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Cleanup Level Evaluation Former Tacoma Metals Facility

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Prepared for

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Section 1: Introduction

In the *Draft Remedial Investigation and Feasibility Study, Former Tacoma Metals Facility* report (Kennedy/Jenks Consultants 2001), Kennedy/Jenks Consultants summarized the results of a remedial investigation and feasibility study (RI/FS) conducted at the former Tacoma Metals facility (site) located at 1919 Portland Avenue in Tacoma, Washington. The RI/FS report included, but was not limited to, the following:

- A detailed evaluation of site conditions and summary of the distribution of chemicals of concern detected in site soils and groundwater.
- An evaluation of site exposure pathways and potential human and ecological receptors.
- An evaluation of multiple remedial techniques and a detailed evaluation of three remedial alternatives in accordance with WAC 173-340-360.
- Recommendation of a remedial alternative for implementation at the site to address site conditions.

Since submittal of the Draft RI/FS report in 2001, additional on-property and off-property investigations have been performed in the northwestern portion of the site. The results of these investigations have been submitted to Washington State Department of Ecology (Ecology) in a separate report (Kennedy/Jenks Consultants 2007). The Draft RI/FS report (submitted to Ecology in 2001) was prepared under an earlier version of the Model Toxics Control Act (MTCA) regulations (WAC 173-340) amended January 1996.

This report provides the following:

- The results of a human health-based screening evaluation for groundwater monitoring analytical results conducted at the site since completion of the Draft RI/FS.
- A summary of proposed cleanup standards for site soil and groundwater based on current amendments to MTCA and the human health risk evaluation.
- An evaluation of the remedial alternative proposed for the site with respect to the recent analytical results and the current MTCA regulations amended 12 February 2001.

1.1 Objectives

The purpose of the human health-based screening evaluation was to identify site-specific cleanup levels for carcinogenic polycylic aromatic hydrocarbons (cPAHs) in groundwater that are protective of human health and the environment. Following proposal of groundwater cleanup levels for total cPAHs in site groundwater, this report summarizes all cleanup standards for site soil and groundwater based on current regulations. Finally, this report evaluates the proposed remedial alternative selected in the Draft RI/FS with respect to current site analytical results and modification to the MTCA regulations outlined in WAC 173-340-360.

1.2 Report Organization

This report is organized as follows:

- Section 2 presents the health-based screening evaluation for selection of groundwater cleanup standards for cPAHs.
- Section 3 presents the proposed cleanup standards for the site soil and groundwater.
- Section 4 identifies minor modifications to the proposed remedial alternative based on recent analytical results and evaluates the remedial alternative selection process with respect to current regulations in WAC 173-340-360.
- Section 5 presents the references.

Section 2: Human Health Risk Evaluation

This section presents the results of the human health risk evaluation.

2.1 Site Setting and Conditions

2.1.1 Site Location

The site is located at 1919 Portland Avenue in Tacoma, Washington, in an industrial-zoned area along the southern bank of the Puyallup River at approximately river mile (RM) 1.7 (refer to Figure 1). The site is separated from the Puyallup River by a man-made levee with an approximate height of 20 feet that was constructed by the Army Corps of Engineers. The Lincoln Avenue Bridge, which crosses the Puyallup River, is adjacent to the site to the east. In 2005, the City of Tacoma completed the Puyallup Side Channel project, which consists of a constructed wetland located adjacent to the site.

2.1.2 Hydrogeologic Setting

The direction of the hydraulic gradient in shallow groundwater at the site is influenced by tidal fluctuations in the Puyallup River and fluctuates between high and low tidal cycles. At low tide, the hydraulic gradient is toward the Puyallup River, and at high tide, the gradient is toward the site, generally away from the Puyallup River. A localized stagnation zone is observed in the central portions of the site at high tide.

No seep discharges from the site have been identified along the bank of the Puyallup River Side Channel wetland located adjacent to the site.

For an expanded discussion of hydrogeologic conditions at the site, refer to the Draft RI/FS report (Kennedy/Jenks Consultants 2001) and the Supplemental Data Summary Report (Kennedy/Jenks Consultants 2007).

2.1.3 Beneficial Uses of Puyallup River

The Puyallup River drains into Commencement Bay of Puget Sound. The Puyallup River (from its mouth to RM 1.0) is designated for beneficial uses, including aquatic life (i.e., rearing/migration only); recreation; industrial, agricultural, and stock water supply; wildlife habitat; harvesting; commerce/navigation; boating; and aesthetics. Domestic water supply is not listed as a beneficial use of the Puyallup River (from its mouth to RM 1.0) (Ecology 2006). The Puyallup River (from RM 1.0 to the junction with the White River) is designated for beneficial uses including aquatic life (i.e., core summer habitat); recreation; domestic, industrial, agricultural, and stock water supply; wildlife habitat; harvesting; commerce/navigation; boating; and aesthetics (Ecology 2006).

The lower-most part of the Puyallup River is a salt-wedge estuary with deeper salt water overlain by a layer of fresh water (Ebbert 2003). The salt wedge generally extends to RM 2.5 (Ebbert and others 1987, as cited by Ebbert 2003); however, monitoring data collected in 2001 indicated that it sometimes reaches RM 2.9 (Ebbert 2002, as cited by Ebbert 2003). These data suggest that the Puyallup River at RM 1.7 is not potable for drinking water purposes due to the salinity resulting from tidal fluctuations.

Shellfish harvesting at Commencement Bay is closed (Washington State Department of Health 2007).

2.1.4 Summary of Groundwater Data

Groundwater monitoring was most recently performed in February 2006. Locations of groundwater monitoring wells are displayed on Figure 2. Tabulated results for the February 2006 monitoring event are presented in Table 1.

cPAHs are considered a single hazardous substance for calculating excess cancer risk and determining compliance with cleanup and remediation levels. WAC 173-340-708(8) requires the entire mixture of cPAHs to be assumed as toxic as benzo(a)pyrene. To account for differences in toxicity among individual cPAHs, toxicity equivalence factors are applied to obtain a toxic equivalent concentration (TEC).

