 U	1.06	0.787	0.637	0.033 U	--	0.033 U	--	0.033 U	1.59	0.033 U	0.885	2.17	0.033 U
Anthracene	NE	1,050,000	NE	1,230	1,270	51 J[10]	68.4	0.033 U	1.42	190	7.13	0.342	--	0.033 U	--	1.34	11.4	2.21	3.47	5.20	2.04
Benzo[a]anthracene[1]	NE	NA[1]	NE	1,160	352	110 J[10]	84.2	0.058	3.28	40.2	11.0	0.288	--	0.033 U	--	1.13	14.8	0.454	9.23	4.70	0.463
Benzo[a]pyrene[1]	2	NA[1]	NE	1,550	209	130 J[10]	88.2	0.062	7.56	20.7	11.6	0.165	--	0.033 U	--	0.575	23.4	0.229	15.8	11.6	0.235
Benzo[b]fluoranthene[1]	NE	NA[1]	NE	1,680	222	170 J[10]	112	0.084	8.72	26.2	12.4	0.165	--	0.033 U	--	0.601	27.0	0.238	20.2	12.0	0.256
Benzo[g,h,i]perylene	NE	NE	NE	418	20.6	59 J[10]	25.4	0.033 U	1.41	2.81	2.92	0.066	--	0.033 U	--	0.144	7.60	0.072	6.92	2.70	0.068
Benzo[k]fluoranthene[1]	NE	NA[1]	NE	576	44.0	59 J[10]	37.2	0.033 U	4.39	10.6	5.60	0.064	--	0.033 U	--	0.216	10.3	0.103	5.90	4.03	0.097
Chrysene[1]	NE	NA[1]	NE	5,650	857	210 J[10]	203	0.126	4.55	69.8	25.4	0.219	--	0.033 U	--	1.11	62.4	0.487	18.2	7.43	0.629
Dibenzo[a,h]anthracene[1]	NE	NA[1]	NE	255	11.0	17 J[10]	10.8	0.033 U	0.433	1.42	1.15	0.033 U	--	0.033 U	--	0.033 U	2.86	0.033 U	1.97	0.831	0.033 U
Dibenzofuran	NE	3,500	NE	21 U[9]	280 [9]	7.7 J[10]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	NE	140,000	NE	418	894	150 J[10]	63.1	0.074	7.62	197	12.1	0.996	--	0.108	--	6.90	13.7	1.87	15.9	8.38	2.68
Fluorene	NE	140,000	NE	31.5	635	10 J[10]	40.6	0.033 U	0.508	105	7.53	0.326	--	0.169	--	1.95	3.08	1.66	0.419	5.39	2.58
Indeno[1,2,3-cd]pyrene[1]	NE	NA[1]	NE	592	30.0	65 J[10]	34.8	0.033 U	1.92	4.08	4.06	0.077	--	0.033 U	--	0.214	10.3	0.097	9.17	3.90	0.091
Naphthalene	5	70,000	NE	10.1	3,540	3.8 J[10]	1.49	0.033 U	0.611	23.8	2.72	0.033 U	--	0.159	--	0.165	5.47	2.79	1.19	4.62	3.02
Phenanthrene	NE	NE	NE	162	2,560	71 J[10]	114	0.095	1.96	420	20.5	2.03	--	0.132	--	4.17	14.3	5.15	4.85	13.7	9.79
Pyrene	NE	105,000	NE	731	856	170 J[10]	61.1	0.07	5.39	135	13.7	0.750	--	0.033 U	--	3.35	11.5	1.25	12.1	4.70	1.62
TTEC[1]	2	18	12	**2,033**	**283**	**170 J**[10]	**118**		9.48	**29.6**	15.3	0.227	--	0.033 U	--	0.802	**30.6**	0.323	**20.6**	14.2	0.332
VOCs (mg/kg)																					
Benzene	0.03	2,400	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	6	350,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Methyl tert-butyl ether	0.1	73,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	7	280,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Xylenes	9	700,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

Bold indicates the detected analyte exceeds MTCA Method C, MTCA Method A if no MTCA Method C is available, or the protection of wildlife cleanup level for soil located at less than 6 ft bgs.

Model Toxics Control Act (MTCA) Cleanup Regulation, WAC 173-340. MTCA Method A, B, and C soil values are from Ecology website CLARC tables downloaded October 2014 (https://fortress.wa.gov/ecy/clarc/CLARCDataTables.aspx).

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The mixture of cPAHs shall be considered a single hazardous substance and compared to the applicable MTCA Method B or C cleanup levels for benzo(a)pyrene.
TTEC was calculated using only results reported as detected.

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[5] DUP-B100 is a field duplicate of sample B56

[6] Results in the diesel organics range are primarily due to overlap from heavy oil range.

[7] The sample chromatographic pattern does not resemble the fuel standard used for quantitation.

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[9] Result reported from sample collected by AECOM and analyzed by ALS Environmental located in Kelso, Washington.

[10] Result reported from sample collected by AECOM and analyzed outside hold time by ALS Environmental located in Kelso, Washington.

[11] The soil recovery in this boring was between 2 to 3 feet per 5 feet of boring depth. Therefore, sample depth intervals are estimated. Although the sample collection interval was logged as 5 to 7 feet bgs, after further review of field logs and field notes it is more likely that this sample was actually collected between 5 and 8 feet bgs.

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NA - not applicable
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PAHs - polynuclear aromatic hydrocarbons
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TTEC - Total Toxic Equivalent Concentration (sum of cPAH concentrations multiplied by their respective toxicity equivalency factors [TEFs] per WAC 173-340-708(8)(e))
U - Compound was analyzed for but not detected above the reporting limit shown.
VOC - volatile organic compound

Table 1-2. Soil Analytical Results for B36 Area, Tacoma Metals Site (Continued)

Sample ID:	MTCA Cleanup Level		Protection of Wildlife[8]	B66	B67			B68		B69			B70	B71			B72			B73	
Depth (feet bgs):				8-9	4-5	8-9	9-13	4-5	13.5-15	3.5-4.5	8.5-9.5	12.5-13.5	4-5	4-5	8-9	14-15	4-5	8-9	13-14	3.5-4.5	9-10
Date Sampled:	Method A	Method C	(<6 ft bgs)	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/8/14	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14
TPH (mg/kg)																					
Diesel	2,000	NE	6,000	**7,620** [3]	20 U	10 U	130 [3]	452	10 U	1,560 [3]	**18,300** [4]	**6,970** [4]	20 U	100 U	51.9 [3]	10 U	93.2 [3]	10 U	10 U	14.3 [3]	10 U
Oil	2,000	NE	NE	**6,530** [3]	370	267	120 [3]	**2,620**	50 U	**3,570** [3]	**3,830** [4]	**2,160** [4]	50 U	205	35 [3]	50 U	**484** [3]	50 U	50 U	74 [3]	50 U
PAHs (mg/kg)																					
1-Methylnaphthalene	NE	4,530	NE	40.2	0.033 U	0.101	17.0	0.670	0.636	--	844	179	0.033 U	0.033 U	0.053	0.033 U	0.070	0.033 U	0.080	0.033 U	0.033 U
2-Methylnaphthalene	NE	14,000	NE	107	0.033 U	0.148	1.31	1.24	0.370	9.5 J[9]	1,420	292	0.033 U	0.033 U	0.033 U	0.033 U	0.113	0.033 U	0.084	0.033 U	0.033 U
Acenaphthene	NE	210,000	NE	272	0.033 U	0.206	19.9	1.26	0.389	14 J[9]	1,070	269	0.122	0.033 U	0.502	0.033 U	0.441	0.033 U	0.152	0.033 U	0.033 U
Acenaphthylene	NE	NE	NE	13.5	0.033 U	0.464	0.146	2.20	0.033 U	11 J[9]	22.5	2.13	0.033 U	0.054	0.033 U	0.033 U	0.325	0.033 U	0.033 U	0.033 U	0.033 U
Anthracene	NE	1,050,000	NE	1,980	0.086	1.62	2.99	16.9	0.527	95 J[9]	889	158	0.033 U	0.065	1.92	0.033 U	2.16	0.033 U	0.065	0.094	0.033 U
Benzo[a]anthracene[1]	NE	NA[1]	NE	407	0.095	4.88	2.01	32.6	0.033 U	200 J[9]	326	90.5	0.138	0.310	1.19	0.033 U	1.50	0.033 U	0.033 U	0.397	0.033 U
Benzo[a]pyrene[1]	2	NA[1]	NE	282	0.090	6.98	2.08	68.2	0.033 U	350 J[9]	192	52.2	0.212	0.618	0.594	0.033 U	11.1	0.033 U	0.033 U	0.741	0.033 U
Benzo[b]fluoranthene[1]	NE	NA[1]	NE	345	0.110	11.0	2.15	81.2	0.033 U	460 J[9]	210	66.5	0.301	0.878	0.744	0.033 U	16.2	0.033 U	0.033 U	1.04	0.033 U
Benzo[g,h,i]perylene	NE	NE	NE	63.8	0.033 U	1.02	0.619	27.6	0.033 U	140 J[9]	36.9	9.69	0.089	0.312	0.162	0.033 U	3.16	0.033 U	0.033 U	0.159	0.033 U
Benzo[k]fluoranthene[1]	NE	NA[1]	NE	113	0.040	5.43	0.666	23.1	0.033 U	150 J[9]	81.0	23.0	0.086	0.243	0.231	0.033 U	5.20	0.033 U	0.033 U	0.282	0.033 U
Chrysene[1]	NE	NA[1]	NE	725	0.149	12.6	2.84	84.8	0.033 U	460 J[9]	437	73.1	0.308	0.686	1.42	0.033 U	14.6	0.033 U	0.033 U	0.896	0.033 U
Dibenzo[a,h]anthracene[1]	NE	NA[1]	NE	25.8	0.033 U	0.367	0.199	8.64	0.033 U	45 J[9]	16.2	3.87	0.033 U	0.127	0.051	0.033 U	0.887	0.033 U	0.033 U	0.074	0.033 U
Dibenzofuran	NE	3,500	NE	--	--	--	--	--	--	6.0 J[9]	570 [9]	180 [9]	--	--	--	--	--	--	--	--	--
Fluoranthene	NE	140,000	NE	1,450	0.137	10.3	6.00	44.1	0.483	160 J[9]	1,250	321	0.171	0.314	10.2	0.033 U	3.67	0.033 U	0.324	0.339	0.033 U
Fluorene	NE	140,000	NE	315	0.033 U	0.274	14.7	1.36	0.805	15 J[9]	758	222	0.033 U	0.033 U	0.897	0.033 U	0.323	0.033 U	0.164	0.033 U	0.033 U
Indeno[1,2,3-cd]pyrene[1]	NE	NA[1]	NE	99.2	0.033 U	1.47	0.809	39.2	0.033 U	170 J[9]	48.9	12.8	0.118	0.403	0.212	0.033 U	4.12	0.033 U	0.033 U	0.266	0.033 U
Naphthalene	5	70,000	NE	82.3	0.033 U	0.307	8.21	2.58	1.28	4.3 J[9]	392	654	0.033 U	0.061	0.075	0.033 U	0.242	0.033 U	0.033 U	0.053	0.033 U
Phenanthrene	NE	NE	NE	1,160	0.116	2.20	21.6	10.3	1.87	28 J[9]	3,120	870	0.123	0.139	1.74	0.053	1.40	0.033 U	0.285	0.185	0.033 U
Pyrene	NE	105,000	NE	1,000	0.131	5.36	3.46	37.8	0.366	270 J[9]	977	222	0.123	0.247	5.46	0.033 U	3.81	0.033 U	0.166	0.291	0.033 U
TTEC[1]	2	18	12	**388**	0.116	9.42	2.69	**87.5**	0.033 U	**460 J[9]**	**265**	**72.6**	0.279	0.821	0.851	0.033 U	**14.0**	0.033 U	0.033 U	0.956	0.033 U
VOCs (mg/kg)																					
Benzene	0.03	2,400	NE	--	--	--	--	--	--	0.025 U	0.80 U	0.035	--	--	--	--	--	--	--	--	--
Ethylbenzene	6	350,000	NE	--	--	--	--	--	--	0.025 U	13.1	0.852	--	--	--	--	--	--	--	--	--
Methyl tert-butyl ether	0.1	73,000	NE	--	--	--	--	--	--	0.025 U	0.80 U	0.025 U	--	--	--	--	--	--	--	--	--
Toluene	7	280,000	NE	--	--	--	--	--	--	0.025 U	4.04	0.064	--	--	--	--	--	--	--	--	--
Total Xylenes	9	700,000	NE	--	--	--	--	--	--	0.050 U	32.8	1.19	--	--	--	--	--	--	--	--	--

Notes:

Bold indicates the detected analyte exceeds MTCA Method C, MTCA Method A if no MTCA Method C is available, or the protection of wildlife cleanup level for soil located at less than 6 ft bgs.

Model Toxics Control Act (MTCA) Cleanup Regulation, WAC 173-340. MTCA Method A, B, and C soil values are from Ecology website CLARC tables downloaded October 2014 (https://fortress.wa.gov/ecy/clarc/CLARCDataTables.aspx).

[1] Carcinogenic PAH (cPAH) cleanup levels under MTCA are based on the calculated total toxicity of the mixture using the Toxicity Equivalency Methodology in WAC 173-340-708(8).
The mixture of cPAHs shall be considered a single hazardous substance and compared to the applicable MTCA Method B or C cleanup levels for benzo(a)pyrene.
TTEC was calculated using only results reported as detected.

[2] Sample contains diesel range organics that appear to be mineral spirits or kerosene

[3] Sample appears to be weathered creosote

[4] Sample appears to be creosote

[5] DUP-B100 is a field duplicate of sample B56

[6] Results in the diesel organics range are primarily due to overlap from heavy oil range.

[7] The sample chromatographic pattern does not resemble the fuel standard used for quantitation.

[8] Direct contact for protection of wildlife based on the TEE (Kennedy/Jenks Consultants 2010). Only applies to soil located at depths less than 6 feet bgs.

