DRAFT

Remedial Investigation Work Plan

Jacobson Terminals

Seattle, Washington

Prepared for
Washington State
Department of Ecology

November 6, 2014
17800-56

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Remedial Investigation Work Plan

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Seattle, Washington

1.0 INTRODUCTION AND BACKGROUND INFORMATION

This Work Plan describes objectives, procedures, and rationale for sampling and analysis activities associated with the Remedial Investigation at the Jacobson Terminals Property (Terminals Property), located at 5350 30th Avenue Northwest in the Ballard district of Seattle, Washington (Figure 1). This investigation is being conducted under contract to the Washington State Department of Ecology (Ecology).

The scope of work described in this Work Plan is designed to acquire additional data in support of a Remedial Investigation (RI) at the property. Sampling activities addressed in this work plan include:

- Collecting up to 90 soil samples from the site for chemical analysis of these samples for volatile organic compounds (VOCs) and polychlorinated biphenyls (PCBs). Select soil samples will be analyzed for metals, total organic carbon (TOC) and for diesel- and oil-range petroleum hydrocarbons.
- Installing and sampling six monitoring wells downgradient of the PCB source area to assess conditions near the treatment wall and installing two wells away from known PCB-impacted areas to determine if low-level PCB impacts are present throughout the Terminals Property and possibly related to regional deposition related to the past industrial operations.
- Collecting groundwater samples from 19 existing monitoring wells and chemical analysis of these samples for VOCs, select total and dissolved metals, diesel- and oil-range petroleum hydrocarbons, and/or PCBs to assess groundwater conditions across the Terminals Property.
- Collecting up to five sediment samples adjacent to the Terminals Property and chemically analyzing these samples for Sediment Management Standards (SMS; Ecology 2013) VOCs, PCBs, total metals, sulfides, ammonia, and TOC.
- Collecting three sediment bioassay samples adjacent to the site that will be compared to performance standards per SMS WAC 173-204-563 Table VII.

1.1 Site Description and History

The property boundaries are the Lake Washington Ship Canal (Ship Canal) to the east and south, Seaborn property to the east, Army Corps of Engineers (Corps) property to the west, and City of Seattle (City) property to the north (Figure 2).

The Terminals property is generally flat. The northwest corner, which is used for parking, is approximately 5 feet above the elevation of the rest of the property, at the approximate elevation of the City property/railroad tracks.

Large boat storage racks are located along the Lake Washington Ship Canal. Offices and small warehouses border the Corps property to the west. Access to the site is controlled by fencing and gates. The Terminals property is zoned industrial (IGIU/45).

1.1.1 Current Site Use

The Terminals property is primarily used for boat storage. Large boat racks are located adjacent to the waterway and various marine businesses occupy the office spaces on the property.

The Corps property contains offices, maintenance buildings, and a tourist facility for the Ship Canal Locks. The Seaborn property is used for boat moorage and office space. The City property consists of a former Burlington Northern Railroad right of way and contains active railroad tracks. North of the City property and railroad tracks, at 2801 NW Market Street, is the Market Street property, which consists of a climbing gym and other commercial businesses.

1.1.2 Historical Site Use

1.1.2.1 Terminals Property

The property is located on a former estuarine tideflat. In the 1920s, the area was filled with sand dredged from the Lake Washington Ship Canal, wood waste, and construction debris. The property was the site of a lumber mill from approximately 1890 to the 1930s. Starting around 1940, the property was used for loading and unloading boats and for storage. Alan and Brian Jacobson (partners in A&B Jacobson, LLC) purchased the property in 1975 and the property has been used as a marine support facility since that date.

1.1.2.2 Market Street Property

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

Wastewater from the Market Street property was discharged to the Lake Washington Ship Canal from approximately 1948 to 1978; in later years, the wastewater was treated on the property and discharged to the King County Metro wastewater collection system. Violations of the Metro permit for pH and metal discharge exceedances are documented in the project file. A video inspection of the sewer lines was conducted in the late 1970s and severe deterioration and disintegration of the lines was observed. The former owner of the property reportedly replaced the lines. Window manufacturing operations ceased at the Market Street property in 1989 (Hart Crowser 2000).

1.2 Summary of Previous Environmental Characterization/Cleanup Activities

A number of environmental investigations and remedial actions have been completed at the Terminals, Corps, City, and Market Street properties. A summary of contaminants of concern and remedial activities are provided below.

1.2.1 Contaminants of Concern

Based on the results of historical environmental investigations completed at the properties, the major contaminants of concern (COCs) include:

- Metals in soil and groundwater on the Market Street and City properties;
- Chlorinated solvents (PCE, TCE, cis-DCE, and vinyl chloride) in groundwater on the Market Street, City, Corps, and Terminals properties;
- PCBs in soil at the Terminals property;
- Tri-, di-, and monochlorobenzenes in soil and groundwater at the Terminals property; and
- Petroleum hydrocarbons in soil at the Terminals property.