Measured concentrations of total cPAHs in unfiltered groundwater samples collected from site wells ranged from 0.00213 micrograms per liter (μg/l) to 11.8μg/l. As discussed in the Draft RI/FS, a conditional point of compliance will be used in accordance with WAC 173-340-720(8)(d)(i) to evaluate compliance with groundwater standards (refer to Section 3.0). These conditional point of compliance wells include MW-2, MW-4R, MW-5, MW-6, MW-9, MW-19, MW-20, MW-23, and MW-29. Concentrations of total cPAHs in unfiltered samples collected from point of compliance wells (wells located along the downgradient property boundary) range from <0.149 to 0.131 μg/l.

2.2 Human Health-Based Cleanup Levels

2.2.1 Selection of Appropriate Cleanup Levels

Groundwater standards for the protection of human health from consumption or organisms are not appropriate for shallow zone groundwater at the site because the shallow zone groundwater is not considered a current or potential future source of potable water. Because shallow zone groundwater at the site discharges to the Puyallup River, site groundwater cleanup levels that are protective of surface water beneficial uses are appropriate. WAC 173-340-720(8)(d)(i) indicates that when groundwater discharges to surface water that abuts the site, a conditional point of compliance may be used. For practical purposes, compliance with surface water standards is evaluated through monitoring groundwater in wells installed adjacent to the surface water body. WAC 173-340-720(8)(e)(ii) allows for natural attenuation when measuring compliance with cleanup standards.

WAC 173-340-730(1)(a) states, "surface water cleanup levels shall be based on estimates of the highest beneficial use and the reasonable maximum exposure expected to occur under both current and potential future site use conditions." As previously discussed, the surface water at RM 1.7 is not potable because of its salinity. The highest beneficial use of the Puyallup River at RM 1.7 is harvesting of fish and shellfish for human consumption. Therefore, surface water standards for the protection of human health from the consumption of organisms are appropriate for the site. According to WAC 173-340-730(3)(b), these standards include state water quality criteria under Chapter 173-201A WAC, Ambient Water Quality Criteria (AWQC) under Section 304 of the Clean Water Act, National Toxics Rule (40 Code of Federal Regulations [CFR] Part 131), and MTCA Method B surface water cleanup levels. The state water quality criteria listed under 173-201A-WAC (Table 240[3]) do not include criteria based on human consumption of organisms only. The National Toxics Rule (NTR) criterion is based on the Gold Book, which has been superseded by the 2004 AWQC.

2.2.2 Bioconcentration of PAHs in Finfish

The derivation of surface water cleanup levels incorporates a bioconcentration factor (BCF), which is defined as the ratio of the chemical concentration in the organism to the substance concentration in the water at equilibrium. The majority of PAHs that are absorbed by vertebrates (i.e., finfish) are efficiently biotransformed by enzymes that increase their water solubility, allowing excretion to take place. As a consequence, tissue levels of PAHs do not provide an appropriate assessment of the exposure level (Varanasi et al. 1989). PAH BCFs estimated from the octanol/water partition coefficient (Kow) are higher than measured BCFs because of the metabolism and excretion of PAHs by finfish (Jonsson et al. 2004).

Significant bioconcentration of cPAHs in finfish would not occur; thus humans would not consume cPAHs in finfish tissue resulting from surface water contributions. As discussed in the following sections, the site-specific surface water cleanup levels were adjusted to reflect consumption of estuarine shellfish/invertebrates only because finfish (i.e., vertebrates) readily metabolize and excrete cPAHs. The most common bivalve species in Washington estuaries include Pacific oysters, blue mussels, and numerous varieties of clams, including littleneck, Manila, butter, geoduck, cockle, horse, softshell, and razor clams (Puget Sound Action Team 2003).

2.3 MTCA Method B Surface Water Cleanup Levels

MTCA Method B surface water cleanup levels for human health protection are based on the fish and shellfish consumption pathway for surface waters that support or have the potential to support fish or shellfish populations. WAC 173-340-730(3)(a) states that either standard or modified Method B surface water cleanup levels may be used at any site. For carcinogens, Method B surface water cleanup levels are concentrations that are estimated to result in an excess cancer risk less than or equal to one in a million (1×10^{-6}) as determined using Equation 730-2 in WAC 173-340-730(3)(a)(iii)(B):

$$\text{Surface water cleanup level } (\mu g/l) = \frac{RISK \times ABW \times AT \times UCF1 \times UCF2}{CPF \times BCF \times FCR \times FDF \times ED}$$

Where:

CPF = Carcinogenic potency factor as specified in WAC 173-340-708(8) [kilograms per day per milligram (kg-day/mg)]

RISK = Acceptable cancer risk level (1 in 1,000,000) (unitless)

ABW = Average body weight during the exposure duration [70 kilograms (kg)]

AT = Averaging time (75 years)

UCF1 = Unit conversion factor [1,000 micrograms per milligram(µg/mg)]

UCF2 = Unit conversion factor (1,000 grams/liter)

BCF = Bioconcentration factor as defined in WAC 173-340-708(9) [liters per kilogram (l/kg)]

FCR = Fish consumption rate (54 grams per day)

FDF = Fish diet fraction (0.5) (unitless)

ED = Exposure duration (30 years)

The acceptable risk level is 1×10^{-6} under Method B because cPAHs are evaluated as a single hazardous indicator substance. For benzo(a)pyrene, the CPF is 7.3 kg-day/mg and the BCF is 30 l/kg (Ecology 2007).

A modified Method B surface water cleanup level was calculated by adjusting the fish consumption rate to account for the consumption of shellfish (i.e., oysters and clams) only. The USEPA (1998) lists mean estuarine shellfish consumption rates, in units of gram per person per day (g/person/day) for fish and shellfish species caught from estuarine systems for human consumption. Of the species listed by the USEPA (1998), oysters and clams are the shellfish species that would mostly likely be harvested within the Puyallup River estuarine system for human consumption. The MTCA Method B Equation 730-2 includes the assumption that 50 percent of the fish consumed over a 30-year period is collected from the site. This assumption for fish diet fraction was not modified for the site-specific cleanup level calculations.

To calculate an adjusted consumption rate, it was assumed that the shellfish species consumed would include oysters and clams. The adjusted consumption rate is 0.26 g/person/day, based on the shellfish consumption rates provided by USEPA (1998):

- Oysters are consumed at a mean rate of 0.23 g/person/day.
- Clams are consumed at a mean rate of 0.031 g/person/day.