[9] Result reported from sample collected by AECOM and analyzed by ALS Environmental located in Kelso, Washington.

[10] Result reported from sample collected by AECOM and analyzed outside hold time by ALS Environmental located in Kelso, Washington.

[11] The soil recovery in this boring was between 2 to 3 feet per 5 feet of boring depth. Therefore, sample depth intervals are estimated. Although the sample collection interval was logged as 5 to 7 feet bgs, after further review of field logs and field notes it is more likely that this sample was actually collected between 5 and 8 feet bgs.

-- Not analyzed
bgs - below ground surface
J - estimated result
NA - not applicable
NE - not established
NR - not reported
PAHs - polynuclear aromatic hydrocarbons
TPH - total petroleum hydrocarbons
TTEC - Total Toxic Equivalent Concentration (sum of cPAH concentrations multiplied by their respective toxicity equivalency factors [TEFs] per WAC 173-340-708(8)(e))
U - Compound was analyzed for but not detected above the reporting limit shown.
VOC - volatile organic compound

Table 1-2. Soil Analytical Results for B36 Area, Tacoma Metals Site (Continued)

Sample ID:	MTCA Cleanup Level		Protection of Wildlife[8]	B74	B75	B76		B77		B78		B79		B80		
Depth (feet bgs):				8-9	4-7	8-9	12-14	5-7[11]	7.5-8.5	7.5-9	14-15	7.5-8.5	12-14	4-5	8-9	12-13
Date Sampled:	Method A	Method C	(<6 ft bgs)	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14	10/30/14
TPH (mg/kg)																
Diesel	2,000	NE	6,000	12.8	16.8 [3]	1,480 [3]	300 [3]	**140,000 J[10]**	**21,200 [4]**	1,410 [3]	365 [4]	10 U	50.3 [3]	11.9 [3]	101 [3]	33.0 [3]
Oil	2,000	NE	NE	50 U	46 [3]	**3,200 [3]**	494 [3]	**140,000 J[10]**	**13,600 [4]**	**3,310 [3]**	233 [4]	57	61 [3]	106 [3]	522 [3]	210 [3]
PAHs (mg/kg)																
1-Methylnaphthalene	NE	4,530	NE	0.033 U	0.033 U	1.19	3.63	45 J[10]	127	0.667	2.06	0.033 U	0.474	0.033 U	0.177	0.100
2-Methylnaphthalene	NE	14,000	NE	0.033 U	0.033 U	2.49	1.60	16 J[10]	51.6	0.936	0.448	0.033 U	0.107	0.033 U	0.184	0.055
Acenaphthene	NE	210,000	NE	0.074	0.164	4.94	7.42	540 J[10]	1210	1.03	21.2	0.033 U	3.88	0.033 U	0.196	0.153
Acenaphthylene	NE	NE	NE	0.033 U	0.033 U	5.58	0.298	30 J[10]	23.6	2.78	0.120	0.033 U	0.033 U	0.033 U	0.694	0.138
Anthracene	NE	1,050,000	NE	0.033 U	0.112	18.6	8.71	380 J[10]	705	11.7	5.74	0.033 U	0.614	0.117	3.00	0.859
Benzo[a]anthracene[1]	NE	NA[1]	NE	0.064	0.332	66.3	7.99	320 J[10]	573	31.6	5.57	0.033 U	1.22	0.275	10.2	1.23
Benzo[a]pyrene[1]	2	NA[1]	NE	0.073	0.749	79.0	7.92	240 J[10]	284	94.7	3.21	0.043	0.844	0.643	31.4	6.04
Benzo[b]fluoranthene[1]	NE	NA[1]	NE	0.081	1.05	86.8	7.78	300 J[10]	418	130	3.49	0.056	1.01	0.845	44.3	6.74
Benzo[g,h,i]perylene	NE	NE	NE	0.033 U	0.199	22.4	1.83	110 J[10]	59.9	17.4	0.376	0.033 U	0.142	0.193	8.37	1.67
Benzo[k]fluoranthene[1]	NE	NA[1]	NE	0.033 U	0.270	32.6	2.90	110 J[10]	91.0	36.4	1.27	0.033 U	0.455	0.277	11.5	3.29
Chrysene[1]	NE	NA[1]	NE	0.080	0.789	78.6	11.9	420 J[10]	741	68.8	4.86	0.046	1.53	0.832	45.2	10.8
Dibenzo[a,h]anthracene[1]	NE	NA[1]	NE	0.033 U	0.090	2.91	0.57	31 J[10]	26.9	5.03	0.189	0.033 U	0.066	0.033 U	2.63	0.529
Dibenzofuran	NE	3,500	NE	--	--	--	--	330 J[10]	--	--	--	--	--	--	--	--
Fluoranthene	NE	140,000	NE	0.095	0.263	238	20.3	1,300 J[10]	2870	37.7	28.0	0.068	3.18	0.221	1.90	0.523
Fluorene	NE	140,000	NE	0.033 U	0.099	2.56	5.71	380 J[10]	910	1.26	12.7	0.033 U	1.09	0.033 U	0.242	0.123
Indeno[1,2,3-cd]pyrene[1]	NE	NA[1]	NE	0.033 U	0.285	28.8	2.43	120 J[10]	91	22.3	0.664	0.034	0.194	0.240	10.5	2.08
Naphthalene	5	70,000	NE	0.033 U	0.055	6.64	4.12	21 J[10]	21.3	1.35	2.70	0.033 U	0.433	0.033 U	0.403	0.255
Phenanthrene	NE	NE	NE	0.088	0.199	7.84	11.7	1,800 J[10]	5110	4.70	28.7	0.033 U	2.45	0.288	1.30	0.445
Pyrene	NE	105,000	NE	0.063	0.293	256	12.1	1,000 J[10]	1770	43.2	18.2	0.033 U	2.13	0.205	2.52	0.285
TTEC[1]	2	18	12	0.088	0.960	**102**	10.2	**330 J[10]**	**411**	**118**	4.38	0.052	1.15	0.815	**39.8**	7.53
VOCs (mg/kg)																
Benzene	0.03	2,400	NE	--	--	--	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	6	350,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--
Methyl tert-butyl ether	0.1	73,000	NE	--	--	--	--	--	--	--	--	--	--	--	--	--
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TTEC was calculated using only results reported as detected.

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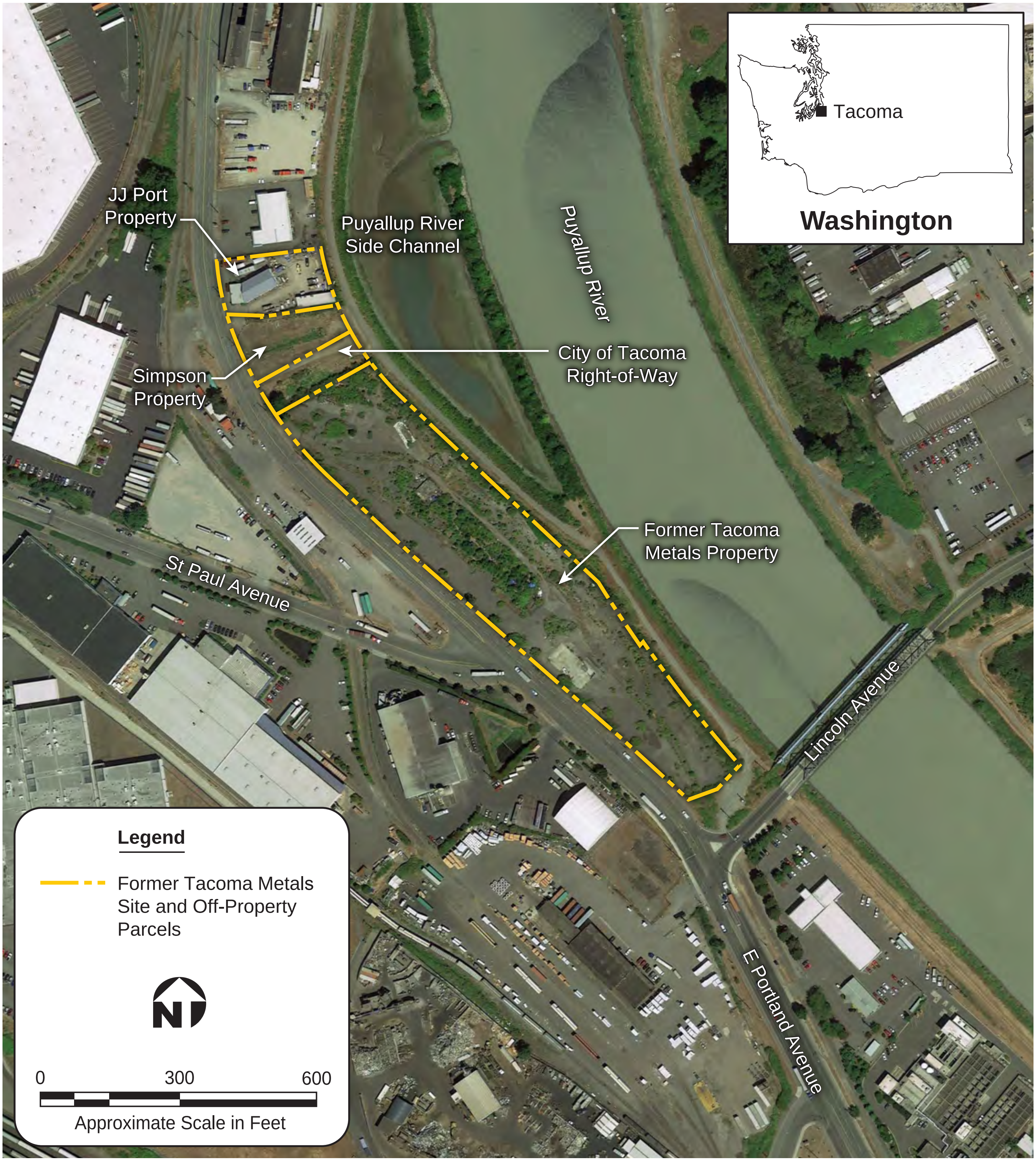
33764085_02.ai



Source: Google Earth Pro, imagery dated (7/10/2014)

Figure 1-1

Site Location Map

Job No. 33764085

AECOM

Tacoma Metals Site
Tacoma, Washington

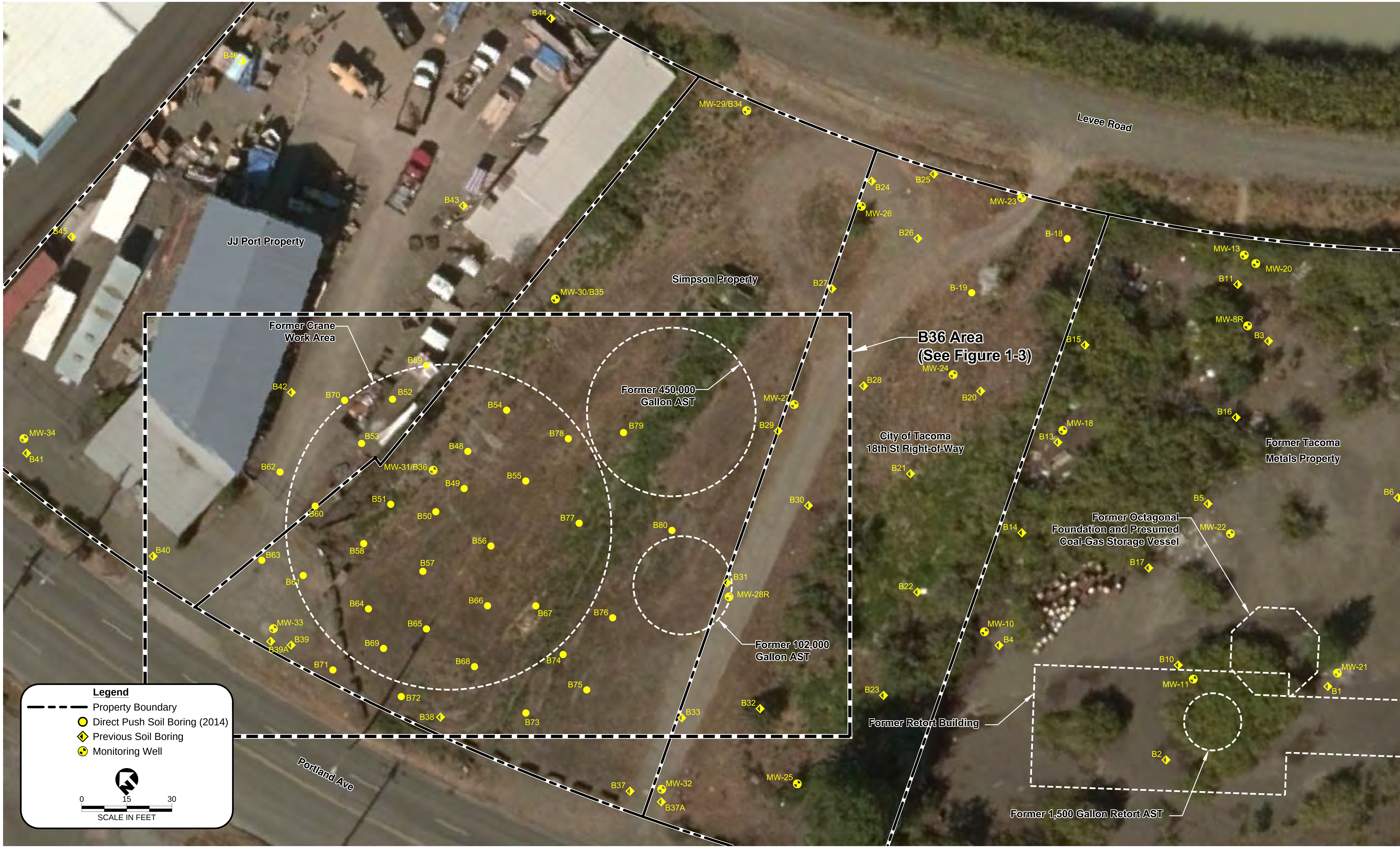


Figure 1-2
Site Plan
Off-Property Parcels

AECOM

J:\GIS\Projects\International Paper\Tacoma Metals\SubTasks\FS\Figure 1-2 (Site Plan).dwg
Mod: 05/18/2015, 10:28 | Plotted: 05/18/2015, 12:59 | JOHN_KNOBBS