Groundwater monitoring was first conducted to delineate a vinyl chloride plume identified at the upgradient Market Street property. Historical releases of metals, low- and high-pH solutions, and solvents occurred on the Market Street and City properties during operations by Fentron Industries (Fentron). The releases created localized exceedances of metals in soil and groundwater and an extensive groundwater plume of tetrachloroethene (PCE) and associated degradation products (primarily trichloroethene [TCE], cis-1,2-dichloroethene [cis-DCE], and vinyl chloride). Prior to installation of a treatment wall in 1999, the plume extended from the Market Street and City properties onto the Corps and Terminals properties. A separate area of chlorinated solvents, located on the City property downgradient of the Market Street treatment wall was identified as the likely source of chlorinated solvent impacts on the Terminals property.

A historical release of transformer oil containing PCBs and trichlorobenzene on the northern portion of the Terminals property (PCB Area) created a plume of several chlorinated benzene compounds in groundwater (Figure 2). Concentrations of PCBs and chlorinated benzenes above applicable cleanup levels have been identified in soil samples up to 30 feet below ground surface (bgs) near where the presumed transformer oil release occurred.

During construction activities in the early 1990s, a separate area of PCB- and petroleum-impacted soil (Petroleum Area) was discovered at the Terminals property in an alley that borders the Corps property (Figure 2).

1.2.2 Remediation Activities

A number of remedial actions have been completed at the Market Street, Terminals, and City properties to address potential human and ecological exposure to the COCs described above. These cleanup actions were conducted under the Voluntary Cleanup Program (VCP) by both Fentron and Jacobson.

1.2.2.1 Market Street Property

In 1989, seven of the ten USTs were taken out of service and all fluids, sludges, aboveground tanks, piping and other features associated with the anodizing process were removed from the Market Street property and disposed of, and the drains, catch basins, floors, and walls of the property were cleaned. In 1993, Fentron decommissioned all ten USTs and removed approximately 100 tons of petroleum-impacted soil from the site.

In 1991, EMCON installed a pump-and-treat system along the southwestern portion of the property to address solvents in groundwater. The system did not fully capture the solvent plume and was shut down in 1999 and replaced with a passive treatment wall and zero-valent iron gates system. The wall consists of three impermeable funnel sections constructed of cement bentonite that captures groundwater and directs it through two permeable gates filled with a mixture of granular iron and sand. At the same time, a magnesium oxide product (ORC) was injected into groundwater on the Terminals property to treat solvents that had already migrated past the newly constructed treatment wall. A deed restriction was also placed on the Market Street property that addresses residual contamination beneath the existing building (Hart Crowser 2000).

1.2.2.2 Terminals Property

In 1996, PCB- and petroleum-contaminated soil was removed from between two buildings bordering the Corps property. Much of the source material was removed, but confirmation sampling showed that petroleum hydrocarbon concentrations remained above cleanup levels in side wall and bottom samples (Hart Crowser 1997). In 2001 and 2002, Fenton’s Reagent (acidified hydrogen peroxide and ferrous iron) was injected on the Terminals property to provide source area treatment of the PCB/chlorinated benzene plume and to provide a more aggressive oxygen enhancement for degrading cis-DCE and vinyl chloride. In December 2003, a continuous permeable treatment wall containing granular activated carbon and zero-valent iron was installed along the Lake Washington Ship Canal to remove PCBs and chlorinated benzenes from groundwater (Aspect 2003).

1.2.3 Recent Investigations

Hart Crowser completed a soil, groundwater, and sediment investigation in 2014. Soil results indicated that PCBs and chlorinated benzene concentrations exceeding screening criteria covered a larger area than previous investigations had estimated. Results of the investigation are summarized in the Draft Interim Action Work Plan (IAWP) (Hart Crowser 2014).

The 2014 investigation delineated the extent of PCB impacts exceeding MTCA Method A Industrial Cleanup levels, but did not delineate concentrations exceeding screening levels protective of surface water. Soil with PCB concentrations exceeding MTCA Method A Unrestricted cleanup levels was largely delineated, except for around the northeast corner of the impacted area. Chlorinated benzene concentrations exceeding surface water protection screening levels were also not delineated along the eastern and southern edges of the impacted area.

Groundwater PCB concentrations exceeding surface water protection levels were found in all wells sampled, including compliance monitoring wells JT-12 and JT-6. Existing deep wells, screened approximately 25-30 feet bgs installed during the 2014 investigation also had low-level PCB impacts exceeding surface water protection levels. Arsenic concentrations in many of the wells also exceeded surface water protection levels.

The sediment investigation found PCBs and arsenic impacts above Washington SMS freshwater Sediment Cleanup Objective (SCO) levels, but below Cleanup Screening Levels (CSL).

2.0 OBJECTIVES AND DESIGN OF THE SOIL, GROUNDWATER, AND SEDIMENT INVESTIGATION

This investigation will focus on the Terminals Property. The soil, groundwater, and sediment characterization and testing objectives and approach are summarized below with details presented in Section 3.0.