Using a consumption rate of 0.26 g/day in Equation 730-2, the resulting modified Method B surface water cleanup level for total cPAHs is 6.22 µg/l.

2.4 Ambient Water Quality Criteria for Human Health

Pursuant to Section 304(a) of the Clean Water Act, the USEPA develops AWQC for the protection of human health and aquatic species. AWQC for the protection of human health are designed to minimize the risk of adverse effects occurring to humans from chronic (lifetime) exposure to substances through the ingestion of drinking water and consumption of fish obtained from surface waters.

The AWQC based on consumption of organisms only was considered applicable for comparison to groundwater data. The criterion for benzo(a)pyrene, based on consumption of organisms only, is 0.018 µg/l (USEPA 2004). The 2004 criterion is based on the USEPA's *Methodology for*

Deriving Ambient Water Quality Criteria for the Protection of Human Health (USEPA 2000). The USEPA initially presented AQWC methodology in 1980, *Guidelines and Methodologies Used in the Preparation of Health Effects Assessment Chapters of the Consent Decree Water Criteria Documents* (45 FR 79347). The 1980 methodology was revised in 2000 to reflect current scientific methods.

The NTR criterion of 0.031 µg/l for benzo(a)pyrene is based on the consumption of organism only and a target risk level of 1×10^{-6}. The NTR criterion of 0.031 µg/l is based on the criterion presented in the USEPA's *Quality Criteria for Water 1986* (Gold Book, USEPA 1986). The water quality criteria presented in the Gold Book have been superseded by subsequent revisions of the AWQC.

The AWQC of 0.018 µg/l was adjusted to account for the consumption of shellfish only. The 2000 USEPA methodology for AWQC calculations, based on the consumption of organisms only, is presented in the following equation:

$$\text{AWQC } (\mu g/l) = \frac{(1 \times 10^{-6}/\text{CPF}) \times 70 \text{ kg} \times 1{,}000\ \mu g/mg}{0.0175 \text{ kilogram per day} \times \text{BCF}}$$

Where:

CPF = Cancer potency factor (kg-day/mg)

BCF = bioconcentration factor (l/kg)

For benzo(a)pyrene the cancer potency factor is 7.3 kg-day/mg and the BCF is 30 l/kg (USEPA 002).

The fish consumption rate of 17.5 g/day is based on the USEPA recommended default fish consumption rate to protect the general population of fish consumers and represents consumption of freshwater and estuarine finfish and shellfish (USEPA 2000). Using a consumption rate of 0.26 g/day, the benzo(a)pyrene criterion that accounts for the consumption of shellfish only (i.e., clams and oysters) is 1.24 µg/l.

2.5 Conservative Assumptions Included

The following conservative assumptions have been included in the calculation of these groundwater cleanup standards:

- The comparison of the adjusted AWQC and MTCA Method B level (based on ingestion of organisms) to groundwater assumes that the shellfish will be collected at the point of groundwater discharge to the Puyallup River. This assumption is highly conservative given that the closest public access to the river is approximately 0.5 miles downstream of the site, these organisms do not migrate, and harvesting of these organisms within Commencement Bay is closed throughout the year.

- Using unfiltered results is highly conservative because only the dissolved constituents would be transported to the Puyallup River to bioconcentrate in shellfish.

- No mixing of the groundwater and surface water is accounted for in the comparison of groundwater concentrations to the adjusted AWQC or MTCA Method B level. Natural attenuation processes would decrease measured concentrations significantly before these constituents could reach surface water.

2.6 Summary and Human Health Risk Evaluation

This section presents a human health-based evaluation of cPAHs in shallow groundwater at the former Tacoma Metals property located in Tacoma, Washington. Shallow groundwater at the site flows toward the Puyallup River during low tide conditions. Though no seeps have been observed, the human health exposure scenario evaluated is based on groundwater discharge to the Puyallup River and subsequent bioconcentration of cPAHs into aquatic organisms that are harvested and consumed by humans (i.e., shellfish). The surface water at RM 1.7 is not potable because of its salinity; therefore, human consumption of organisms is the highest beneficial use to be protected.

Site-specific groundwater cleanup levels were calculated based on the protection of human health and consumption of aquatic organisms. A modified MTCA Method B cleanup level and an adjusted AWQC were calculated to derive site-specific surface water cleanup levels. The NTR criterion is based on the Gold Book, which has been superseded by the 2004 AWQC. The site-specific cleanup levels for cPAHs are based on the toxicity of benzo(a)pyrene because WAC 173-340-708(8) requires that the entire mixture of cPAHs be assumed to be as toxic as benzo(a)pyrene

PAHs are metabolized and excreted by vertebrate aquatic organisms (i.e., finfish). As a consequence, finfish tissue levels of PAHs do not provide an adequate assessment of the exposure level (Varanasi et al. 1989). Human consumption of shellfish only (i.e., clams and oysters) was evaluated for calculation of site-specific cleanup levels. Using an adjusted consumption rate, the resulting adjusted MTCA Method B cleanup level and AWQC for benzo(a)pyrene are 6.22 µg/l and 1.24 µg/l, respectively. Using the AWQC of 1.24 µg/l as the proposed cleanup level for cPAHs provides the most conservative and appropriate standard for the site.

Section 3: Proposed Cleanup Levels/Points of Compliance

The cleanup levels proposed for the site are summarized in Table 2. In accordance with the Draft RI/FS, soil cleanup standards selected for the site are based on an industrial scenario in accordance with WAC 173-340-745. Cleanup levels presented in Table 2 are based on Method C values as provided in Ecology's CLARC online database. When Method C values were not available, Method A values for the industrial scenario were used. The point of compliance for soil is throughout the site.

As indicated above, cleanup standards for groundwater are based on protection of surface water in accordance with WAC 173-340-730(1)(a) and WAC 173-340-720(8)(d)(i) because groundwater discharges to surface water adjacent to the site and groundwater or surface water is not a current or potential source of potable water. 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 source. Groundwater standards for non-carcinogenic compounds are based on MTCA Method A/B standards and appropriate AWQC. For cPAH compounds, groundwater standards are based on the revised MTCA Method B and revised AWQC presented in Section 2. The point of compliance for site groundwater will be in wells located along the northern/western property boundary (e.g., MW-2, MW-4(R), MW-5, MW-6, MW-9, MW-19, MW-20, MW-23, and MW-29) (refer to Figure 2).