Tacoma Metals Site
Tacoma, Washington

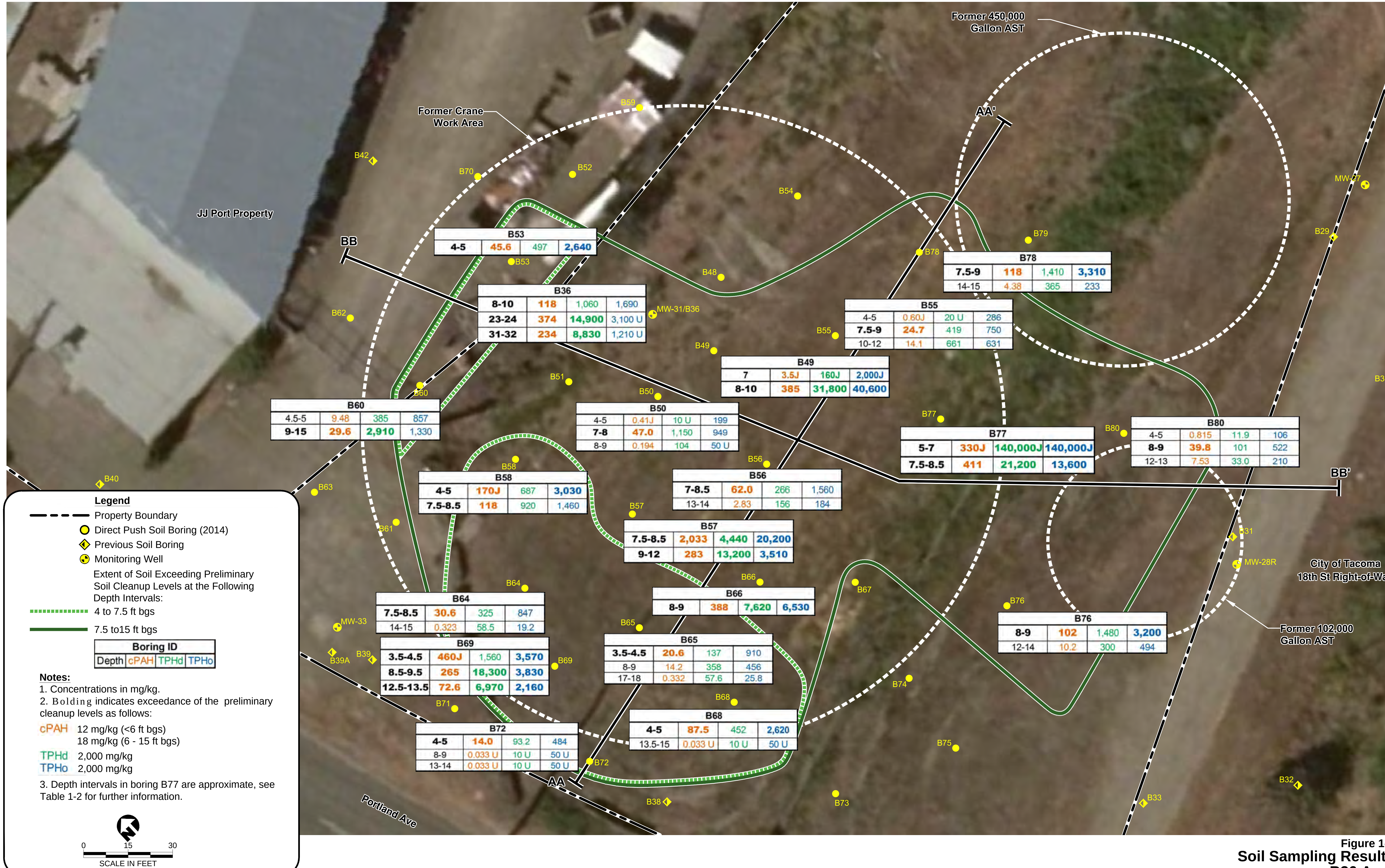
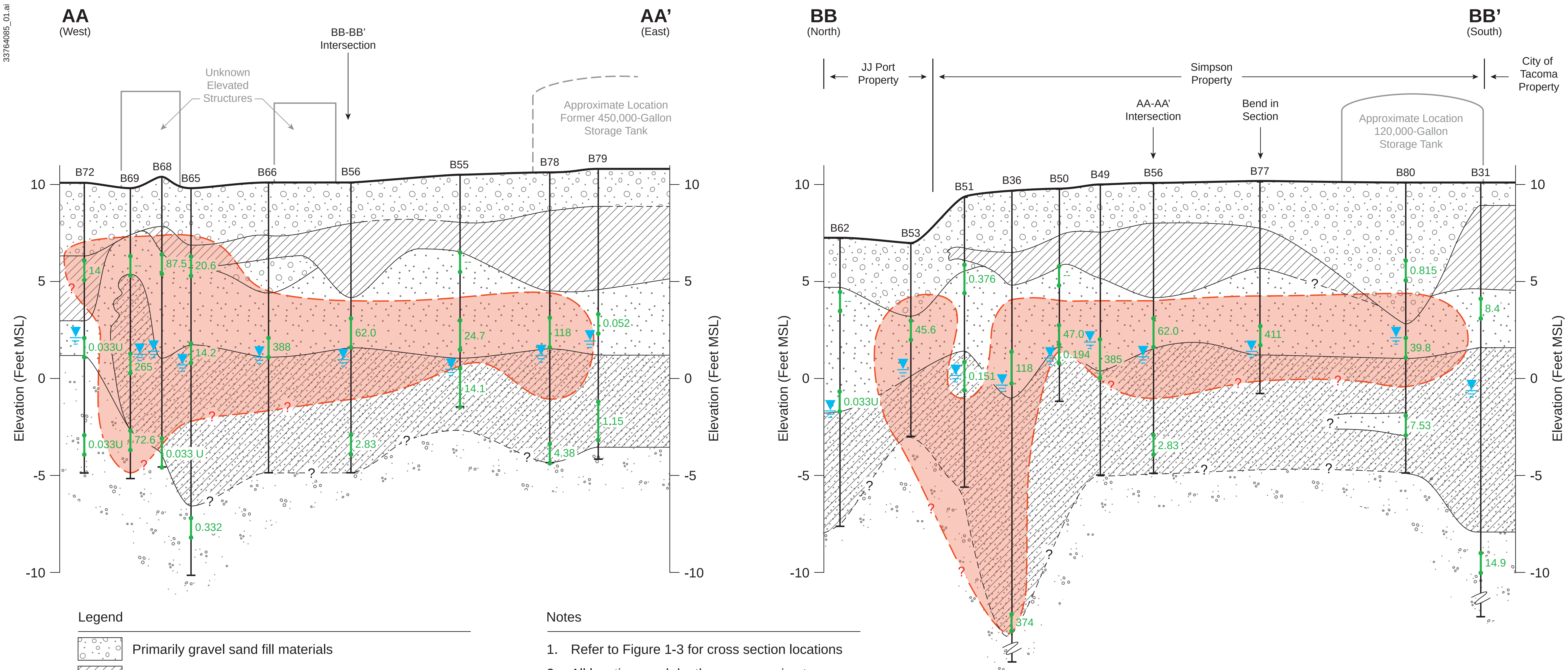


Figure 1-3
Soil Sampling Results
B36 Area

AECOM

J:\GIS\Projects\International Paper\Tacoma Metals\SubTasks\FS\Figure 1-3 (Soil Samp Results).dwg
Mod: 06/24/2015, 11:35 | Plotted: 06/24/2015, 11:35 | JOHN_KNOBBS

Tacoma Metals Site
Tacoma, Washington



Legend

- Primarily gravel sand fill materials
- Primarily woody material with no matrix
- Primarily silty sand
- Primarily woody material with sand, silt and/or clay matrix
- Primarily sand with some silt
- Approximate groundwater depth at time of drilling
- 14.2 cPAH concentrations in mg/kg
- -- Sample collected but not analyzed for cPAHs
- Approximate area of soil exceeding MTCA cleanup levels and protection of wildlife cleanup levels

Notes

1. Refer to Figure 1-3 for cross section locations
2. All locations and depths are approximate
3. MSL = feet above mean sea level (NGVD 1929)

0 20 40

Horizontal Scale in Feet
Vertical Exaggeration = 4x

Job No. 33764085

Figure 1-4

B36 Area Profiles

AECOM

Tacoma Metals Site
Tacoma, Washington

2 Development of Cleanup Action Alternatives

This section presents the cleanup action goals and the quantity and location of environmental media requiring cleanup. This section also presents the development and descriptions of cleanup action alternatives that address the cleanup action goals for the B36 Area.

2.1 Cleanup Action Goals

The cleanup action goals are:

- To prevent direct contact by workers performing subsurface construction in soil containing concentrations of COCs exceeding the preliminary soil cleanup levels included in Table 1-1
- To prevent direct contact by wildlife with soil containing concentrations of COCs exceeding the preliminary soil cleanup levels established for wildlife included in Table 1-1

In accordance with WAC 173-340-740(6)(d), the POC shall be established in the soils throughout the Site from the ground surface to 15 feet bgs based on human exposure via direct contact or other exposure pathways where contact with the soil is required to complete the pathway. This represents a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of site development activities. To prevent the direct contact wildlife exposure pathway, a conditional POC may be set at the biologically active soil zone, which is assumed to extend to a depth of 6 feet bgs in accordance with WAC 173-340-7490(4)(a).

2.2 Environmental Media Requiring Cleanup

Development of cleanup action alternatives relies on an assessment of the quantities of environmental media that require cleanup, and the location of those environmental media relative to site features. This assessment is performed using the B36 area investigation results (Section 1.3), the preliminary cleanup levels (Section 1.2 and Table 1-1), and the site description information (Section 1.1). Note that the areas and volumes of environmental media requiring cleanup discussed in this section may be different than the treatment areas and volumes used in the cost estimates. The treatment areas and volumes take into account constructability of the alternatives.

2.2.1 Lateral and Vertical Extent of Media Requiring Cleanup

The lateral and vertical extent of cPAHs exceeding the preliminary soil cleanup levels beneath the Site were estimated using data from soil investigations conducted between 2006 and 2014. As discussed in Section 1.3, for locations where only TPH data is available, exceedances of the TPH MTCA Method A industrial soil cleanup levels are considered indicative of an exceedance of the cPAH cleanup level. Therefore, the total area of soil located at depths less than 15 feet bgs with concentrations of TPH-diesel, TPH-oil, and/or cPAHs exceeding the preliminary soil cleanup levels is shown on Figure 1-3, with an estimated area of 9,300 square feet (sf) (see Figures B-1 through B-3 in Appendix D).

The area of shallow soil exceeding the preliminary soil cleanup levels is also shown on Figure 1-3. For this analysis, soil located at depths less than 7.5 feet bgs is considered shallow soil. The main area with soil contamination located at depths less than 7.5 feet bgs is in the vicinity of borings B58, B65, B68, B69, and B72. Soil exceedances were generally detected in samples collected between 4 and 7.5 feet bgs in this area. However, preliminary cleanup levels were exceeded for TPH-oil in the sample collected from 3.5 to 4.5 feet bgs in boring B69. One area with soil contamination at depths less than 7.5 feet bgs is located on the JJ Port property at boring B53. The soil exceedance was detected in the sample collected between 4 and 5 feet bgs. However, it should be noted that the elevation at boring B53 is several feet lower than at the borings on the Simpson property. The areal extent of soil contamination located at less than 7.5 feet bgs on the Simpson property is estimated at 2,300 sf, and the areal extent of soil contamination located at less than 7.5 feet bgs on the JJ Port property is estimated at 480 sf (see Figures B-1 through B-3 in Appendix D).

2.2.2 Quantity of Media Requiring Cleanup

The total quantity of soil requiring cleanup was estimated based on the lateral and vertical extent of soil containing COCs described in Section 2.2.1. Approximately 10 percent of the total quantity of soil was assumed to be impacted by DNAPL. The mass of cPAHs present in the soil volume requiring cleanup was also estimated. The mass estimate relied in part on a general assumption regarding soil density. The estimated mass also relied on the mean concentrations of cPAHs within the soil volume requiring remediation. Details regarding the assumptions are included in the calculations provided in Appendix D. Estimated quantities of soil, DNAPL, and cPAHs requiring cleanup are:

- 3,100 cubic yards of soil containing COCs exceeding the preliminary cleanup levels
- 310 cubic yards of soil exhibiting DNAPL
- 900 gallons of DNAPL
- 1,500 pounds of cPAHs

2.3 Description of Cleanup Action Alternatives

This section describes the cleanup action alternatives developed for the B36 Area. The alternatives are summarized in Table 2-1 including system components, treatment times, treatment areas, and treatment volumes. As further discussed in Section 3, the alternatives developed in this section are all protective of human health. All alternatives are assumed to include institutional controls through a restrictive environmental covenant on the property, which limits the property to industrial uses. This restrictive environmental covenant is a requirement of using MTCA Method C cleanup levels (WAC 173-340-440). All alternatives assume that this restrictive environmental covenant also places conditions on excavation at the Site until soil cleanup levels are achieved. Because institutional controls and the implementing restrictive environmental covenant are a part of all alternatives, this element of the cleanup action alternative is not further discussed in each section and is not considered as part of the comparative analysis of alternatives in Section 3.

All alternatives include some degree of groundwater monitoring. The scope of the groundwater monitoring and the associated costs are expected to be the same for all alternatives. Because long-term groundwater monitoring is included as part of all alternatives, 5-year reviews would be performed for all alternatives. The 5-year review would assess whether the cleanup action continues to satisfy the MTCA requirements for cleanup actions (WAC 173-340-360(2)) including whether it continues to be protective of human health and whether cleanup levels have been achieved. This element of the cleanup action alternative is not discussed in each section and is also not considered as part of the comparative analysis of alternatives in Section 3.