2.1 Soil Investigation

Source removal has been identified as the preliminary preferred IA to address the PCB- and chlorinated benzene-impacted area (Figure 2). Logistical limitations (e.g., sheet pile walls, shallow groundwater) will likely prevent collection of representative grab confirmation samples from the source area excavation. As a result of the anticipated construction limitations, push probe soil sampling data around the PCB source area collected during this investigation and the previous 2014 investigation will be used to guide the IA and determine the extent of excavation. This investigation will attempt to further delineate the extent of PCB impacts exceeding MTCA Method A Unrestricted cleanup levels around the northeast corner of the PCB source area and delineate chlorinated benzene concentrations exceeding surface water protection levels around the southwest limits of the source area. These areas were identified as data gaps in the IAWP. Proposed push probe and monitoring well installation locations are shown on Figure 3 and sampling analysis and rationale is presented in Table 1A.

Soil sampling away from PCB-impacted areas will determine if widespread low-level PCB detections found in the 2014 investigation are related to the PCB- and chlorinated benzene-impacted area or potentially a result of regional deposition and/or widespread deposition from previous industrial site activities.

Following a 2010 PCB detection in monitoring well MW-4 in the petroleum area, additional soil samples will be collected downgradient of the excavated area to determine if residual soil impacts have migrated from under the buildings.

The soil investigation will include the collection of up to 60 soil samples from up to 24 push probes and collection of up to 30 samples during installation of 8 monitoring wells. Sixteen push probes are planned and up to eight additional push probes may be advanced depending on field observations at the time of drilling. Six push probes will be located around the perimeter of the PCB source area to further delineate the horizontal extent of PCBs and chlorinated benzenes. Two push probes and three monitoring wells will be located downgradient of the treatment wall and an additional two monitoring wells will be installed at the south end of the treatment wall. One deep monitoring well will be located upgradient of the treatment wall to assess conditions in the lower aquifer. Two push probes will be advanced in the east and west driveways and two monitoring wells will be installed west of the south boat rack to assess soil and groundwater conditions away from areas with known PCB and chlorinated benzene impacts. Five push probes will also be advanced around the petroleum area bordering the Corps property, including one boring located in the alley between the two buildings.

Up to three samples will be collected from each push probe and monitoring well to refine understanding of the vertical distribution of contaminants. Soil samples will be analyzed for VOCs and PCBs. Metals and diesel- and oil-range petroleum hydrocarbon analysis will be performed at boring locations near the petroleum area. Metals and TOC analysis will also be performed at other select borings to examine potential transport pathways between soil, groundwater, and sediment. Additional metals and/or petroleum-range hydrocarbon analysis may be performed if field indications of contamination (i.e., petroleum-like odors or discoloration) are observed.

2.2 Groundwater Investigation

Existing monitoring wells will be sampled and new wells installed to evaluate groundwater conditions downgradient of the PCB- and chlorinated benzene-impacted area, around the PCB area, and at locations away from areas with known PCB and chlorinated benzene impacts. Existing groundwater monitoring wells to be sampled are shown on Figure 4 and the locations of new monitoring wells are shown on Figure 3. The wells selected for analysis are listed in Table 1B.

Groundwater sampling from existing wells around the PCB source area will occur in four downgradient wells (JT-3, JT-7, JT-9, JT-10, and JT-11), three wells within the treatment wall (SRW-1 thru SRW-3), three deep wells (MW-100, MW-200, and JT-5), and the two compliance wells (JT-6 and JT-12). Three wells (JT-4, IW-5S, and IW-5D) will be sampled to assess PCB and chlorinated benzene concentrations away from areas with known PCB and chlorinated benzene impacts. Wells associated with the petroleum area (HC-MW-1 thru HC-MW-3 and MW-4) will also be sampled. Groundwater analytical data from these wells will provide information on current groundwater conditions and support evaluation of remediation options.

Six new monitoring wells will be installed downgradient of the PCB source area. Three deep wells—one downgradient of the treatment wall, one at the south end of the wall, and one between the treatment wall and the source area—will be installed to assess groundwater conditions in the lower aquifer. Three shallow wells—two downgradient of the treatment wall and one at the south end of the wall will—assess groundwater conditions around and downgradient of the wall.

Groundwater samples will be collected using low-flow sampling techniques and analyzed for PCBs, VOCs, and total and dissolved metals. Monitoring wells HC-MW-1 thru HC-MW-4 will be also be analyzed for diesel- and oil-range petroleum hydrocarbons and total and dissolved lead. If field indications of contamination are observed during sampling, additional analysis may be performed.

2.3 Sediment Sampling

Sediment in the portion of the Ship Canal adjacent to the site will be sampled to evaluate potential environmental impacts. Sediment samples will be analyzed for VOCs (including dichlorobenzenes and 1,2,4-trichlorobenzene), PCBs, total metals, sulfides, ammonia, and TOC. Bioassay samples will be collected from three locations to assess potential sediment toxicity to aquatic organisms. Sediment sampling locations are shown on Figure 5.