Section 4: Evaluation of Selected Remedial Alternative

4.1 Background

As indicated above, the draft RI/FS report for the site was prepared under the January 1996 amendment of the MTCA regulations. Following review and evaluation of a range of cleanup technologies, the FS performed a detailed evaluation of three remedial alternatives to address site conditions. The FS report recommended Alternative 2 as the preferred remedial alternative because it best meets the evaluation criteria identified under WAC 173-340-360(5). In their draft Cleanup Action Plan (CAP) Ecology selected Alternative 2 as the cleanup action for the site based on the results of the RI/FS report. Alternative 2 includes the following major components (refer to the draft RI/FS for a detailed description of all three alternatives):

- Source control (free product removal and petroleum hydrocarbon-impacted soil excavation with offsite disposal)
- Localized removal and consolidation of metals-impacted soils along the northern portion of the site
- Installation of an asphalt cap with stormwater controls
- Enhanced groundwater biodegradation / monitored natural attenuation
- Institutional controls
- Groundwater monitoring
- Periodic review.

Changes included in the February 2001 amendment of the MTCA regulations require performance of a disproportionate cost analysis for the remedial alternatives to demonstrate that the selected alternative uses permanent solutions to the maximum extent practicable [WAC 173-340-360(2)(b)(i)]. Prior to implementation, Ecology has requested performance of an evaluation to demonstrate that Alternative 2 uses permanent solutions to the maximum extent practicable.

4.2 Disproportionate Cost Evaluation for Alternative 2

The cleanup action Alternative 2 presented in the FS was previously accepted by Ecology under the 1996 MTCA in their draft CAP and meets the substantive requirements of the February 2001 amendment of the MTCA regulations. Alternative 2 meets the threshold and other requirements under the current MTCA regulations, uses permanent solutions to the extent practicable, and provides a reasonable restoration time frame for the site.

Cleanup action considerations such as permanence, protectiveness, effectiveness, cost, and time frame were evaluated for the FS under the 1996 amendment of MTCA and are reflected in the three cleanup alternatives presented in the FS (Kennedy/Jenks Consultants 2001). The framework under which the permanence of a cleanup action is evaluated under the 2001 amendment of MTCA includes a disproportionate cost analysis, WAC 173-340-360(3)(e), which was not part of the 1996 amendment of MTCA. Although the term "disproportionate cost analysis" was not specifically discussed in the FS (Kennedy/Jenks Consultants 2001), a disproportionate cost analysis evaluation was performed when screening remedial response actions and process options (refer to Table 9.4 of the FS). This information was then used to develop remedial alternatives in the FS. Section 9.2.5 of the FS includes a detailed comparative analysis of the remedial alternatives in which the MTCA threshold criteria are used to compare the three remedial alternatives being evaluated. This section also includes a comparative cost analysis meeting the substantive criteria of the disproportionate cost analysis requirements identified under the 2001 amendment of MTCA. This indicates that if a disproportionate cost analysis evaluation were performed for the alternatives identified in the FS, this evaluation would result in selection of Alternative 2 as the preferred remedial option.

Under a disproportionate cost analysis evaluation, it is likely that Alternative 3 would be selected as the baseline standard because it includes onsite treatment of excavated soil materials (thermal desorption for hydrocarbon-affected soil and chemical stabilization for metals-affected soil materials) in addition to the remedial components included in Alternative 2. However, a large portion of the materials to be excavated would be unsuitable for use as backfill because of the physical characteristics of the material (abundant wood debris, including logs, pilings, planks, etc.). This material would need to be transported offsite for disposal or treatment under either Alternative 3 or Alternative 2. Onsite treatment of excavated material suitable as backfill would provide only a minimal reduction in the volume of contaminated materials remaining onsite, and the cost would likely outweigh the benefits. Given that an impermeable cap will be installed across the entire site under Alternative 2, treatment of that portion of excavated material that is suitable as backfill would not increase the protectiveness or permanence of the remedial action. Therefore, Alternative 2 would likely be chosen under a disproportionate cost analysis as the most practicable alternative because Alternatives 2 and 3 provide a similar level of permanence.

4.3 Proposed Cleanup Action Modification

Alternative 2 includes application of oxygen release compound (ORC) in excavations on the western portion of the site following removal of soil to the water table. The intended purpose of the ORC application is to provide for enhanced biodegradation of petroleum hydrocarbon compounds remaining in the excavation areas. However, data from soil and groundwater samples collected since the completion of the RI/FS has modified our understanding of the nature of the compounds intended for treatment with ORC. As indicated in Friedman & Bruya's report dated 19 January 2007, the primary source of hydrocarbon compounds in the western portion of the site was a retort associated with a creosoting plant located onsite until the mid-1930s. Because the chemicals are of pyrogenic rather than petrogenic (petroleum-based) origin, ORC is not expected to be an effective remedial technique to treat residual hydrocarbon compounds.

Based on our evaluation of this technology and in light of current information regarding the contaminants of concern, it is anticipated that any benefit realized by ORC application in excavation areas would be insignificant compared to the costs associated with the ORC materials and their application. Therefore, it is recommended that Alternative 2 be modified to omit the use of ORC in excavations where creosote compounds may be encountered below the water table.