2.3.1 Baseline Alternative (Excavation) - Alternative 1

The baseline alternative (Alternative 1) for cleanup is the most permanent alternative developed in this FS addendum and is used when comparing alternatives to one another in the disproportionate cost analysis (DCA) to assess whether other alternatives are permanent to the maximum extent practicable pursuant to WAC 173-340-360(3)(e).

Alternative 1 consists of excavation and off-site landfill disposal or off-site treatment and disposal of soil located at depths less than 15 feet bgs containing DNAPL or COCs at concentrations exceeding preliminary soil cleanup levels (Figure 2-1). Soil exhibiting field indications of DNAPL would not be eligible for direct off-site disposal at a landfill because of the characteristics of the waste stream, but would instead be treated offsite by incineration to destroy the DNAPL. Under the baseline alternative, shoring would be utilized along the northern edge of the excavation and a 1:1 slope would be utilized along the remainder of the excavation perimeter (see Figure 2-1). Shoring would be used to minimize impacts on the JJ Port property and is assumed to be a sheet pile wall for purposes of the cost estimate. However, other shoring systems would also be evaluated for the Site by the contractor implementing the cleanup action.

Because temporary shoring would be used on the north side of the excavation, it would not be possible to obtain post-excavation confirmation samples of the excavation sidewalls on the JJ Port property. Therefore, additional soil sampling would be performed on the JJ Port property north of the excavation area in order to confirm the horizontal and vertical extent of soil contamination during the design phase of the cleanup action. Samples would be analyzed for PAHs and petroleum hydrocarbons.

Soil would be excavated and segregated as uncontaminated overburden, soil likely containing COCs but not exhibiting DNAPL, and soil containing DNAPL. Soil containing NAPL or saturated with water would be placed in shipping containers equipped with drainage nets and staged on site within an area equipped with temporary secondary containment. Water and

DNAPL would be decanted and phase separated by pumping or vacuum extraction from the shipping containers until the soil was dry enough to transport for disposal.

Alternative 1 would include the following elements:

a. Identifying applicable or relevant and appropriate requirements (ARARs) and substantive requirements
b. Designing the cleanup action including additional soil sampling on the JJ Port property north of the excavation area to confirm extent of soil contamination
c. Installing a shoring system along the northern edge of the excavation on or near JJ Port property
d. Decommissioning and replacing groundwater monitoring wells within the excavation area (MW-28(R), MW-31, MW-33)
e. Excavating, stockpiling, and analytical testing of clean overburden material to confirm reuse as backfill
f. Excavating, handling, dewatering (including phase separation and separate disposal of liquid DNAPL), segregating, hauling, treating, and disposing of soil containing DNAPL and COCs exceeding preliminary cleanup levels located at depths less than 15 feet bgs
g. Post-excavation sampling and analysis of soils and over-excavation as required based on initial post-excavation sampling results
h. Backfilling the excavation with clean fill from a source verified to be free of impacted media and verified clean overburden material from the Site
i. Implementing environmental protection measures during construction, including handling and treatment of construction stormwater and groundwater
j. Hydroseeding the disturbed areas of the Site
k. Long-term groundwater monitoring for 5 years
l. Closure reporting

The estimated quantities of contaminated media and contaminants that would be remediated under Alternative 1 are summarized in Table 2-1. Back-up calculations are provided in Appendix D. No concentrations of COCs exceeding the preliminary cleanup levels would remain in soil at depths less than 15 feet bgs under the baseline alternative.

2.3.2 *In Situ* Solidification Alternative - Alternative 2

Alternative 2 consists of solidification of soil located at depths less than 15 feet bgs containing DNAPL or COCs at concentrations exceeding preliminary soil cleanup levels (Figure 2-2). Solidification binds COCs within a modified matrix exhibiting significantly lower permeability compared to the surrounding soil. This treatment reduces the likelihood of COC migration by significantly reducing groundwater migration through the treated matrix, and chemically binding the impacted media within the matrix. This alternative includes additional testing following construction to document parameters specifically related to solidification performance including leachability and strength.

The solidification mixing additives would be selected based on bench-scale and pilot-scale treatability testing performed as part of cleanup action design. Bench-scale treatability testing could be performed using a two-step process. During the first step, impacted soil from the Site could be mixed with a wide-range of test mixes to identify the best performing mix. Additional testing of the best performing mix along with slight variations of the most promising mix would then be conducted to optimize the mixture prior to pilot testing. All solidified soil samples would be tested for strength, leachability, and hydraulic conductivity criteria. Following treatability testing, a pilot test could be performed on a small section (approximately 400 sf or 5 percent of the total treatment area) of the Site prior to full-scale implementation. The pilot test would be performed to further refine the mix design and determine the preferred mixing tools and techniques for full-scale remediation. Only mechanical mixing methods are being considered for this Site. These methods may include, but are not limited to, mixing with large-diameter augers, excavator buckets, or specialized *in situ* blenders manufactured by Lang Tool Company. Like the bench-scale test, the pilot test would include strength and leachability testing.

Full-scale solidification is assumed to include soil exceeding preliminary cleanup levels from 4 to 15 feet bgs within the designated treatment boundary. The solidification process is estimated to create volumetric expansion of the treated soils by approximately 35 percent which would result in a solidified surface elevation increase of approximately 4 feet. In order to retain site grades in the work yard of the JJ Port property, soil above 7.5 feet bgs within the treatment boundary on the JJ Port property would be excavated. Of this, the top 4 feet would be stockpiled for reuse at the Site, and the bottom 3.5 feet would be relocated to the Simpson property within the area of contamination (AOC) for solidification. Therefore, all material would remain on Site. Shoring would be used to minimize impacts on the JJ Port property for the excavation portion, and is assumed to be a trench box for purposes of the cost estimate. However, other shoring systems would also be evaluated by the contractor implementing the cleanup action.

Because temporary shoring would be used around the excavation limits on the JJ Port property, it would not be possible to obtain post-excavation confirmation samples of the excavation sidewalls in this area. Therefore, additional soil sampling would be performed on the JJ Port property north of the excavation area in order to confirm the horizontal and vertical extent of soil contamination during the design phase of the cleanup action. Samples would be analyzed for PAHs and petroleum hydrocarbons.

Prior to solidification, the overburden (0 to 4 feet bgs) on the Simpson property would be removed and temporarily stockpiled for reuse after solidification. Contaminated material from the JJ Port property excavation would be placed within the treatment limits on the Simpson property, and would be solidified along with the material located on the Simpson property. The solidified soil would be graded and a geotextile fabric or other physical marker would be installed above the solidified soil to demarcate the top of the solidified soil. A minimum of 2 feet of clean fill, consisting of overburden previously excavated at the Site, would be placed above the geotextile fabric.

Clean fill (overburden) would also be used to transition between the new higher grades within solidification treatment limits and the surrounding existing grade. In order to minimize erosion, a maximum 4:1 transition slope would be used on the east and south sides of the solidification area. Because of the proximity of the JJ Port property work yard and Portland Avenue, space is not available to install a 4:1 transition slope on the north and west sides of the solidification area. Therefore, a retaining wall would be constructed in these areas. For purposes of the cost estimate, the retaining wall is assumed to be constructed of engineered concrete blocks with a rail/fence installed along the top for safety. However, other materials to be used to construct the retaining wall could also be evaluated by the contractor implementing the cleanup action. Following construction, the disturbed areas of the Site would be hydroseeded with grass.

Alternative 2 would include the following elements:

a. Identifying ARARs and substantive requirements

b. Designing the cleanup action, including bench-scale testing of the mixing additive and additional soil sampling on the JJ Port property north of the excavation area to confirm extent of soil contamination

c. Implementing a pilot-scale test of the mixing additive and various mechanical mixing equipment and methods in a 20- by 20-foot area of the Site and documenting findings and recommendations in a report

d. Decommissioning and replacing groundwater monitoring wells located within and close to the solidification area (MW-28(R), MW-31, MW-33)

e. Installing a shoring system around the perimeter of the JJ Port excavation area

f. Excavating, stockpiling, and analytical testing of clean overburden material to confirm reuse as backfill

g. Temporarily storing and reusing all clean overburden material to maintain a minimum of 2 feet of clean fill above all solidified soils

h. Excavating soil to a depth of 7.5 feet bgs at the JJ Port property and relocating it to the Simpson property for solidification

i. In-place mixing of soil with the mixing additives and mechanical mixing equipment recommended by the pilot test

j. Removing any hidden obstacles during *in situ* solidification

k. Grading surface of solidified soil and installing a geotextile fabric or other physical marker above the solidified soil to demarcate the top of the solidified soil

l. Reusing clean overburden materials stockpiled on site to cover solidified material with a minimum of 2 feet of clean fill and to transition to the existing surrounding site grades

m. Installing a retaining wall on the north and west edges of the solidification area (with a rail or fence along the top for wall heights greater than 4 feet)

n. Hydroseeding the disturbed areas of the Site

o. Implementing environmental protection measures during construction (e.g., stormwater pollution protection plan), including handling and treatment of construction stormwater

p. Closure reporting

q. Long-term monitoring of leachate and physical performance of solidified soil

The estimated quantities of contaminated media and contaminants that would be remediated under Alternative 2 are summarized in Table 2-1. Back-up calculations are provided in Appendix D. All soil with COCs exceeding the cleanup levels and exhibiting DNAPL at depths less than 15 feet bgs would be solidified.

2.3.3 Multi-Component Alternative - Alternative 3

Alternative 3 consists of:

- Excavation and off-site landfill disposal or off-site treatment and disposal of soil located at depths less than 7.5 feet bgs containing DNAPL or COCs at concentrations exceeding preliminary soil cleanup levels on the Simpson property
- Excavation and off-site landfill disposal or off-site treatment and disposal of soil located at depths less than 15 feet bgs containing DNAPL or COCs at concentrations exceeding preliminary soil cleanup levels on the JJ Port property
- Placement of clean fill in the excavation areas
- Installation of a low-permeability asphalt cap on the Simpson property

The components of Alternative 3 are shown on Figure 2-3.

Handling and disposal of excavated soil would be similar to the baseline alternative. However, under Alternative 3, soil containing COCs exceeding preliminary cleanup levels currently located at depths greater than 7.5 bgs would remain on the Simpson property. In order to address the cleanup action goals of preventing direct contact with soil by workers and wildlife, a cap would be installed on the Simpson property. Because this alternative relies on containment of soil exceeding cleanup levels on the Simpson property, compliance monitoring would be required until residual hazardous substance concentrations no longer exceed preliminary cleanup levels. In addition, the DCA, provided in Section 3, would be used to demonstrate that this alternative, if selected, is permanent to the maximum extent practicable in accordance with WAC 173-340-740(6)(f).

Under Alternative 3, shoring would be utilized for the excavation area on the JJ Port property and a 1:1 slope would be utilized for the excavation area on the Simpson property (see Figure 2-3). Shoring would be used to minimize impacts on the JJ Port property and is assumed to be a sheet pile wall for purposes of the cost estimate. However, any shoring system utilized at the Site would be selected by the contractor implementing the cleanup action. Because temporary shoring would be used around the excavation limits on the JJ Port property, it would not be possible to obtain post-excavation confirmation samples of the excavation sidewalls in this area. Therefore, additional soil sampling would be performed on the JJ Port property north of the excavation area in order to confirm the horizontal and vertical extent of soil contamination during the design phase of the cleanup action. Samples would be analyzed for PAHs and petroleum hydrocarbons.

The area that would be capped is shown on Figure 2-3. The cap would be 7.5 feet thick and consist of 6.5 feet of clean imported fill followed by an 8-inch layer of gravel base course and 4-inches of low-permeability asphalt. Placement of this cap would prevent direct contact with soil by workers and wildlife, because all soil with DNAPL and concentrations exceeding preliminary cleanup levels would be located at depths greater than 15 feet bgs. In addition, the placement of the low-permeability asphalt would limit infiltration of stormwater.

Clean imported fill would also be used to transition between the new higher grades within the cap area and the surrounding existing grade. In order to minimize erosion, a maximum 4:1 transition slope would be used on the east and south sides of the cap area. Because of the proximity of the JJ Port property work yard and Portland Avenue, space is not available to install a 4:1 transition slope on the north and west sides of the cap area. Therefore, a retaining wall would be constructed in these areas. For purposes of the cost estimate, the retaining wall is assumed to be constructed of engineered concrete blocks with a rail/fence installed along the top for safety. However, other materials used to construct the retaining wall could also be evaluated by the contractor implementing the cleanup action.

The transition slope would also be paved with the low-permeability asphalt. To prevent spalling of the edge of the asphalt, ecology blocks would be installed around the perimeter of the transition-sloped area. The ecology blocks would be installed such that the top edge of the ecology block would be level with the top of the asphalt.

Alternative 3 would include the following elements:

a. Identifying ARARs and substantive requirements
b. Designing the cleanup action including additional soil sampling on the JJ Port property north of the excavation area to confirm extent of soil contamination
c. Installing a shoring system around the perimeter of the JJ Port excavation area
d. Decommissioning and replacing groundwater monitoring wells located within the work area (MW-28(R), MW-31, MW-33)
e. Excavating stockpiling, and analytical testing of clean overburden material to confirm reuse as backfill
f. Excavating, handling, dewatering (including phase separation and separate disposal of liquid DNAPL), segregating, hauling, treating, and disposing of soil containing DNAPL and COCs exceeding cleanup levels located at depths less than 15 feet bgs on the JJ Port property and located at depths less than 7.5 feet bgs on the Simpson property
g. Post-excavation sampling and analysis of soils and over-excavation as required based on initial post-excavation sampling results
h. Backfilling the excavation with clean fill from a source verified to be free of impacted media and verified clean overburden material from the Site
i. Installing a retaining wall on the north and west edges of the cap area (with a rail or fence along the top for wall heights greater than 4 feet)
j. Importing clean fill and placing 6.5 feet deep in cap area and transitioning to the existing surrounding site grades adjacent to the cap area
k. Installing ecology blocks along the perimeter of the transition-sloped area
l. Placing base course and paving the cap area and the transition slope with low-permeability asphalt
m. Implementing environmental protection measures during construction, including handling and treatment of construction stormwater and groundwater
n. Long-term groundwater monitoring for 5 years
o. Closure reporting

The estimated quantities of contaminated media and contaminants that would be remediated under Alternative 3 are summarized in Table 2-1, as well as the estimated quantities of untreated contaminated media and contaminants that would remain on site. Back-up calculations are provided in Appendix D.