3.0 FIELD SAMPLING METHOD REQUIREMENTS

This section describes the general requirements for naming, collecting, and evaluating samples.

3.1 General Procedures

3.1.1 Sample Identification

This investigation will include collecting samples of upland soil, groundwater, and sediment. The components of the sample names will be as follows:

Project: JT=Jacobson Terminals

Type of sample: SS=surface sediment; MW=monitoring well; US=upland soil

Location ID: ###

Sample Type: S= soil; GW=groundwater

For example, an upland soil sample could be named: JT-US-013-S1.

Monitoring wells will be identified with S (shallow) and D (deep) following the location ID. For example, a groundwater sample from a new shallow well would be labeled JT-MW-01S-GW.

3.1.2 Sample Containers and Labels

Sample container requirements vary according to analyte and sample matrix. Precleaned sample containers will be obtained from the analytical laboratory. Sample containers shall be cleaned following the requirements described in Specifications and Guidance for Contaminant-Free Sample

Containers (EPA 1992, OSWER Directive 92.0-05a). The required storage temperatures and holding times are summarized in Tables 3 through 5.

3.1.3 Field Documentation Procedures

Field notes will be maintained during sampling and processing operations. The following information will be included in the field notes:

- Names of the field sampling crew including vessel operator and person(s) collecting and logging the samples;
- Weather conditions;
- GPS coordinates of each sampling location;
- Mudline elevation of each sediment sampling location as measured from mean lower low water (MLLW);
- Date and time of collection of each sample;
- The sample location;
- Descriptions of cores; and
- Any deviation from the approved sampling plan.

This information will be recorded on the appropriate field forms (Appendix A).

3.1.4 Equipment Decontamination and Waste Disposal

Staff will wear disposable nitrile gloves when collecting samples, and will put on a clean pair of gloves before starting work on a new sample in order to prevent cross-contamination. All non-dedicated equipment will be cleaned between uses according to the procedures described below.

3.1.4.1 Soil and Sediment Sample Equipment Decontamination

Reusable soil and sediment sampling equipment (e.g., stainless steel spoons and bowls) will be thoroughly decontaminated before use following this procedure:

- Rinse with water and wash with a scrub brush until free of soil;
- Wash with Liquinox detergent and tap water;
- Rinse with tap water; and
- Rinse three times with distilled or deionized water.

3.1.4.2 Monitoring Well Development and Sample Equipment Decontamination

Since the monitoring wells do not have dedicated pumps, a stainless steel bailer and pump will be used to develop the wells. The equipment will be decontaminated using the following procedure:

- Wash with Liquinox detergent and tap water;
- Rinse with tap water; and
- Rinse three times with distilled or deionized water.

New, disposable polyethylene tubing and a peristaltic pump will be used to collect groundwater from each monitoring well.

3.1.4.3 Field-Generated Waste Disposal

All excess sediment, drill cuttings, and development and purge water will be drummed and stored on site until sampling is completed and then properly disposed of. Any sediment spilled on the deck of the sampling vessel will be washed into the surface water at the collection site.

All disposable sampling materials and personal protective equipment such as gloves and paper towels will be placed in heavy-duty garbage bags and placed in a normal refuse container for disposal as solid waste.

Decontamination wash and rinse water will be collected and disposed of in the sanitary sewer system.

3.2 Soil Borings and Well Installation

3.2.1 Push Probe Investigation

We will advance 16 direct-push explorations to refine the understanding of the nature and extent of contamination at the site. Up to eight additional direct-push explorations may be advanced if observations at the time of drilling indicate the need for additional borings. The proposed probe locations are shown on Figure 3. These locations may be modified after work begins based on our field observations.

The area to be investigated will be located and marked in the field by a Hart Crowser field representative. We will contract with a private utility locating company to search for utilities at the proposed probe locations. Note that there may be other underground obstacles such as concrete slabs that cannot be detected by a utility locator; therefore, multiple push probe attempts near each target location may be necessary if undetected obstacles are encountered.

Direct-push probes will be advanced to a depth of approximately 20 feet below ground surface (bgs) using a truck-mounted drill rig. The work will be conducted by a driller subcontracted by Hart Crowser, and a Hart Crowser field representative will supervise all drilling and sample collection activities.

Push probe samples will be collected continuously in approximately 5-foot intervals from dedicated, disposable acetate liners. All samples will be classified in general accordance with ASTM Method D 2888 and all pertinent characteristics of the subsurface conditions will be recorded on the boring logs.

We will evaluate samples in the field using visual observations, headspace vapor screening, and water sheen testing for potential soil contamination at approximately 2.5-foot intervals. One soil sample will be collected from each 5-foot sampling interval. Two to three soil samples from each probe will be submitted for chemical analysis according to the following protocol.

- If we observe no evidence of soil contamination, we will submit the soil collected from at or just below the water table and at the bottom of the boring, generally above the silt/clay layer, for chemical analysis.