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Tables

TABLE 1

FEBRUARY 2006
GROUNDWATER MONITORING WELL ANALYTICAL RESULTS - TPH and PAHs
Former Tacoma Metals Facility - Tacoma, Washington

Analyte	Groundwater Sample Designation														Proposed Cleanup Level[b]
	MW-8(R)[a]		MW-10		MW-11		MW-14		MW-15		MW-16		MW-17		
	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	
TPHs (mg/l)[c]															
Gasoline-range hydrocarbons	41.8	---[d]	0.124	---	0.221	---	<0.050[e]	---	<0.050	---	<0.050	---	<0.050	---	NA[f]
Diesel-range hydrocarbons	8.12[g]	---	0.799	---	1.91	---	0.859[h]	---	0.903[h]	---	0.495[h]	---	0.429[h]	---	NA
Oil-range hydrocarbons	<2.60	---	<0.532	---	<0.562	---	<0.562	---	<0.568	---	<0.562	---	<0.526	---	NA
PAHs (µg/l)[i]															
Naphthalene	***6,810***	2,370	3.38	1.37	5.47	1.49	1.11	1.02	0.0636 J[j]	0.334	0.0233 J	0.236	0.180 J	0.366	4,940
1-Methylnaphthalene	883	107	8.47	0.753	58.4	3.86	3.64	1.68	0.410	0.216	<0.0176	0.0706 J	0.264 J	0.0989 J	NA
2-Methylnaphthalene	1,420	56.7	0.158	0.114 J	<0.0478	0.114	0.326	0.139	<0.0276	0.0565 J	<0.0269	<0.0266	<0.136	0.0607 J	NA
Acenaphthylene	12.4 J	<10.5	0.238	<0.0512	0.878	0.159	0.115	<0.00980	0.0502 J	<0.0518	<0.00958	<0.00947	<0.0484	<0.0494	NA
Acenaphthene	280	28.6	28.1	0.828	72.4	2.73	9.54	2.06	2.63	0.635	0.280	0.201	5.05	0.211	643
Fluorene	146	<7.86	14.0	0.193	53.0	0.507	3.71	0.222	1.22	0.113 J	<0.00749	0.0506 J	2.64	0.0854 J	3,460
Phenanthrene	188	<6.19	14.3	0.684	60.5	3.13	1.84	1.23	0.0899 J	0.842	<0.00506	0.600	0.388 J	0.888	NA
Anthracene	31.0	<8.33	2.87	0.598	14.7	2.12	0.566	0.299	0.279	0.146	0.172	0.186	0.297 J	0.142	25,900
Fluoranthene	38.6	<5.00	4.52	0.537	17.0	3.02	1.26	0.402	0.235	0.334	<0.00264	0.249	0.830	0.519	90.2
Pyrene	24.8	<5.95	2.91	0.428	10.7	2.38	0.786	0.363	0.188	0.240	<0.00414	0.199	0.615	0.369	2,590
Benzo(g,h,i)perylene	<7.86	<7.86	<0.0388	<0.0384	<0.0359	<0.0375	<0.0379	<0.00319	<0.00319	<0.0388	<0.00311	<0.00308	<0.0157	<0.0371	NA
cPAHs (µg/l)[k]															
Chrysene	6.52	<0.107	0.353	0.0953 J	0.678	0.450	0.115	<0.00305	<0.00305	<0.0212	<0.00298	<0.00294	<0.0151	0.0517 J	NA
Benzo(b)fluoranthene	2.12	<0.482	0.0988 J	<0.0942	0.137	0.148	<0.0931	<0.00331	<0.00331	<0.0953	<0.00324	<0.00320	<0.0164	<0.0910	NA
Benzo(k)fluoranthene	2.52	<0.125	0.0941 J	<0.0244	0.161	0.145	0.0437 J	<0.00380	<0.00380	<0.0247	<0.00372	<0.00367	<0.0188	<0.0236	NA
Benzo(a)anthracene	6.00	<0179	0.320	0.105 J	0.739	0.455	0.110 J	<0.00427	<0.00427	<0.0353	<0.00417	<0.00412	<0.0211	0.0494 J	NA
Benzo(a)pyrene	2.48	<0.155	0.104 J	<0.0302	0.159	0.125	0.0460 J	<0.00226	<0.00226	<0.0306	<0.00220	<0.00218	<0.0111	<0.0292	NA
Indeno(1,2,3-cd)pyrene	<0.333	<0.167	<0.0329	<0.0326	<0.0304	<0.0318	<0.0322	<0.00258	<0.00258	<0.0329	<0.00252	<0.00249	<0.0128	<0.0315	NA
Dibenz(a,h)anthracene	<0.345	<0.173	<0.0341	<0.0337	<0.0315	<0.0330	<0.0333	<0.00295	<0.00295	<0.0341	<0.00289	<0.00285	<0.0146	<0.0326	NA
Total cPAHs[o]	***3.61***	<0.155	0.159	0.0115	0.269	0.204	0.0625	<0.00226	<0.00226	<0.0306	<0.0022	<0.00218	<0.0111	0.00546	1.24