Table 2-1. Comparison of Alternative Components, B36 Area, Tacoma Metals Site

Alternative Component	Alternative 1 Excavation (Baseline)	Alternative 2 *In Situ* Solidification	Alternative 3 Multi-Component Alternative
Conceptual Details			
Install temporary erosion and sediment controls	✓	✓	✓
Decommission monitoring wells in work area	✓	✓	✓
Install temporary shoring (JJ Port property only)	✓	✓	✓
Excavate, stockpile, and perform analytical testing of overburden	✓	✓	✓[1]
Excavate to 15 feet bgs, dewater, and segregate contaminated materials	✓	○	✓[2]
Excavate to 7.5 feet bgs, dewater, and segregate contaminated materials	○	✓[3]	✓[4]
Import clean fill material	✓	○	✓
Backfill excavation area with imported clean fill material and/or clean overburden	✓	✓	✓
In situ solidification	○	✓	○
Replace clean fill over solidified soil and to transition from the new higher grades in the solidification area resulting from volumetric expansion and the surrounding existing grades	○	✓	○
Capping with 7.5 ft of clean material (0.5 ft impermeable asphalt and 7 feet clean fill)	○	○	✓
Install retaining wall	○	✓	✓
Off-site disposal of contaminated materials	✓	○	✓
Replace monitoring wells in work area	✓	✓	✓
Non-remediated soil would remain on site	○	○	✓
Dimensions of Environmental Media Requiring Cleanup			
Depths of Environmental Media Requiring Cleanup			
Depth of clean overburden (ft)	4/7.5[5]	4/7.5[5]	4/7.5[5]
Depth of excavation (ft)	15	7.5[3]	7.5/15[2,4]
Depth of solidification (ft)	NA	15	NA
Areas of Environmental Media Requiring Cleanup			
Area of shallow excavation or solidification (4 to 7.5 ft bgs) on Simpson property (sf)[6]	2,300	2,300	2,300
Area of deep excavation or solidification (7.5 to 15 ft bgs) on Simpson property (sf)	8,800	8,800	0
Area of capped soil (sf)	0	0	8,800
Area of shallow excavation (4 to 7.5 ft bgs) and deep solidification (7.5 to 15 ft bgs) on JJ Port property (sf)	0	480	0
Area of shallow and deep excavation (4 to 15 ft bgs) on JJ Port property (sf)	480	0	480
Total Area of Environmental Media Requiring Cleanup (sf)	**9,300**	**9,300**	**9,300**
Volumes of Environmental Media Requiring Cleanup			
Volume of shallow excavation or solidification (4 to 7.5 ft bgs) on Simpson property (cy)	300	300	300
Volume of deep excavation or solidification (7.5 to 15 ft bgs) on Simpson property (cy)	2,500	2,500	0
Volume of capped soil (cy)	0	0	2,500
Volume of shallow excavation (4 to 7.5 ft bgs) and deep solidification (7.5 to 15 ft bgs) on JJ Port property (cy)	0	210	0
Volume of shallow and deep excavation (4 to 15 ft bgs) on JJ Port property (cy)	210	0	210
Total Volume of Environmental Media Requiring Cleanup (cy)	**3,100**	**3,100**	**3,100**
Estimated Volume of Excavated Soil Containing NAPL (cy)[7]	**310**	**0**	**50**
Mass of COCs Targeted			
Mass of COCs (cPAHs) excavated and disposed of offsite (lbs)	1,500	0	60
Mass of COCs solidified (lbs)	0	1,500	0
Mass of COCs contained onsite (lbs)	0	0	1,400
Total Targeted Mass (lbs)	**1,500**	**1,500**	**1,500**

Table 2-1. Comparison of Alternative Components, B36 Area, Tacoma Metals Site (Continued)

Alternative Component	Alternative 1 Excavation (Baseline)	Alternative 2 *In Situ* Solidification	Alternative 3 Multi-Component Alternative
Alternative Details[8]			
Length of temporary shoring installed (ft)	100	120	120
Length of retaining wall installed (ft)	0	170	220
Total excavation area not including sidewalls (sf)	9,600	480	2,800
Total solidification area (sf)	0	9,900	0
Total capping area not including transition slope (sf)	0	0	8,800
Area of 7.5-ft excavation sloped sidewalls on Simpson property (sf)	0	0	1,600
Area of 15-ft excavation sloped sidewalls on Simpson property (sf)	5,900	0	0
Area of transition between new higher grades in the solidification or capping areas to the surrounding existing grades (sf)	0	3,700	9,100
Total in place excavation volume including sidewalls and excluding overburden (cy)	4,000	90	550
Total in place overburden volume including sidewalls (cy)	3,200	1,500	600
Total in place excavation volume (cy)	7,200	1,600	1,200
Total in place solidification volume (cy)	0	4,200	0
Volume of imported clean fill (cy)	4,600	0	4,500
Volume of imported gravel (cy)	0	0	450
Off-Site Disposal Volumes			
Non-DNAPL soil disposal including material from sidewall (cy), in place	3,700	0	500
DNAPL soil disposal needing incineration (cy), in place	310	0	50
Non-DNAPL disposal (tons)	6,100	0	830
DNAPL Soil Disposal (tons)	510	0	80
DNAPL Contaminated Liquid Disposal (gallons)	900	0	150
Estimated Implementation Time			
Construction/mob/demob (months)	6	6	6
LTM after treatment (years)	5	5	5
Total Time (Years)	**6**	**6**	**6**

Notes:

Values in table presented to two significant figures.

[1]Excavation of overburden would be performed in areas with shallow impacts only (see Figure 2-3).

[2]Excavation to 15 ft bgs would be performed on JJ Port property only (see Figure 2-3).

[3]Excavation to 7.5 ft bgs would be performed on JJ Port property only (see Figure 2-2).

[4]Excavation to 7.5 ft bgs would be performed on Simpson property in areas where contaminated materials are located at depths less than 7.5 ft bgs (see Figure 2-3).

[5]Depth of clean overburden is either 4 ft or 7.5 ft depending on the depth of soils exceeding the preliminary cleanup levels (see Figure 1-3).

[6]This overlaps with the deep excavation area or the capped area, and therefore is not included in the calculation for Total Area of Environmental Media Requiring Cleanup.

[7]Ten percent of excavated soil volume is assumed to contain DNAPL.

[8]Backup for the alternative details provided in Appendix B.

✓- included
○ - not included

COCs - chemicals of concern
cPAH - carcinogenic polynuclear aromatic hydrocarbon
cy - cubic yards
DNAPL - dense nonaqueous phase liquid
ft - feet
lbs - pounds
LTM - long-term monitoring
NA - not applicable
sf - square feet

Figure 2-1

Alternative 1
Soil Excavation and Disposal

Tacoma Metals Site
Tacoma, Washington

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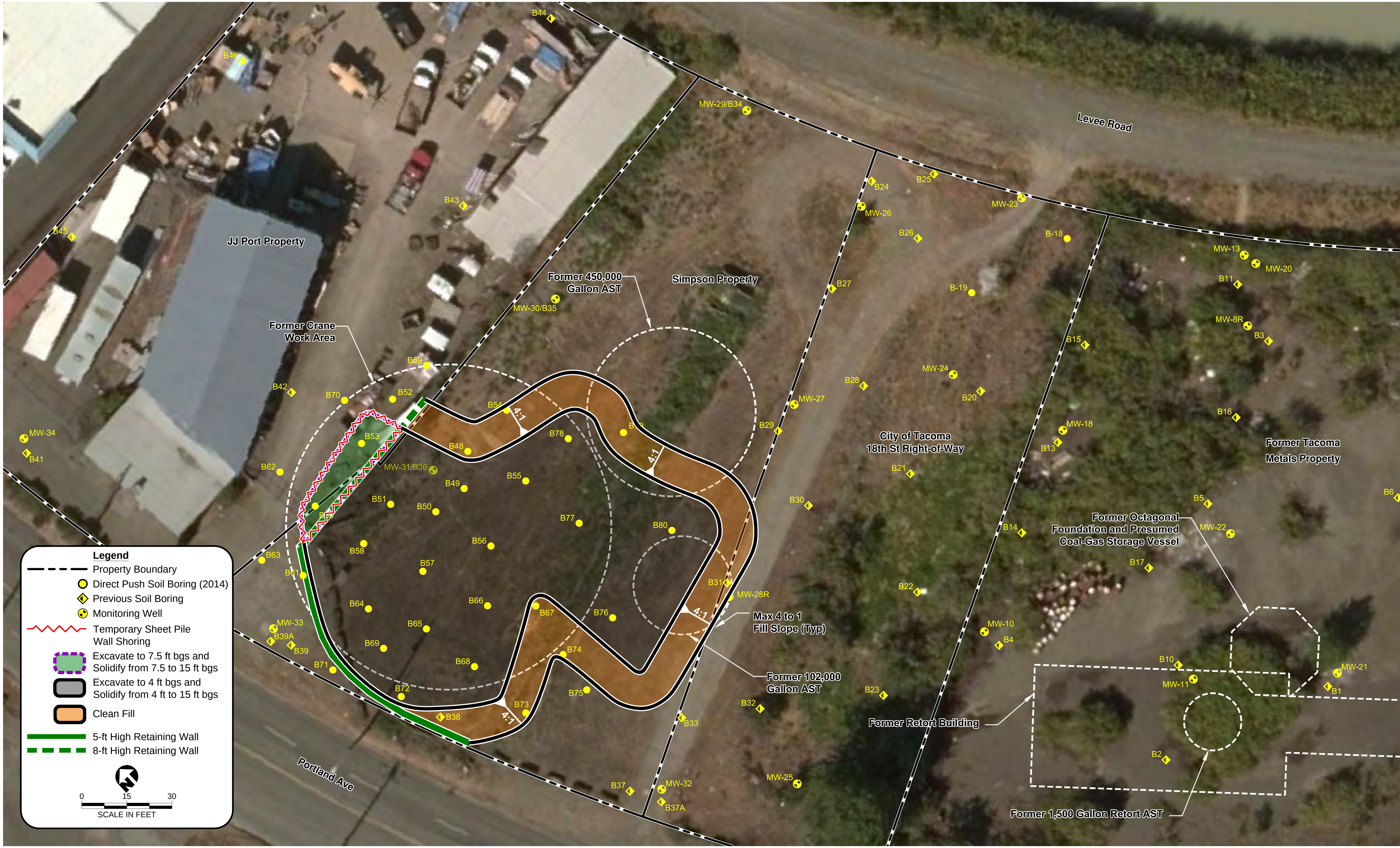

Figure 2-2
Alternative 2
***In Situ* Solidification**

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Tacoma Metals Site
Tacoma, Washington

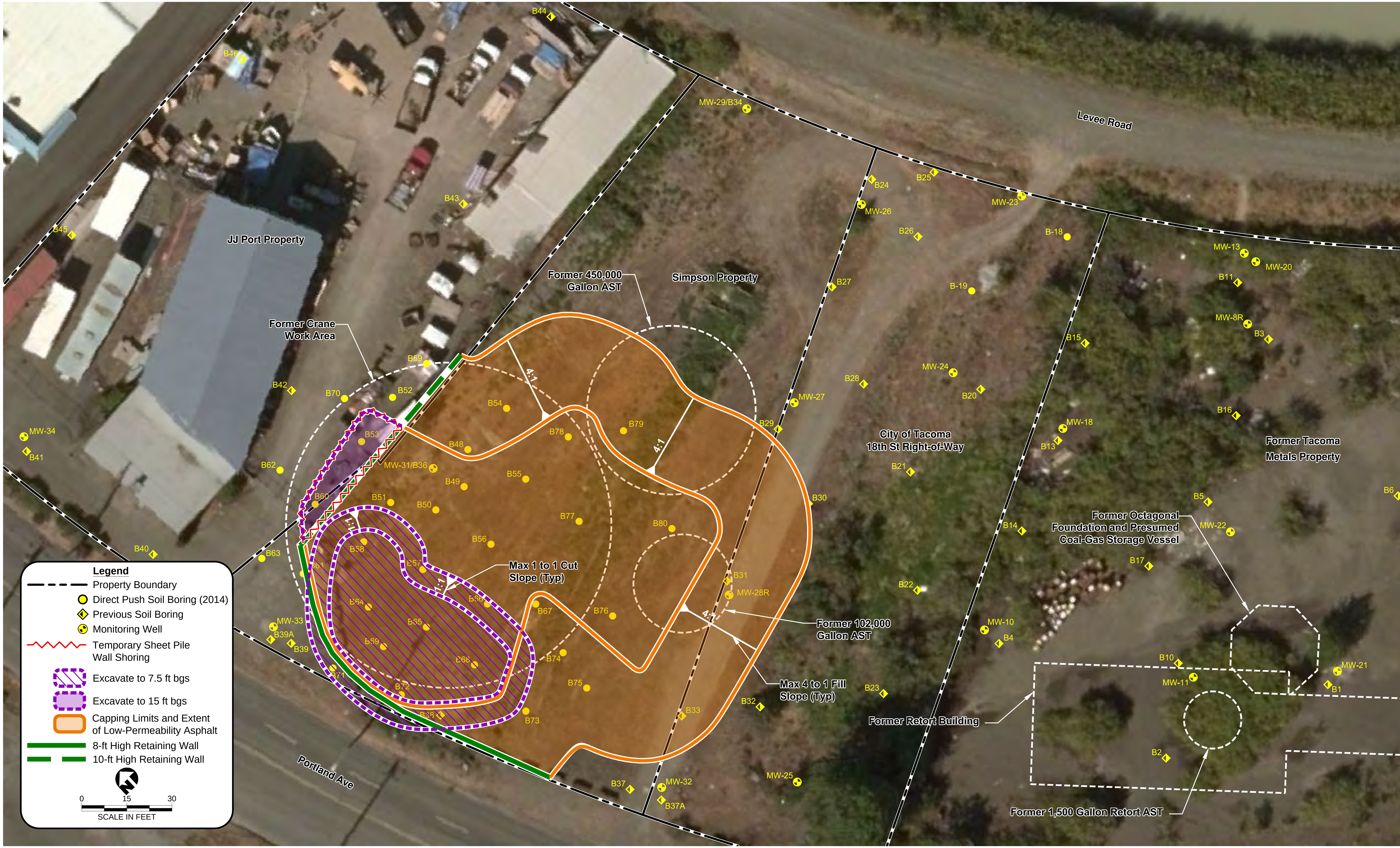

Figure 2-3
Alternative 3
Multi-Component Alternative

Tacoma Metals Site
Tacoma, Washington

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3 Analysis of Cleanup Action Alternatives

This section provides the evaluation and comparison of the three cleanup action alternatives developed and described in the previous section. This section also describes the results of the DCA performed on those alternatives in accordance with WAC 173-340-360(3)(e). Finally, this section culminates with the selection of a preferred cleanup action alternative for the B36 Area of the Site.