- If we observe evidence of soil contamination, we will select up to three samples for chemical analysis including at least one sample from the zone exhibiting the most significant evidence of contamination, from at or just below the water table, and at the bottom of the boring.

After the samples are collected, the probe locations will be abandoned in accordance with the State of Washington Administrative Code on Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 WAC).

Samples will be collected in pre-cleaned sample containers provided by the analytical laboratory, packed in an ice-chilled cooler, and submitted to the laboratory using chain of custody protocols. Soil sampling analytical methods, reporting limits, and cleanup levels are listed in Table 2A and containers are holding times are listed in Table 3.

3.2.2 Hollow-Stem Auger and Monitoring Well Installation

This subsurface investigation includes installation of three deep monitoring wells (JT-MW-03D, JT-MW-04D, and JT-MW-06D) to collect soil and groundwater data from the lower aquifer, five shallow wells, three wells (JT-MW-01S, JT-MW-02S, and JT-MW-05S) to assess conditions around the treatment wall, and two wells (JT-MW-07S and JT-MW-08S) to assess conditions away from known PCB and chlorinated benzene impacts. The proposed well locations are shown on Figure 3.

The area to be investigated will be located and marked in the field by a Hart Crowser field representative. We will contract with a private utility locating company to search for utilities at the proposed probe locations. Note that there may be other underground obstacles such as concrete slabs that cannot be detected by a utility locator; therefore, multiple attempts near each target location may be necessary if undetected obstacles are encountered.

The deep wells will be advanced to a depth of approximately 30 feet bgs and shallow wells to 20 feet bgs using a truck-mounted drill rig. Monitoring wells will be installed in each boring and screens will be set from approximately 25 to 30 feet in deep borings and 7 to 17 feet in shallow borings. Final depths will be determined after consultation with the project manager. Monitoring wells will consist of 2-inch PVC casing and 5 feet of 10-slot screen. The work will be conducted by a driller subcontracted by Hart Crowser, and a Hart Crowser field representative will supervise all drilling and sample collection activities.

Soil samples will be collected at 2.5-foot intervals from clean stainless steel split-spoon samplers. All samples will be classified in general accordance with ASTM Method D 2888 and all pertinent characteristics of the subsurface conditions will be recorded on the boring logs.

We will evaluate all samples in the field using visual observations, headspace vapor screening, and water sheen testing for potential soil contamination. Up to three soil samples from each boring will be submitted for chemical analysis according to the following protocol.

- If we observe no evidence of soil contamination, we will submit the soil collected from at or just below the water table and at the bottom of the boring, generally above the silt/clay layer, for chemical analysis.
- If we observe evidence of soil contamination, we will select up to three samples for chemical analysis including at least one sample from the zone exhibiting the most significant evidence of contamination, from at or just below the water table, and at the bottom of the boring.

Samples will be collected in pre-cleaned sample containers provided by the analytical laboratory, packed in an ice-chilled cooler, and submitted to the laboratory using chain of custody protocols. Soil sampling analytical methods, reporting limits, and cleanup levels are listed in Table 2A and containers are holding times are listed in Table 3.

3.3 Soil Screening and Analysis

Soil samples will be field screened for evidence of petroleum-related contamination using: (1) visual examination; (2) water sheen testing; and (3) headspace vapor screening using a PID. The effectiveness of field screening varies with temperature, moisture content, organic content, soil type, and age of contaminant, and the presence or absence of a sheen or headspace vapor does not necessarily indicate the presence or absence of petroleum hydrocarbons.

Visual examination consists of inspecting the soil for stains that may indicate contamination. Visual screening is generally more effective when contamination is related to heavy petroleum hydrocarbons such as motor or hydraulic oil, or when hydrocarbon concentrations are high.

Water sheen testing involves placing a small volume of soil in a pan of water and observing the water surface for signs of sheen. Sheens are classified as follows:

No Sheen (NS)	No visible sheen on water surface.
Slight Sheen (SS)	Light colorless film, spotty to globular; spread is irregular, not rapid, areas of no sheen remain, film dissipates rapidly.

Moderate Sheen (MS)	Light to heavy film, may have some color or iridescence, globular to stringy, spread is irregular to flowing; few remaining areas of no sheen on water surface.
Heavy Sheen (HS)	Heavy colorful film with iridescence; stringy, spread is rapid; sheen flows off the sample; most of the water surface may be covered with sheen.

Headspace vapor screening is intended to indicate the presence of volatile organic vapors associated with gasoline and involves placing a soil sample in a plastic sample bag. Air is captured in the bag and the bag is shaken to expose the soil to the air trapped in the bag. The PID probe is then inserted in the bag and the instrument measures the concentration of organic vapors in the sample headspace. The highest vapor reading for each sample is then recorded on the boring log. The PID measures concentrations in ppm (parts per million), is calibrated to isobutylene, and can typically quantify organic vapor concentrations in the range of 0 to 1,000 ppm.