Analyte	Groundwater Sample Designation														Proposed Cleanup Level[b]
	MW-18		MW-19		MW-20		MW-21		MW-22		MW-23		MW-24		
	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	
TPHs (mg/l)[c]															
Gasoline-range hydrocarbons	20.8	---	<0.250	---	3.77	---	2.69[l]	---	4.59[l]	---	5.03[m]	---	0.736[m]	---	NA
Diesel-range hydrocarbons	2.35	---	<0.272	---	1.70	---	4.74	---	2.95	---	2.66	---	0.479	---	NA
Oil-range hydrocarbons	<0.521	---	<0.543	---	<0.510	---	0.694[n]	---	<0.532	---	<0.510	---	<0.515	---	NA
PAHs (µg/l)[i]															
Naphthalene	***7,650***	***6,280***	0.0569 J	0.629	734	658	139	202	883	301	799	191	133	18.0	4,940
1-Methylnaphthalene	334	143	0.722	0.300	282	186	264	30.8	334	36.1	287	31.4	25.7	2.62	NA
2-Methylnaphthalene	210	94.9	0.0308 J	0.130	268	140	31.0	1.63	197	4.36	219	5.68	11.6	0.703	NA
Acenaphthylene	2.34	0.831	<0.00992	<0.0100	<10.1	<10.0	1.60	0.215	1.79	0.106 J	1.20	<0.0506	0.294	<0.0473	NA
Acenaphthene	198	84.3	1.07	0.282	166	92.7	207	17.0	213	13.4	199	14.7	35.1	1.79	643
Fluorene	106	3.51	0.103 J	0.0479 J	71.7	<7.50	116	1.18	110	0.209	72.7	<0.0379	18.4	0.140	3,460
Phenanthrene	113	0.371 J	<0.00524	0.123	55.2	<5.91	130	2.77	110	0.910	72.6	0.292	13.6	0.312	NA
Anthracene	12.1	0.236 J	0.0784 J	0.0753 J	<8.05	<7.95	12.6	1.63	12.3	0.499	5.67	0.159	2.82	0.185	25,900
Fluoranthene	8.19	0.315 J	<0.00273	0.124	<4.83	<4.77	16.3	1.53	12.6	0.616	7.75	0.262	5.89	0.249	90.2
Pyrene	4.65	0.247 J	<0.00428	0.145	<5.75	<5.68	10.4	1.20	7.37	0.463	4.07	0.195	3.51	0.189	2,590
Benzo(g,h,i)perylene	<0.192	<0.185	<0.00322	<0.00326	<7.59	<7.50	0.0744 J	<0.0347	<0.0375	<0.0371	<0.0375	<0.0379	<0.0371	<0.0355	NA
cPAHs (µg/l)[k]															
Chrysene	<0.105	<0.101	<0.00308	<0.00312	<0.103	<0.102	0.877	0.280	0.505	0.0989 J	0.214	0.0391 J	0.288	0.0301 J	NA
Benzo(b)fluoranthene	<0.471	<0.455	<0.00335	<0.00339	<0.466	<0.460	0.249	0.101 J	0.0955 J	<0.0910	<0.0920	<0.0931	<0.0910	<0.0871	NA
Benzo(k)fluoranthene	<0.122	<0.118	<0.00385	<0.00389	<0.121	<0.119	0.279	0.105	0.105 J	<0.0236	<0.0239	<0.0241	<0.0236	<0.0226	NA
Benzo(a)anthracene	<0.174	<0.169	<0.00432	<0.00437	<0.172	<0.170	0.930	0.274	0.455	0.0966 J	0.200	0.0391 J	0.272	0.0344 J	NA
Benzo(a)pyrene	<0.151	<0.146	<0.00228	<0.00231	<0.149	<0.148	0.291	0.109	0.102 J	<0.0292	<0.0295	<0.0299	<0.0292	<0.0280	NA
Indeno(1,2,3-cd)pyrene	<0.163	<0.157	<0.00261	<0.00264	<0.161	<0.159	0.0744 J	<0.0295	<0.0318	<0.0315	<0.0318	<0.0322	<0.0315	<0.0301	NA
Dibenz(a,h)anthracene	<0.169	<0.163	<0.00299	<0.00302	<0.167	<0.165	0.667	<0.0305	<0.0330	<0.0326	<0.0330	<0.0333	<0.0326	<0.0312	NA
Total cPAHs[o]	<0.151	<0.146	<0.00228	<0.00231	<0.149	<0.148	0.720	0.160	0.173	0.0106	0.0221	0.00430	0.0301	0.00374	1.24

TABLE 1

FEBRUARY 2006
GROUNDWATER MONITORING WELL ANALYTICAL RESULTS - TPH and PAHs
Former Tacoma Metals Facility - Tacoma, Washington

Analyte	Groundwater Sample Designation														Proposed Cleanup Level[b]
	MW-25		MW-26		MW-27		MW-28(R)[a]		MW-29		MW-30		MW-31		
	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	unfiltered	filtered	
TPHs (mg/l)[c]															
Gasoline-range hydrocarbons	0.262	---[d]	1.37[l]	---	<0.050[e]	---	10.4[l]	---	0.323	---	0.586	---	0.446	---	NA[f]
Diesel-range hydrocarbons	0.300	---	1.65[h]	---	<0.278	---	3.53[h]	---	0.816[j]	---	1.76[h]	---	2.20[h]	---	NA
Oil-range hydrocarbons	<0.485	---	<0.526	---	<0.556	---	<0.490	---	<0.521	---	<0.505	---	<0.543	---	NA
PAHs (µg/l)[i]															
Naphthalene	0.640	0.536	501	125	1.64	2.05	***5,900***	4,260	2.14	0.507	8.13	3.59	57.5	61.7	4,940
1-Methylnaphthalene	27.9	1.53	81.9	5.90	0.522	0.365	488	260	41.0	2.61	171	9.38	140	85.3	NA
2-Methylnaphthalene	1.29	0.0943 J[j]	79.6	0.736	0.0677 J	0.0821 J	574	233	6.60	0.0916 J	43.4	1.32	16.9	12.3	NA
Acenaphthylene	0.208	<0.115	<0.0102	<0.00958	<0.00992	0.0927 J	28.0	11.4	0.745	<0.00937	<0.00926	<0.00916	1.42	<0.00958	NA
Acenaphthene	39.1	1.23	129	3.23	14.2	1.71	439	184	66.6	1.84	225	8.06	211	71.3	643
Fluorene	5.79	0.0644 J	84.7	0.0480 J	7.45	<0.00766	197	8.00	31.6	0.0468 J	65.3	2.84	80.3	4.14	3,460
Phenanthrene	0.446	0.163	76.9	0.110 J	0.280	0.0794 J	275	1.19 J	46.2	0.114	24.9	5.51	99.7	3.34	NA
Anthracene	0.229	0.170	4.62	0.253	2.33	1.15	32.1	1.41 J	7.81	0.271	1.94	0.652	16.3	1.01	25,900
Fluoranthene	0.0589 J	0.159	10.3	0.717 J	2.53	0.0695 J	68.4	0.527 J	8.16	0.0962 J	1.07	1.25	44.6	1.99	90.2
Pyrene	0.0379 J	0.113 J	4.66	0.0542 J	1.70	0.0547 J	48.0	<0.549	4.76	0.0635 J	0.724	0.965	29.5	1.97	2,590
Benzo(g,h,i)perylene	<0.0347	<0.0379	<0.00330	<0.00311	<0.00322	<0.00319	2.20	<0.725	0.0222 J	<0.00304	<0.00301	<0.00298	0.551 J	<0.00311	NA
cPAHs (µg/l)[k]															
Chrysene	<0.0189	<0.0207	0.103	<0.00298	<0.00308	<0.00305	10.6	<0.396	0.265	<0.00291	<0.00288	0.0853	3.76	0.187	NA
Benzo(b)fluoranthene	<0.0853	<0.0931	0.0327	<0.00324	<0.00335	<0.00331	5.58	<1.78	0.0951	<0.00317	<0.00313	0.0558	1.30	0.160	NA
Benzo(k)fluoranthene	<0.0221	<0.0241	0.0142	<0.00372	<0.00385	<0.00380	6.02	<0.462	0.0387	<0.00363	<0.00359	0.0170	1.96	0.0795	NA
Benzo(a)anthracene	<0.0316	<0.0345	0.157	<0.00417	<0.00432	<0.00427	11.0	<0.659	0.392	<0.00408	<0.00403	0.134	3.87	0.336	NA
Benzo(a)pyrene	<0.0274	<0.0299	<0.00234	<0.00220	<0.00228	<0.00226	6.51	<0.571	0.0698	<0.00216	<0.00213	0.0267	1.83	0.105	NA
Indeno(1,2,3-cd)pyrene	<0.0295	<0.0322	<0.00267	<0.00252	<0.00261	<0.00258	1.89	<0.615	0.0641	<0.00247	<0.00244	<0.00241	0.472 J	<0.00252	NA
Dibenz(a,h)anthracene	<0.0305	<0.0333	<0.00306	<0.00289	<0.00299	<0.00295	6.79	<0.637	<0.00254	<0.00282	<0.00279	<0.00276	3.27	<0.00289	NA
Total cPAHs[o]	<0.0274	<0.0299	0.0214	<0.0022	<0.00228	<0.00226	***11.8***	<0.571	0.131	<0.00216	<0.00213	0.0482	***3.94***	0.164	1.24