3.1 Evaluation of Cleanup Action Alternatives

Each of the alternatives developed in Section 2 individually are evaluated using the criteria established by MTCA. WAC 173-340-360 requires that all cleanup action alternatives evaluated first meet the following four threshold requirements:

a. Protect human health and the environment

b. Comply with cleanup standards (WAC 173-340-700 through 760)

c. Comply with applicable state and federal laws (WAC 173-340-710)

d. Provide for compliance monitoring (WAC 173-340-410 and 720 through 760)

MTCA then requires that cleanup action alternatives that fulfill the threshold requirements also be evaluated against the following “other requirements” (WAC 173-340-360[2][b]):

e. Use permanent solutions to the maximum extent practicable by evaluating specific elements described in WAC 173-340-360(3)

f. Provide for a reasonable restoration time frame (WAC 173-340-360[4])

g. Consider public concerns (WAC 173-340-600)

In this section each cleanup action alternative is evaluated against criteria a through d, and f. In section 3.2 the cleanup action alternatives are then compared to one another by assessing their relative degrees of permanence (criterion e above). Analysis of criterion g, public concerns, will be performed in the future CAP after public comment on this FS addendum has been received. A summary of the evaluation is provided in Table 3-1.

3.1.1 Baseline Alternative (Excavation) – Alternative 1

Alternative 1 meets the threshold requirements of WAC 173-340-360. This baseline alternative protects human health and the environment by excavating, off-site treating (if needed), and off-site landfilling of soil in the B36 Area located at depths less than 15 feet bgs containing DNAPL or COCs at concentrations exceeding preliminary soil cleanup levels. This alternative meets the requirements under MTCA that elimination of sources would be performed for liquid wastes or media with high concentrations of hazardous substances (WAC 173-340-360[c][ii][A]) to maximize protection of groundwater. This alternative complies with the anticipated final cleanup standards by eliminating soil sources located at depths less than 15 feet bgs containing DNAPL or COC concentrations exceeding MTCA Method C cleanup levels. This alternative relies on institutional controls as part of the action only to the extent that use of MTCA Method C cleanup levels for soil requires a restrictive environmental covenant on the property. Alternative 1 complies with state and federal laws by identifying ARARs as part of the action and complying with those ARARs for excavation, disposal, and site restoration.

Prior to cleanup action design, this alternative includes additional soil sampling on the JJ Port property to the north of the planned temporary shoring to ensure compliance with the cleanup standards. Along the southern, eastern, and western excavation limits, this alternative includes post-excavation compliance monitoring consisting of sampling to demonstrate that soil remaining on site meets the cleanup standards. To confirm that groundwater at the conditional POC continues to meet the groundwater cleanup levels specified in the revised augmented RI/FS report (see Table 3 of that document), this alternative provides groundwater compliance monitoring for 5 years. This baseline alternative provides a reasonable restoration timeframe by eliminating soil sources located at depths less than 15 feet bgs containing DNAPL or COC concentrations exceeding MTCA Method C cleanup levels within approximately 2 years of approval of the CAP. This restoration timeframe is based on best engineering judgment and estimated by comparing the proposed action to similar actions and considering the likely lead times for design, permitting, coordination with property owners, excavation, and site restoration.

3.1.2 *In Situ* Solidification Alternative – Alternative 2

Alternative 2 meets the threshold requirements of WAC 173-340-360. This alternative protects human health and the environment by solidifying soil in the B36 Area located at depths less than 15 feet bgs containing DNAPL or COCs at concentrations exceeding the preliminary soil cleanup levels. This alternative meets the requirements under MTCA that a reasonable effort should be made to treat liquid wastes or media with high concentrations of hazardous substances (WAC 173-340-360[c][ii][A]) to maximize protection of groundwater. Alternative 2 complies with anticipated final cleanup levels by solidifying soil throughout the Site located at depths less than 15 feet bgs exhibiting DNAPL or COC concentrations exceeding MTCA Method C cleanup levels. This alternative relies on institutional controls as part of the action only to the extent that use of MTCA Method C cleanup levels for soil requires a restrictive environmental covenant on the property. This alternative complies with state and federal laws by identifying ARARs as part of the action, and complying with those ARARs for temporary shoring installation, excavation (relocation of shallow contaminated soil from the JJ Port property to the Simpson property within the AOC), solidification, retaining wall construction, and site restoration.

Prior to cleanup action design, this alternative includes additional soil sampling on the JJ Port property to the north, east, and west of the planned temporary shoring to ensure compliance with the cleanup standards. This alternative provides compliance monitoring by including long-term monitoring of leachate and physical performance testing of solidified soil. To confirm that groundwater at the conditional POC continues to meet the groundwater cleanup levels specified in the revised augmented RI/FS report (see Table 3 of that document), this alternative provides groundwater compliance monitoring for 5 years. This alternative provides a reasonable restoration timeframe by solidifying soil at depths less than 15 feet bgs containing DNAPL or COC concentrations exceeding MTCA Method C cleanup levels within approximately 2 years of approval of the CAP. This restoration timeframe is based on best engineering judgment and estimated by comparing the proposed action to similar actions and considering the likely lead times for design, permitting, coordination with property owners, temporary shoring installation, excavation, solidification, retaining wall construction, and site restoration.

3.1.3 Multi-Component Alternative – Alternative 3

Alternative 3 meets the threshold requirements of WAC 173-340-360. This alternative protects human health and the environment in the B36 Area by:

- Excavating, off-site treating (if needed), and off-site landfilling of soil located at depths less than 7.5 feet bgs containing DNAPL or COCs at concentrations exceeding the preliminary soil cleanup levels
- Containing soil located at depths between 7.5 and 15 feet bgs with DNAPL or COCs at concentrations exceeding preliminary soil cleanup levels through placement of a 7.5-foot cap consisting of clean fill and low-permeability asphalt

This alternative meets the requirements under MTCA that a reasonable effort would be made to eliminate as sources liquid wastes or media with high concentrations of hazardous substances (WAC 173-340-360[c][ii][A]) to maximize protection of groundwater. The low-permeability asphalt cap contains the residual source located at depths between 7.5 and 15 feet bgs by significantly limiting water infiltration that could mobilize COCs. Furthermore, COC concentrations in groundwater at the conditional POC are currently below the anticipated groundwater cleanup levels, which are based on surface water standards. This constitutes an empirical demonstration that even under current conditions groundwater with concentrations exceeding groundwater cleanup levels has not migrated to surface water.

Alternative 3 complies with the anticipated final cleanup levels by removing or containing soil throughout the Site located at depths less than 15 feet bgs exhibiting DNAPL or COC concentrations exceeding MTCA Method C cleanup levels. This alternative relies on institutional controls as part of the action only to the extent that use of MTCA Method C cleanup levels for soil requires a restrictive environmental covenant on the property. This alternative complies with state and federal laws by identifying ARARs as part of the action, and complying with those ARARs for temporary shoring installation, excavation, disposal, cap and retaining wall construction, and site restoration.

Prior to cleanup action design, this alternative includes additional soil sampling on the JJ Port property to the north, east, and west of the planned temporary shoring to ensure compliance with the cleanup standards. Along the shallow soil excavation limits on the Simpson property, this alternative includes post-excavation compliance monitoring consisting of sampling to demonstrate that shallow soil remaining on Site following implementation of the action meets the cleanup standards. To confirm that groundwater at the conditional POC continues to meet the groundwater cleanup levels specified in the revised augmented RI/FS report (see Table 3 of that document), this alternative provides groundwater compliance monitoring for 5 years. Alternative 3 provides a reasonable restoration timeframe by removing or containing soil containing DNAPL or COC concentrations exceeding MTCA Method C cleanup levels within approximately 2 years of approval of the CAP. This restoration timeframe is based on best engineering judgment and estimated by comparing the proposed action to similar actions and considering the likely lead times for design, permitting, coordination with property owners, temporary shoring installation, excavation, cap and retaining wall construction, and site restoration.

3.2 Comparison of Alternatives

This section compares the relative degree of permanence of the cleanup action alternatives. MTCA requires that the cleanup action alternative for a site use permanent solutions to the maximum extent practicable, as evaluated by performing a DCA (WAC 173-340-360[3][e][ii][A]). In this analysis, the cleanup action alternatives are ranked from most to least permanent, based on the evaluation of the alternatives using the following specific criteria (WAC 173-340-360[3][f]):

a. Protectiveness (WAC 173-340-360[3][f][i]) – Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality.

b. Permanence (WAC 173-340-360[3][f][ii]) – The degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated.

c. Cost (WAC 173-340-360[3][f][iii]) – The cost to implement the alternative, including the cost of construction, the net present value of any long-term costs, and agency oversight costs that are cost recoverable. Long-term costs include operation and maintenance costs, monitoring costs, equipment replacement costs, and the cost of maintaining institutional controls. Cost estimates for treatment technologies shall describe pretreatment, analytical, labor, and waste management costs. The design life of the cleanup action shall be estimated and the cost of replacement or repair of major elements shall be included in the cost estimate.

d. Effectiveness over the long term (WAC 173-340-360[3][f][iv]) – Long-term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on site at concentrations that exceed cleanup levels, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes. The following types of cleanup action components may be used as a guide, in descending order, when assessing the relative degree of long-term effectiveness: Reuse or recycling; destruction or detoxification; immobilization or solidification; on-site or off-site disposal in an engineered, lined and monitored facility; on-site isolation or containment with attendant engineering controls; and institutional controls and monitoring.

e. Management of short-term risks (WAC 173-340-360[3][f][v]) – The risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.

f. Technical and administrative implementability (WAC 173-340-360[3][f][vi]) – Ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary off-site facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential cleanup actions.

g. Consideration of public concerns (WAC 173-340-360[3][f][vii]) – Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the site. Further analysis of this criterion will be performed in the future CAP after public comment on this FS has been received.

The relevance of each of these criteria varies on a site-by-site basis. The ranked alternatives are compared against the baseline alternative, which is the most permanent alternative being considered. The test used to evaluate the ranked alternatives is given in MTCA as:

> ***Test.*** *Costs are disproportionate to benefits if the incremental costs of the alternative over that of a lower cost alternative exceed the incremental degree of benefits achieved by alternative over that of the lower cost alternative (WAC 173-340-360[3][e][i]).*

The term "disproportionate" implies that the degree of exceedance of incremental costs to incremental benefits must be substantial. MTCA further clarifies the DCA as follows:

> *The comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment. In particular, the department has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action. Where two or more alternatives are equal in benefits, the department shall select the less costly alternative provided the requirements of subsection (2) of this section are met (WAC 173-340-360[3][e][ii][C]).*

At environmental sites, quantitative comparisons of cost versus benefit typically must compare cost in dollars against non-monetary measures of benefits (such as mass or volume of contaminant removed). One approach to measuring benefit, used in this FS, is to estimate the amount of contaminant reduction using each cleanup action alternative. These quantitative estimates of benefit are used in Sections 3.2.1, 3.2.2, 3.2.3, along with quantitative estimates of the cost of each cleanup action alternative, to assess protectiveness, permanence, and cost (criteria 1, 2 and 3 above). The remaining criteria were assessed in a qualitative manner, as allowed under MTCA (WAC 173-340-360[3][e][ii][C]), using best professional judgment.

This evaluation is organized by criterion. Under the subheading for each criterion, all cleanup action alternatives are compared based on that criterion. The elements of the alternatives are summarized in Table 2-1, to facilitate comparison.

3.2.1 Protectiveness

The comparative protectiveness of the three alternatives is evaluated in this section by comparing the overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, the time required to reduce risk at the facility and attain cleanup standards, the on-site and off-site risks resulting from implementing the alternative, and the improvement of the overall environmental quality.

3.2.1.1 Quantitative Protectiveness Evaluation Component

A key element of the comparative protectiveness evaluation is captured by a quantitative comparison of the relative protectiveness and permanence (see Section 3.2.2) of each alternative against the relative cost of each alternative. In this analysis, the degree of risk reduction achieved by each alternative is evaluated by considering an estimate of contaminant removed or stabilized in soil by each alternative as a surrogate measure of risk reduction, and therefore the "benefit" of each alternative. The mass of COCs (cPAHs only) was used as a measure of the benefit to evaluate the three alternatives. The mass of cPAHs was estimated in pounds for each alternative and also compared to the total alternative cost as shown in Figure 3-1. Calculations of the estimated cPAH mass removal or stabilization for each alternative are provided in Appendix D. The estimated cost to implement each alternative is shown in Table 3-2, with back-up materials in Appendix E.