All field screening observations will be recorded on the boring logs, and this information will be used to select which samples to submit for chemical analysis.

3.4 Groundwater Sample Collection Methods

Groundwater samples will be collected from 19 existing monitoring wells. The list of wells to be sampled is presented in Table 1B. All newly installed wells and existing wells not recently sampled will be developed prior to sampling. Existing wells to be developed include the following:

- HC-MW-1
- HC-MW-2
- HC-MW-3
- MW-4
- IW-5S
- IW-5D
- JT-4
- JT-9
- SRW-1
- SRW-2
- SRW-3

3.4.1 Groundwater Monitoring Well Development

The depth to water in each well will be measured before well development using an electronic interface probe. Wells will be developed by pumping and surging until either: (a) water from the wells becomes visibly clear, (b) turbidity measurements stabilize, or (c) a minimum of 10 well volumes are purged.

The development water will be stored in drums on site until all the samples have been collected. The development and purge water will be disposed of properly after the analytical results are available for review.

3.4.2 Groundwater Field Measurements

We will use low-flow sampling procedures to collect samples from the groundwater monitoring wells. The project staff will measure water quality parameters (pH, temperature, specific conductance, turbidity, oxidation-reduction potential [ORP], and dissolved oxygen) in the field using a hand-held probe and record the results on a well observation form. The probe will be calibrated according to the manufacturer's procedures, and staff will perform a calibration check in the field before using the instrument.

3.4.3 Groundwater Sample Collection

We will collect groundwater samples no sooner than 24 hours after the wells are developed. First we will measure the depth to water in each well using an electronic interface probe; this probe can also be used to determine the thickness of the layer of free product, if present, in a well. If free product is detected, then we will not collect a sample from the well.

All groundwater samples will be collected through new, disposable polyethylene tubing using a peristaltic pump and low-flow sampling techniques. Staff will use a flow-through cell to monitor groundwater field parameters including oxygen, temperature, conductivity, and pH, unless the well contains free product. The water samples will be collected directly into the pre-cleaned containers provided by the analytical laboratory, packed in an ice-chilled cooler, and submitted to the laboratory using chain of custody protocols. Groundwater samples will be analyzed for the parameters listed in Table 1B. Groundwater sampling analytical methods, reporting limits, and cleanup levels are listed in Table 2B and sampling containers are holding times are listed in Table 4.

3.5 Sediment Sample Collection Methods

Sediment samples will be collected adjacent to the Terminals property dock using boat-mounted Power Van Veen surface sediment sampling equipment. The samples will be analyzed for volatiles (including dichlorobenzenes and 1,2,4-trichlorobenzene), PCBs, total metals, ammonia, sulfides, and TOC. At three locations, sediment will be collected for bioassay analysis.

The proposed locations and coordinates for the sediment samples are shown on Figure 5.

3.5.1 Positioning Methods

A differential global positioning system (DGPS) will be used aboard the sampling vessel for location positioning. Navigation systems will be used to provide a target horizontal accuracy of three meters in accordance with Ecology's Sediment and Analysis Plan Appendix (SAPA) (Ecology 2008) and PSEP protocols (PSEP 1998). The DGPS receiver will be placed above the block on the sampling device deployment boom to accurately record the sampling location position. Once the corer has been deployed, the actual position will be recorded when the sampler is on the bottom and the deployment cable is in a vertical position. Horizontal coordinates will be referenced to NAD83 State Plane North northings and eastings, and decimal minutes of latitude and longitude.

3.5.2 Water Depth Measurement

Water depths will be measured directly by lead-line or sonar and converted to mudline elevations. The lead-line measurements also serve as a check on location positioning, as the actual water depth at the location coordinates should closely match the predicted depth at those locations. Sampling coordinates and water depths will be recorded in the field notebook.

3.5.3 Power Van Veen Surface Sediment Sampling

A 0.1-square-meter pneumatic power surface grab (Van Veen) sampler will be used to collect large-volume, surface sediment samples (approximately 1 to 2 gallons from the top 10 centimeters). Samples are collected using a pneumatic ram that closes the grab around debris and substrate. During processing, the ram swings away from the grab and the doors are removed, allowing unobstructed access to the sample for photos and visual characterization.

Sediment samples collected with the power grab sampler will be carefully inspected to ensure that the following acceptability criteria are satisfied:

- The sampler is not over-filled, so that the sediment surface is pressed against the top of the sampler;
- Overlying water is present (indicating minimal leakage);
- The overlying water is not excessively turbid (indicating minimal sample disturbance);
- The sediment surface is relatively flat (indicating minimal disturbance or winnowing); and
- The desired penetration depth is achieved (e.g., several centimeters more than the targeted sample depth).

If sediment acceptance criteria are not achieved, the sample will be rejected and the location resampled. If a sample that meets the appropriate acceptance criteria within 25 feet of the proposed location cannot be collected, the sample will be relocated as determined by the Project Manager. If rejection is due to debris, the depth, location, and type of debris, if known, will be recorded in the field log.