Notes:

(a) Well MW-8(R) was installed in May 2000 as a replacement for MW-8, which was damaged. Well MW-28(R) was installed in February 2006 as a replacement for MW-28, which was damaged during construction activities in the 18th Street right-of-way.
(b) Refer to Table 2 for cleanup level basis. Non-carcinogenic PAH cleanup levels are MTCA Method B Surface Water Cleanup Levels based on Ecology's online CLARC database.
(c) Samples were analyzed for total petroleum hydrocarbons (TPHs) by Ecology Methods NWTPH-G and NWTPH-Dx(extended) with silica gel cleanup.
(d) "---" Denotes sample was not analyzed for the listed analyte
(e) "<" Denotes analyte was not detected at the indicated laboratory reporting limit.
(f) "NA" denotes cleanup level is either not available or not appropriate.
(g) Results in the diesel organics range are primarily due to overlap from a gasoline range product (Laboratory note D-08).
(h) The sample chromatographic pattern does not resemble the fuel standard used for quantitation (Laboratory note D-06).
(i) Samples were analyzed for polycyclic aromatic hydrocarbons (PAHs) by EPA Method 8270C using selected ion monitoring (SIM) mode (where appropriate). Non-detected analytes are reported to the MDL.
(j) "J" denotes an analyte detected at a concentration between the method reporting limit (MRL) and the method detection limit (MDL).
(k) Samples were analyzed for carcinogenic polycyclic aromatic hydrocarbons (cPAHs) by EPA Method 8270C using SIM mode (where appropriate). Non-detected analytes are reported to the MDL.
(l) The total hydrocarbon result in this sample is primarily due to an individual compound eluting in the volatile hydrocarbon range (Laboratory note G-03).
(m) The chromatogram for this sample does not resemble a typical gasoline pattern (Laboratory note G-02).
(n) The heavy oil range organics present are due to hydrocarbons eluting primarily in the diesel range (Laboratory note D-10).
(o) Total cPAHs based on benzo(a)pyrene equivalent values. Individual cPAH concentrations were multiplied by toxicity equivalency factors (TEFs) prior to summation (per WAC 173-340-708). TEFs are summarized on Table 1-A. Non-detected cPAH analytes were not included in the summation.

TABLE 1-A Summary of TEFs	
Chrysene	0.01
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.1
Benzo(a)anthracene	0.1
Benzo(a)pyrene	1
Indeno(1,2,3-cd)pyrene	0.1
Dibenz(a,h)anthracene	0.4

Analytes detected in samples at concentrations exceeding one or more of the cleanup levels or comparison values are shown in bold and italics.

mg/l = milligrams per liter
µg/l = micrograms per liter

TABLE 2

SUMMARY OF PROPOSED CLEANUP STANDARDS FOR SOIL AND GROUNDWATER
Former Tacoma Metals Facility - Tacoma, Washington

Table 2A - Soil Cleanuup Standards (mg/kg)

Analyte	MTCA Method A Industial[a]	MTCA Method C Industial[b]	Proposed Cleanup Level
Lead	1,000	NA[c]	**1,000**
Chromium (III / IV)	2,000 / 19	NA	**2000 / 19**
Total PCBs	10	NA	**10**
Naphthalene	NA	70,000	**70,000**
Total cPAHs	NA	18	**18**

Table 2B - Groundwater Cleanup Standards (µg/l)

Analyte	MTCA Method B Surface Water[d]	AWQC for Human Health Consumption of Organisms[e]	Ecology Freshwater Chronic AWQC [f]	Proposed Cleanup Level
Lead	NA	NA	4.74[g]	**4.74**
Mercury	NA	NA	0.012 / PQL[h]	**0.012 / PQL**
Cadmium	20	NA	1.59[g]	**1.59**
Chromium (III / IV)	24,000 / 490	NA	288[g] / 10	**288 / 10**
Copper	NA	NA	18.76[g]	**18.76**
Selenium	NA	4,200	5.0	**5.0**
Total PCBs	NA	0.000064 / PQL	0.014 / PQL	**0.000064 / PQL**
Naphthalene	4,940	NA	NA	**4,940**
Total cPAHs	6.22	1.24	NA	**1.24**

Notes:
(a) Model Toxics Control Act (MTCA) (WAC 173-340) Method A industrial soil cleanup levels (Ecology 2001).
(b) Model Toxics Control Act (MTCA) (WAC 173-340) Method C industrial soil cleanup levels based on Ecology's online CLARC database.
(c) 'NA' denotes no clenaup level established.
(b) Model Toxics Control Act (MTCA) (WAC 173-340) Method B surface water cleanup level based on Ecology's online CLARC database.
(e) Ambient Water Quality Criteria (AWQC) for consumption of organisms only (EPA 2004) pursuant to Section 304(a)(1) of the Clean Water Act.
(f) Freshwater Chronic AWQC based on Ecology's Water Quality Standards (WAC 173-201A) dated 20 November 2006.
(g) Based on an average groundwater hardness of 180 mg/l.
(h) PQL = Practical Quantitation Limit. Where the PQL is higher that the proposed cleanup level, the cleanup level will be considered to have been attained if the chemical of concern is "non-detect".