To effectively compare the benefit of each alternative against the cost of each alternative, the calculated numerical values of the benefit (cPAH mass) and cost data (e.g., the estimated cost of each alternative in dollars), were mathematically converted to unitless relative benefits and costs using a calculation method described as follows. This conversion calculates the estimated incremental change in benefit and cost of each alternative relative to the lowest and highest benefit/cost alternatives (Ecology 2007). The resulting unitless relative benefit (cPAH mass) and cost values range between zero and one for each alternative, as shown on Table 3-3. The unitless values of benefit for COC (cPAH) mass are plotted relative to total alternative cost to directly compare each alternative (see Figure 3-1). In general, the alternative that plots the furthest below (bottom right corner of the graph) the reference line is considered to have the greatest benefit for the cost. Two alternatives plotted on the graph can be directly compared by evaluating the slope of a line connecting the two data points to determine whether the incremental change in cost as a fraction of the total cost range is greater to or less than the incremental change in benefit. The equations for calculating the relative cost and benefit values are shown in the graphic below.

Unitless Cost Versus Benefit Calculation

Equations for Relative Cost and Benefit of Each Alternative (Alternative 1 used as an example):

$$RelC_1 = \frac{[C_1 - MinCOST]}{[MaxCOST - MinCOST]} \qquad RelB_1 = \frac{[B_1 - MinBEN]}{[MaxBEN - MinBEN]}$$

Terms:

$C_1 \ldots C_3$ – Total estimated cost of each alternative, 1 through 3
MinCOST – The cost of the lowest cost alternative
MaxCOST – The cost of the highest cost alternative
$RelC_1 \ldots RelC_3$ – The calculated relative cost of each alternative, 1 through 3

$B_1 \ldots B_3$ – Total estimated benefit (as defined in the text) of each alternative, 1 through 3
MinBEN – The benefit of the lowest benefit alternative
MaxBEN – The benefit of the highest benefit alternative
$RelB_1 \ldots RelB_3$ – The calculated relative benefit of each alternative, 1 through 3

The graphical presentation of the results of this relative cost versus benefit analysis (Figure 3-1) shows that Alternative 2 is the most favorable alternative. Although both Alternative 1 and 2 address the target volume of soil exhibiting DNAPL or COC concentrations exceeding MTCA Method C cleanup levels (soil located at depths less than 15 feet bgs), Alternative 2 achieves this benefit at a lower cost. Figure 3-1 also illustrates that the costs of implementing Alternatives 1 or 3 are disproportionate compared to Alternative 2. The data point for Alternative 2 is below and to the right of any 1:1 reference lines drawn through the other two alternatives.

Figure 3-1 can also be used to compare the relative costs and benefits between the other two alternatives. Because Alternatives 1 and 3 are joined by a line with a slope of 1.0, these two alternatives rank the same in the disproportionate cost analysis.

3.2.1.2 Qualitative Protectiveness Evaluation Component

The degree to which existing risks are reduced by each alternative, the on-site risks resulting from implementing each alternative, and improvement of the overall environmental quality under each alternative, are evaluated quantitatively in this section as relative “benefit.” Other components of the comparative protectiveness evaluation are largely qualitative and are discussed below.

The estimated time required to reduce risk at the facility and attain cleanup standards is estimated to be the same for Alternatives 1 and 3, because these alternatives rely on construction techniques that can be implemented in similar timeframes (e.g., soil excavation over various footprints and depths and capping). These two alternatives are estimated to be implementable within 2 years of CAP approval. Because *in situ* solidification would require bench- and pilot-scale testing prior to design of the cleanup action, Alternative 2 is estimated to take 3 years to implement following CAP approval.

The off-site risks resulting from implementing each alternative can be evaluated by considering the risks associated with transport and disposition of soil containing COCs under each alternative. For this criterion, Alternative 2 has the lowest off-site risk because only very small quantities of soil containing DNAPL or COCs would be transported off Site (e.g., primarily drill cuttings and miscellaneous investigation-derived waste). Alternative 3 would have the next lowest off-site risk, because only shallow soil (soil located at depths less than 7.5 feet bgs) would be transported off Site. Finally, Alternative 1 would have the highest off-site risk, because this alternative includes excavation, transport, and disposal of the largest quantity of soil containing DNAPL and COCs.

3.2.2 Permanence

The comparative permanence of the three alternatives is evaluated in this subsection by evaluating the degree to which each alternative permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated.

The quantitative estimation and comparison of "benefit" for each alternative under Section 3.2.1.1 captures many of the elements of the comparative permanence evaluation. In general, alternatives that remove or treat a larger fraction of the COCs in soil can be considered more permanent because less contaminant would remain with the potential to act as a residual source and the potential to result in future exposures.

The treatment technologies considered by the alternatives include, in generally decreasing order of relative irreversibility:

a. Solidification (which immobilizes contaminants and eliminates them as sources)
b. Off-site stabilization/treatment of soil with landfill disposal (this technology treats the contaminants off-site prior to placement in an engineered, lined and monitored facility)
c. Landfill disposal (which contains contaminants off site in an engineered, lined, and monitored facility)
d. Containment (on-site containment using an low-permeability cap)

However, evaluation of the relative irreversibility of the alternatives needs to take into consideration that most alternatives rely on more than one technology and apply each to differing volumes of soil with differing levels of contamination. The alternatives are discussed below in decreasing order of relative irreversibility (i.e., from greatest degree of irreversibility to least).

Alternative 2 is considered the most irreversible alternative because it does not rely on containment on-site or landfill disposal for any soil with DNAPL or COCs exceeding the cleanup levels and it relies solely on solidification, which immobilizes contaminants thus eliminating them as sources.

Alternative 1 is the next most irreversible alternative, which relies on off-site treatment and landfill disposal for approximately 10 percent of the target volume, but relies on direct off-site landfill disposal for approximately 90 percent of the target volume.

Alternative 3 is the least irreversible alternative, which relies on containment on Site for about 81 percent of the target volume, results in off-site treatment and landfill disposal for approximately 2 percent of the target volume and relies on direct landfill disposal for approximately 17 percent of the target volume.

The treatment technologies relied upon by each alternative vary with regard to the probable completeness of treatment, and therefore each technology results in treatment residuals of varying characteristics and quantity remaining following treatment.

Treatment residuals from Alternative 2 consist of a solidified soil mass containing chemically and physically bonded COCs with a much reduced probability of leaching, migration, and exposure. To the extent that the lateral and vertical extent of solidification covered the entire soil volume with COCs exceeding the cleanup level, and to the extent that soil mixing was uniform and complete, unsolidified soil would be minimal. Achieving good mixing and sufficient lateral and vertical coverage should be straightforward at this Site because of the relatively open work area. Bench- and pilot-scale testing would be performed prior to cleanup action implementation to optimize the mixture to be used for solidification.

Alternative 1 relies primarily on excavation and off-site landfill disposal with approximately 10 percent of the target soil volume treated off-site prior to landfill disposal. Under this alternative, no soil containing COCs exceeding the cleanup levels or DNAPL would remain on Site at depths less than 15 feet bgs. Any recovered DNAPL liquids would be recycled or destroyed through incineration. Incineration residuals are minimal and managed at the incineration facility. Landfilled soils (unless treated at the landfill) have similar characteristics to the soil currently present at the Site.

Alternative 3 relies on excavation and off-site landfill disposal of 19 percent of the target soil volume (with 2 percent of the target soil volume treated off-site prior to landfill disposal) and on-site containment of the remaining 81 percent of the target soil volume. Any recovered DNAPL liquids would be recycled or destroyed through incineration. Incineration residuals are minimal and managed at the incineration facility. Landfilled soils (unless treated at the landfill) and soil contained on site have similar characteristics to the soil currently present at the Site.

3.2.3 Cost

The estimated cost to implement each alternative is summarized in Table 3-2, with backup materials in Appendix E. The analysis of the relative cost of each alternative compared to the relative benefit is included in the analysis discussed under Section 3.2.1.1.

3.2.4 Effectiveness over the Long Term

MTCA provides guidance for the relative degree of long-term effectiveness of the various treatment components relied upon by the alternatives:

> *WAC 173-340-360(3)(f)(iv): The following types of cleanup action components may be used as a guide, in descending order, when assessing the relative degree of long-term effectiveness: Reuse or recycling; destruction or detoxification; immobilization or solidification; on-site or off-site disposal in an engineered, lined and monitored facility; on-site isolation or containment with attendant engineering controls; and institutional controls and monitoring.*

Therefore, solidification or encapsulation of COCs is considered by Ecology to achieve the third-highest relative degree of long-term effectiveness. The WAC considers off-site disposal in an engineered, lined, and monitored facility to achieve the fourth-highest relative degree of long-term effectiveness compared to other treatment and disposal options. On-site containment is considered by the WAC to achieve the fifth-highest relative degree of long-term effectiveness, compared to other treatment technologies.

The degree to which each alternative relies on these treatment components provides a relative comparison of the long-term effectiveness of the alternatives and is presented as follows from greatest to the least relative degree of long-term effectiveness:

- Alternative 2 – Solidification of 100 percent of the target soil volume
- Alternative 1 – Off-site treatment to encapsulate the COCs followed by landfill disposal of approximately 10 percent of target volume, and landfill disposal of 90 percent
- Alternative 3 – Off-site treatment to encapsulate the COCs followed by landfill disposal of approximately 2 percent of target volume, on-site containment of approximately 81 percent, and landfill disposal of 17 percent

3.2.5 Management of Short-Term Risks

Short-term risks to human health and the environment during construction and implementation of the alternatives include risks from construction activities and potential short-term exposure to DNAPL and COCs. In general, alternatives that are less complex, involve less transportation of contaminated soil and are of shorter duration typically have lower short-term risks.

Alternative 2 is considered to have the lowest short-term risks for the following reasons:

- No contaminated soil would be transported off site, eliminating potential risks from transportation and handling at the point of disposition
- Only a limited amount of contaminated soil from the JJ Port property would be brought to the ground surface, minimizing worker exposures
- Only limited shoring would be required on the JJ Port property to stabilize excavation walls to a depth of 7.5 feet bgs
- The construction processes involved are of relatively short duration and utilize standard construction techniques

Unique to Alternative 2 are the risks associated with grout and bentonite materials needed for solidification and use of large-diameter auger equipment. The risks from this activity are similar to other construction projects that rely on concrete work and drilling techniques. The short-term risks associated with Alternative 2 can be managed by using standard construction quality assurance and health and safety protocols.

Alternative 3 is considered to have the next lowest short-term risks based on the following:

- Shoring would be required on the JJ Port property to stabilize the excavation walls to a depth of 15 feet bgs.
- Contaminated soil would be brought to the ground surface and managed in containers. However, on-site management of soil dewatering and consequent management of DNAPL and water waste streams would be limited with this alternative because only a small portion of the Site on the JJ Port property would be excavated to depths below the water table. This would increase risks to worker safety and potential exposure pathways from releases, however these risks can be controlled with engineering controls and BMPs.

- Contaminated soil would need to be transported substantial distances. Accidents during transport, though rare, do occur and could result in both releases to the environment and harm to human health.
- The construction processes involved for the limited excavation and the retaining wall and low-permeability cap construction are relatively short duration and utilize standard construction techniques.

The short-term risks for Alternative 3 require management both using standard construction protocols and specialized health and safety protocols specific to DNAPL and groundwater handling, although the volumes of DNAPL and groundwater requiring handling are substantially less than compared to Alternative 1.

Alternative 1 is considered to have the highest short-term risks based on the following:

- Shoring would be required on the JJ Port property to stabilize the excavation walls to a depth of 15 feet bgs.
- A large volume of contaminated soil would be brought to the ground surface and managed in containers, with on-site management of soil dewatering and consequent management of a substantial volume of DNAPL and water waste streams. Therefore, risks are expected to be greater with this alternative compared to Alternative 3. However, these risks can be controlled with engineering controls and BMPs.
- A large volume of contaminated soil would need to be transported substantial distances. Accidents during transport, though rare, do occur and could result in both releases to the environment and harm to human health.

The short-term risks for Alternative 1 require management both using standard construction protocols and specialized health and safety protocols specific to DNAPL and groundwater handling. The volumes of DNAPL and groundwater to be handled are substantially greater than compared to Alternative 3. Therefore, risks are expected to be greater with this alternative.

3.2.6 Technical and Administrative Implementability

All alternatives could be implemented at the Site with regard to technically practicability; availability of necessary off-site facilities; services and materials; administrative and regulatory requirements; scheduling; size; complexity; monitoring requirements; access for construction operations and monitoring; and integration with existing facility operations and other current or potential cleanup actions. However, some alternatives would be more easily implemented than others, based on the relative complexity of implementation and the technical certainty each technology's effectiveness given the Site and contaminant characteristics. The discussion below is presented in the relative order from greatest to least implementable soil alterative.

Alternative 2 is the most favorable with regard to technical and administrative implementability for many of the same reasons listed in Section 3.2.5. This alternative is less complex than the other alternatives because it relies less on shoring and dewatering control and does not involve off-site transport of soil (including permitting and treatment at the disposal facilities). Solidification is expected to work well to sequester the contaminants at the Site. The solidification mixture could be selected to allow future excavation or drilling, as needed. Because of the increased strength of the solidified soil, future excavation although feasible requires more robust excavation techniques than would be needed for native or imported gravel soils (e.g., larger excavators might be needed). Future solidified soil generated during hypothetical future excavations would require characterization and disposal at a facility approved to receive corrective action management unit-eligible waste, because the solidified soil would contain a listed waste. Procedures for characterizing and disposing of any solidified soil excavated in the future could be written in to the institutional controls plan for the Site. Similarly, worker notifications and health and safety precautions for performing excavation in the solidified soil could be provided in the institutional controls plan for the Site.

Alternative 3 is the next most favorable, because it involves excavation over a smaller area than Alternative 1 and requires less management of DNAPL and water waste streams than Alternative 1. Alternative 3 would require construction of a low-permeability cap and a retaining wall, but these utilize standard construction practices. Both Alternative 1 and 3 are complicated by the need for shoring.

Alternative 1 is the least favorable, because it involves shoring and handling, transport, and disposal of large volumes of contaminated soil and DNAPL, as well as handling and treatment of a large volume of groundwater.

3.2.7 Consideration of Public Concerns

Analysis of this criterion will be performed in the future CAP after public comment on this FS addendum has been received.