3.5.4 Surface Sediment Processing and Handling Procedures

After the surface sediment sample is collected, the following procedure will be followed if it is decided to process the sample.

Each sample will be photographed and visually classified in the field in accordance with the Unified Soil Classification System (USCS; ASTM D 2488). The sediment classification will be documented in a field notebook; the description of each sample will include the following parameters as appropriate:

- Approximate depth and volume recovered;
- Physical soil description in accordance with the USCS (includes soil type, density/consistency of soil, color);
- Vegetation;
- Debris;
- Biological activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms);
- Presence of oil sheen; and
- Any other distinguishing characteristics or features.

If the sediment sample at a given location is determined to be acceptable, sediment from the upper 10 centimeters will be placed into a decontaminated stainless-steel mixing bowl for manual homogenization. Sediment in direct contact with the sides of the grab sampler will not be used. Observable organisms and pieces of debris will be removed. Once homogenized, sediment will be placed into appropriate sampling containers for chemical analysis. Table 5 provides specifications for sample containers, sample volumes, and holding times. All samples will be kept on ice until shipped to the laboratory.

4.0 SAMPLE HANDLING PROCEDURES

4.1 Sample Storage Requirements

Samples will be preserved, extracted, and analyzed according to the requirements of the analytical methods and within the appropriate holding time. Sample storage temperatures and holding times are summarized in Tables 3 through 5.

4.2 Chain of Custody Procedures

Chain of custody forms will be used to document the collection, custody, and transfer of samples from their initial collection location to the laboratory, and their ultimate use and disposal. Entries for each sample will be made on the custody form after each sample is collected.

Sample custody procedures will be followed to provide a documented record that can be used to follow possession and handling of a sample from collection through analysis. A sample is considered to be in custody if it meets at least one of the following conditions:

- The sample is in someone's physical possession or view;
- The sample is secured to prevent tampering (i.e., custody seals); and/or
- The sample is locked or secured in an area restricted to authorized personnel.

A chain of custody form will be completed in the field as samples are packaged. At a minimum, the information on the custody form shall include the sample number, date and time of sample collection, sampler, analysis, and number of containers. Two copies of the custody form will be placed in the cooler prior to sealing for delivery to the laboratory with the respective samples. The other copy will be retained and placed in the project files after review by the Project Chemist. Custody seals will be placed on each cooler or package containing samples so the package cannot be opened without breaking the seals.

4.2.1 Delivery of Samples to Analytical Laboratory

All soil, groundwater, and sediment samples will be packed on ice in coolers. The coolers will be transferred to Analytical Resources Inc. (ARI) in Tukwila, Washington, for chemical analysis. Bioassay samples will be shipped to Northwest Aquatic Sciences in Newport, Oregon. Specific handling procedures are as follows.

- Samples will be packaged and shipped according to U.S. Department of Transportation regulations as specified in 49 CFR 173.6 and 49 CFR 173.24.
- Individual sample containers will be packed to prevent breakage.
- Coolers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the cooler, and the Hart Crowser office name and address) to enable positive identification.
- Custody forms will be sealed in an envelope, enclosed in a plastic bag, and taped to the inside lid of the cooler.
- Signed and dated custody seals will be placed on all coolers.
- Samples will be shipped by overnight courier or will be hand delivered to the laboratory by Hart Crowser personnel.
- Upon transfer of sample possession to the testing laboratory, the custody form will be signed by the persons transferring custody of the coolers. Upon receipt of samples at the laboratory, the shipping container custody seal will be broken and the laboratory sample-receiving custodian will compare the information on the sample labels to information on the chain of custody form and record the condition of the samples received.

5.0 LABORATORY ANALYTICAL METHODS

The laboratory analytical methods for this project are EPA methods as described in Update III or Update IV to Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846 (EPA 1986, EPA 2008a); Methods for Chemical Analysis of Water and Wastes (EPA 1983); and Standard Methods for the Examination of Water and Wastewater. Sample methods, preparation, analysis, and practical quantitation limits (PQLs) are presented in Tables 2A through 2C.

5.1 Chemical Analysis and Target Detection Limits

5.1.1 Chemical Analysis of Soil Samples

Soil samples will be analyzed for one or more of the following:

- Volatile Organic Compounds (VOCs) by EPA Method 8260C;
- Polychlorinated Biphenyls (PCBs) by EPA Method 8082A;
- Metals (including arsenic, cadmium, chromium, lead, and mercury) by EPA Method 200.8/7471;
- TOC by Plumb;
- Diesel- and oil-range petroleum hydrocarbon analysis by Northwest Test Method NWTPH-Dx; and
- Total solids by EPA Method 160.3M/SM 2540B.

Metals and diesel- and oil-range petroleum hydrocarbon analysis may be performed on additional samples if field indications of contamination (i.e., petroleum-like-odor or visible staining) are observed.

The results of the total solids analysis will be used to correct the results from the other tests to a dry weight basis.