mg/kg = milligrams per kilogram
µg/l = micrograms per liter
mg/l = milligrams per liter

Figures

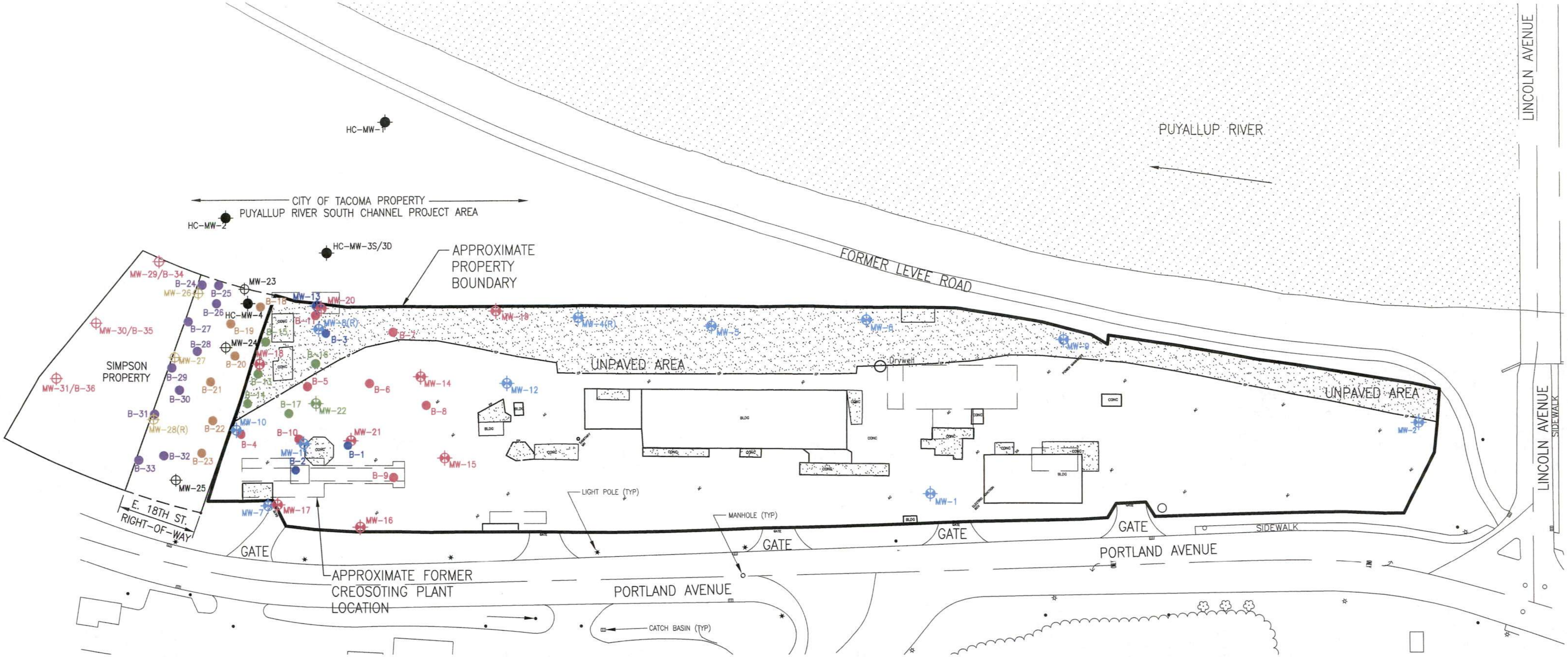
Kennedy/Jenks Consultants

FORMER TACOMA METALS FACILITY
TACOMA, WA

SITE LOCATION MAP

996098.00/LOCATION.VSD

FIGURE 1



LEGEND:

MW-29/B-34	OFF-PROPERTY MONITORING WELL AND SOIL BORING LOCATION (FEBRUARY 2006)
MW-26	OFF-PROPERTY MONITORING WELL LOCATION (MARCH 2005)
B-24	OFF-PROPERTY GEOPROBE BORING LOCATION (MARCH 2005)
MW-23	OFF-PROPERTY MONITORING WELL LOCATION (MARCH 2004)
B-18	OFF-PROPERTY GEOPROBE BORING LOCATION (MARCH 2004)
MW-12	MONITORING WELL LOCATION (REMEDIAL INVESTIGATION 2000–2001)
MW-13	MONITORING WELL LOCATION (JUNE – AUGUST 2002 INVESTIGATION)
MW-14	MONITORING WELL LOCATION (FEBRUARY – MARCH 2003 INVESTIGATION)
MW-22	MONITORING WELL LOCATION (NOVEMBER – DECEMBER 2003 INVESTIGATION)
HC-MW-4	FORMER OFF-PROPERTY MONITORING WELL LOCATION INSTALLED BY HART-CROWSER (JUNE 2003)
B-1	HOLLOW-STEM AUGER BORING LOCATION (JUNE – AUGUST 2002 INVESTIGATION)
B-4	GEOPROBE BORING LOCATION (FEBRUARY – MARCH 2003 INVESTIGATION)
B-12	GEOPROBE BORING LOCATION (NOVEMBER – DECEMBER 2003 INVESTIGATION)
	UNPAVED AREA
	APPROXIMATE PREVIOUS STRUCTURE LOCATION (IDENTIFIED IN HISTORICAL AERIAL PHOTOGRAPHS AND/OR SANBORN MAPS)

NOTES:

1. BORING AND WELL LOCATIONS ARE BASED ON SITE SURVEY BY EARTH TECH, INC. ON 28 MARCH 2000, 13 MARCH 2003, 31 DECEMBER 2003, 14 APRIL 2004, 21 APRIL 2005, AND 29 MARCH 2006.

N

0 50 100

SCALE: 1=100

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FORMER TACOMA METALS FACILITY
TACOMA, WA

MONITORING WELL AND BORING LOCATION MAP

996098.00\2006 DATA SUMMARY\FIG_2

FIGURE 2