3.3 Preferred Cleanup Action Alternative

This section draws conclusions based on the analyses presented in Section 3.2 and recommends a preferred cleanup action alternative for consideration in the CAP. The preferred alternative is Alternative 2 – *In Situ* Solidification. Under this alternative, DNAPL and COCs exceeding the preliminary cleanup levels in soil located at depths less than 15 feet bgs would be immobilized in place. This alternative exhibits several substantial advantages over the other two alternatives evaluated:

- The other two alternatives are disproportionately costly compared to Alternative 2, when relative benefits and costs are compared
- Alternative 2 has the highest combined rank considering six of the seven MTCA criteria. Table 3-4 presents a summary of the rankings for all of the alternatives.
- Alternative 2 avoids the short-term and off-site risks associated with excavation, handling, off-site transport, and off-site disposal of soil containing DNAPL and COCs, as well as the risks associated with on-site management of soil dewatering and consequent management of DNAPL and water waste streams
- Alternative 2 is the most irreversible alternative because it does not rely on containment on site or landfill disposal for any soil with DNAPL or COCs exceeding the cleanup levels and it relies solely on solidification, which immobilizes contaminants thus eliminating them as sources
- Treatment residuals from Alternative 2 consists of a solidified soil mass containing chemically and physically bonded COCs with a much reduced probability of leaching, migration, and exposure
- Alternative 2 has the highest expected effectiveness over the long term, because solidification is considered a more effective technology than off-site landfill disposal and on-site containment, which are relied upon by the other two alternatives
- Alternative 2 is considered to have the lowest short-term risks for the following reasons:
  - No contaminated soil would be transported off site, eliminating potential risks from transportation and handling at the point of disposition
  - Only a limited amount of contaminated soil from the JJ Port property would be brought to the ground surface, minimizing worker exposures
  - No dewatering would be required
  - Only limited shoring would be required on the JJ Port property to stabilize excavation walls to a depth of 7.5 feet bgs
  - The construction processes involved are of relatively short duration and utilize standard construction techniques

Table 3-1. Evaluation of Alternatives Using MTCA Criteria[1], B36 Area, Tacoma Metals Site

Alternative	Protect Human Health and the Environment	Comply with Cleanup Standards	Comply with Applicable State and Federal Regulations	Provide for Compliance Monitoring	Provide for a Reasonable Restoration Timeframe	Consider Public Concerns
Alternative 1: Excavation (Baseline)	• Excavates and landfills/treats off site all soil containing DNAPL or COCs at concentrations exceeding the preliminary cleanup levels at depths less than 15 feet bgs • Eliminates the direct contact pathway for human and ecological receptors • Reduces the vadose zone sources to significantly reduce further migration of COCs from soil to groundwater	• Complies by eliminating soil sources containing DNAPL or COC concentrations exceeding cleanup levels at depths less than 15 feet bgs • Relies on institutional controls only to the extent that use of Method C cleanup levels would require a restrictive environmental covenant on the property	• Complies with ARARs for excavation, disposal, and site restoration	• Uses pre- and post-excavation sampling to demonstrate that soil remaining on site at depths less than 15 feet bgs following implementation of the action meets the cleanup standards • Uses long-term monitoring of groundwater at the conditional point of compliance	• Eliminates soil sources containing DNAPL or COC concentrations exceeding cleanup levels at depths less than 15 feet bgs within approximately 2 years of approval of the CAP not including long-term groundwater monitoring	• Analysis of this criterion will be performed in the future CAP after public comment on this FS addendum has been received
Alternative 2: In Situ Solidification	• Solidifies soil containing DNAPL or COCs at concentrations exceeding the cleanup levels at depths less than 15 feet bgs • Eliminates the direct contact pathway for human and ecological receptors • Makes a reasonable effort to reduce vadose zone sources (DNAPL or media with high concentrations of hazardous substances) to significantly reduce further migration of COCs from soil to groundwater	• Complies by solidifying soil exhibiting DNAPL or COC concentrations exceeding cleanup levels at depths less than 15 feet bgs • Relies on institutional controls only to the extent that use of Method C cleanup levels would require a restrictive environmental covenant on the property	• Complies with ARARs for temporary shoring installation, excavation, solidification, retaining wall construction, and site restoration	• Uses pre-excavation sampling to demonstrate that unsolidified soil remaining on the JJ Port property at depths less than 15 feet bgs following implementation of the action meets the cleanup standards • Uses physical performance testing of solidified soil following implementation of the action • Uses long-term monitoring of groundwater at the conditional point of compliance	• Solidifies soil containing DNAPL or COC concentrations exceeding cleanup levels within approximately 3 years of approval of the CAP, not including long-term groundwater monitoring	• Analysis of this criterion will be performed in the future CAP after public comment on this FS addendum has been received
Alternative 3: Multi-Component Alternative	• Excavates and landfills/treats off site soil containing DNAPL or COCs at concentrations exceeding the preliminary cleanup levels at depths less than 7.5 feet bgs • Places a soil cap so that remaining soil exceeding the preliminary cleanup levels would be located at depths greater than 15 feet bgs to eliminate the direct contact pathway for human and ecological receptors • Uses impermeable asphalt over the soil cap to contain the residual vadose zone sources by significantly limiting water infiltration and reducing further migration of COCs from soil to groundwater	• Complies by removing soil sources containing DNAPL or COC concentrations exceeding cleanup levels at depths less than 7.5 feet bgs and placing a soil and asphalt cap so that remaining soil exceeding the preliminary cleanup levels would be located at depths greater than 15 feet bgs • Relies on institutional controls to the extent that use of Method C cleanup levels would require a restrictive environmental covenant on the property	• Complies with ARARs for temporary shoring installation, excavation, disposal, cap and retaining wall construction, and site restoration	• Uses pre- and post-excavation sampling to demonstrate that soil remaining on site at depths less than 15 feet bgs following implementation of the action meets the cleanup standards • Uses long-term monitoring of groundwater at the conditional point of compliance	• Removes soil containing DNAPL or COC concentrations exceeding cleanup levels at depths less than 7.5 feet bgs and places a 7.5 foot soil and asphalt cap within approximately 2 years of approval of the CAP not including long-term groundwater monitoring	• Analysis of this criterion will be performed in the future CAP after public comment on this FS addendum has been received

Notes:
[1]The criteria, use permanent solutions to the maximum extent practicable, is evaluated in Section 3.2, and not included in this table.

ARAR - applicable, relevant, and appropriate requirement
bgs - below ground surface
CAP - corrective action plan
COC - chemical of concern
DNAPL – dense nonaqueous phase liquid

Table 3-2. Comparison of Alternative Costs, B36 Area, Tacoma Metals Site

Task	Alternative 1 Excavation (Baseline)	Alternative 2 *In Situ* Solidification	Alternative 3 Multi-Component Alternative
Capital Costs			
Capital Direct Costs	$3,580,000	$1,750,000	$1,320,000
Contingency Assumed (%)	30%	30%	25%
Capital Indirect Costs	$414,000	$361,000	$381,000
Total Capital Costs	**$3,990,000**	**$2,110,000**	**$1,700,000**
O&M Costs			
Total O&M Costs (5 years)	$122,000	$122,000	$157,000
O&M Contingency	25%	25%	25%
Total Capital and O&M Costs	$4,110,000	$2,230,000	$1,860,000
Years of O&M	5	5	5
Annualized O&M Costs	$24,000	$24,000	$32,000
PW O&M Costs [a]	**$105,000**	**$105,000**	**$136,000**
Other Costs			
Sales Tax	$340,000	$166,000	$126,000
Agency Oversight (Ecology)	$80,000	$42,000	$34,000
Project Totals			
Total Capital and PW O&M Costs	**$4,100,000**	**$2,200,000**	**$1,800,000**
Total Project PW [a]	**$4,500,000**	**$2,400,000**	**$2,000,000**
Total Project Cost	**$4.5M**	**$2.4M**	**$2.0M**

Notes:

[a] Present worth costs were calculated using a 3% discount rate.

[b] Construction of Alternative 3 is more straightforward and there are fewer uncertainties compared to Alternatives 1 and 2. Therefore, a lower contingency was used for Alternative 3.

Discount rate (3%) = interest rate (6%) - inflation (3%)

M - million

O&M - operation and maintenance

PW - present worth

Table 3-3. Disproportionate Cost Analysis Summary, B36 Area, Tacoma Metals Site

Alternative No.	Description	Mass Removed, Contained, or Stabilized		Cost ($)	
		COC Mass - cPAHs (lbs)	Relative Benefit[2]	Total Estimated Project Cost	Relative Cost[3]
1	Excavation (Baseline)	1,500	1.00	$4.5M	1.00
2	In Situ Solidification	1,500	1.00	$2.4M	0.16
3	Multi-Component Alternative[1]	60	0.00	$2.0M	0.00
	Minimum:	60	NA	$2.0M	NA
	Maximum:	1,500	NA	$4.5M	NA

Notes:

[1]The multi-component alternative removes 60 lbs of cPAHs by excavation; it also contains in place 1,400 lbs of cPAHs.

[2]Relative benefit = (estimated benefit of alternative - the benefit of the lowest benefit alternative)/(the benefit of the highest benefit alternative - the benefit of the lowest benefit alternative)

[3]Relative cost = (estimated cost of alternative - the cost of the lowest cost alternative)/(the cost of the highest cost alternative - the cost of the lowest cost alternative)

COC - chemical of concern
cPAHs - carcinogenic polynuclear aromatic hydrocarbons
lb - pound

Table 3-4. MTCA Criteria Rankings Summary, B36 Area, Tacoma Metals Site

Alternative	Protectiveness Rank	Permanence Rank	Cost (PW) Rank	Long-Term Effectiveness Rank	Short-Term Risk Rank	Implementability Rank	Public Concerns Rank	Sum of Individual Ranks	Combined Rank
1	3	2	3	2	3	3	NR	16	3
2	1	1	2	1	1	1	NR	7	1
3	3	3	1	3	2	2	NR	14	2

Notes:
1 - Excavation (Baseline)
2 - *In Situ* Soil Solidification
3 - Multi-Component Alternative
NR - not ranked
PW - Present Worth

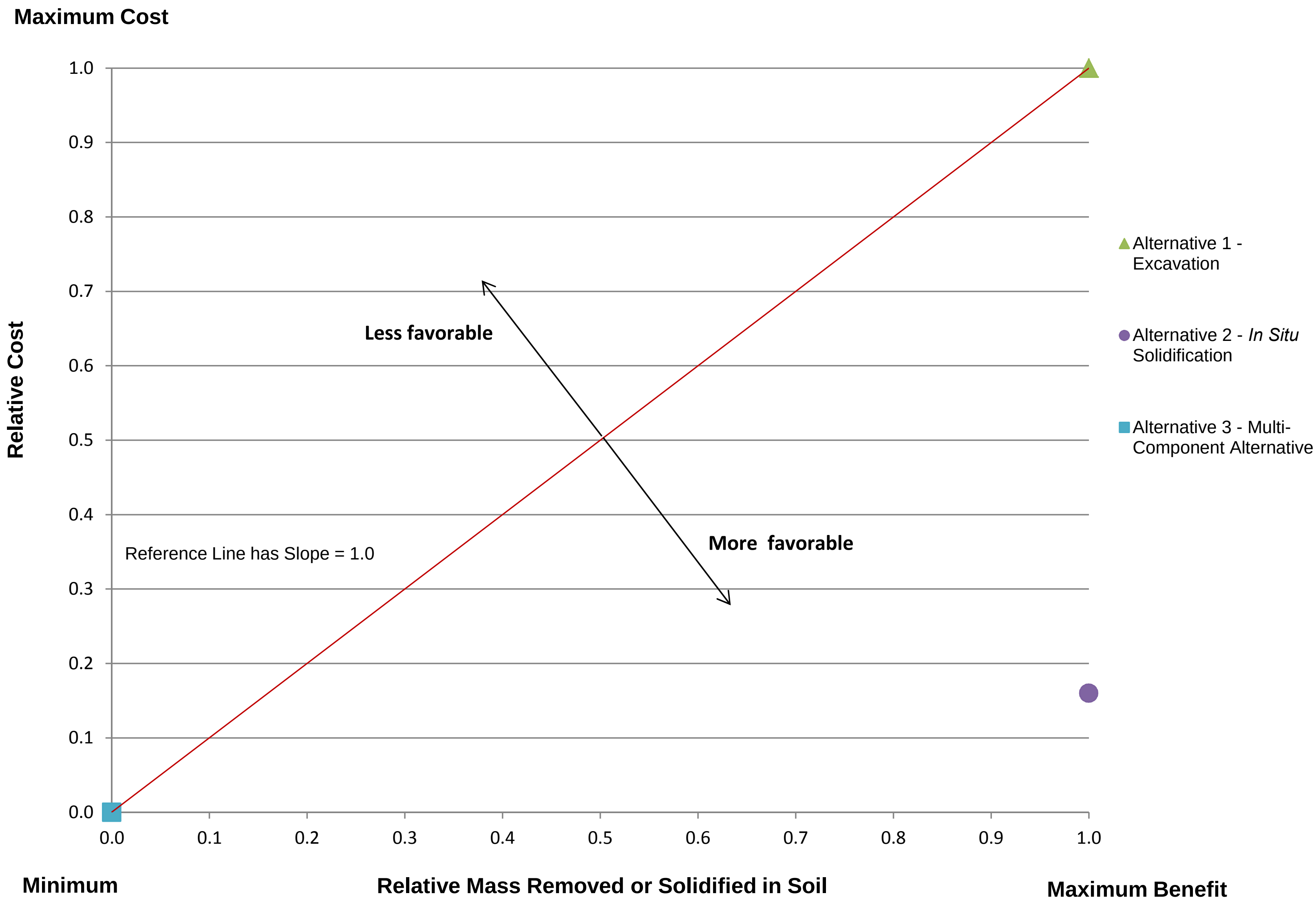

Figure 3-1

Disproportionate Cost Analysis

Job No. 33764085

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Tacoma Metals Site
Tacoma, Washington

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