A summary of soil sampling analysis is presented in Table 1A. The laboratory’s PQLs for the soil sample analysis are shown in Table 2A.

5.1.2 Chemical Analysis of Water Samples

All groundwater samples will be analyzed for one or more of the following:

- VOCs by EPA Method 8260C;
- PCBs by EPA Method 8082A;
- Diesel- and oil-range hydrocarbons by NWTPH-DX;
- Total Metals (including arsenic, cadmium, chromium, lead, and mercury) by EPA Methods 200.8/7470A;
- Dissolved Metals (including arsenic, cadmium, chromium, lead, and mercury) by EPA Methods 200.8/7470A;

A summary of groundwater sampling analysis is presented in Table 1B. The laboratory’s PQLs for these analytes are shown in Table 2B.

5.1.3 Physical/Chemical Analysis of Sediment Samples

Sediment samples will be analyzed for the following analytes:

- VOCs by EPA Method 8260C;
- PCBs by EPA Method 8082;
- Metals (including arsenic, cadmium, chromium, lead, and mercury) by EPA Method 200.8/6010/7470; and
- TOC by Plumb (1981).

At bioassay sample locations, sediments will also be analyzed for ammonia by EPA Method 350.3 and total sulfides using Puget Sound Estuary Program (PSEP) protocols (PSEP 1986).

In all cases, to avoid potential problems and maintain the option for retesting, sediment or extracts will be kept under proper storage conditions until the chemistry data are deemed acceptable.

The laboratory's PQLs for these analytes are shown in Table 2C.

5.2 Sediment Bioassay Analysis

Sediment samples will be analyzed using both bioassay and chemical methods. Northwest Aquatic Sciences will evaluate chronic and acute exposure including lethal and sub-lethal endpoints. These analyses will meet the minimum requirements, including the quality assurance requirements in accordance with the new SMS (Ecology 2013) WAC 173-204-563(3)d. These requirements are summarized below:

- Three endpoints
- Two species (Hyalella azteca and Chironomus dilutus)
- One chronic endpoint (e.g., 20–28 day)
- One sub-lethal endpoint (e.g., growth)

The following sediment bioassays will be conducted:

- Amphipod (Hyalella azteca)
  - 28-day growth
  - 28-day mortality
- Midge (Chironomus dilutus)
  - 10-day mortality
  - 10-day growth

Bioassay performance criteria and quality control standards are presented in Table 11. Upon receipt of laboratory results, Hart Crowser will complete an analytical data validation using standard methods.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL REQUIREMENTS

6.1 QA/QC for Chemical Analysis

The quality of analytical data generated is assessed by the frequency and type of internal QC checks specific to the analytic test type. Hart Crowser will assess the quality of measurements reviewing results for method blanks, matrix spikes, laboratory control samples, surrogate compound recoveries, instrument calibration, performance evaluation samples, interference checks, and other data, as specified for the analytical methods to be used.

The following general procedures will be followed for all laboratory analyses:

- Laboratory blank measurements at a minimum frequency of 5 percent or one per batch of 20 samples or fewer for each matrix;
- Matrix spike (MS) and matrix spike duplicate (MSD) or duplicate analysis to assess accuracy and precision at a minimum frequency of 5 percent or one per batch of 20 samples or fewer for each matrix;
- Analysis of surrogate compounds, for all organic analyses, to assess accuracy; and
- Laboratory control sample analysis to assess accuracy in the absence of any matrix effect at a minimum frequency of 5 percent or one per batch of 20 samples or fewer for each matrix.

Laboratory quality control procedures, criteria, and corrective action for the various analyses are summarized in Tables 6 through 10.

6.2 QA/QC for Sediment Bioassays

This section contains the specific QA/QC requirements for solid phase biological testing. General procedures are given first, followed by specific performance standards for each bioassay. These standards aid in interpreting the bioassay responses because they control for environmental effects that may produce confounding factors not associated with the toxicity of the contaminants of interest.

6.2.1 Negative Controls

Negative control sediment will be used in bioassays to check laboratory performance. Negative control sediment will be clean sediment in which the test organism normally lives (or is cultured) and will be expected to produce low mortality. Negative control reliability will be demonstrated.

6.2.2 Replication

Laboratory replicates of test sediment and negative controls will be run for each bioassay (per ASTM guidance).

6.2.3 Positive Controls

A positive control (sometimes called the reference toxicant test) will be run for each bioassay. Positive controls are chemicals known to be toxic to the test organism and provide an indication of the sensitivity of the particular organisms used in a bioassay. Positive controls will be performed on spiked fresh water and compared with historical laboratory reference toxicity test results to confirm that organism responses are within control limits established by the testing laboratory. Control charts will be constructed to show performance variability (organism sensitivity) over time.

The performance criteria and quality control standards for each of the sediment bioassays can be found in Table 11.

6.2.4 Water Quality Monitoring

Water quality monitoring of the overlying water will be conducted for the bioassays. Measurements of temperature, pH, conductivity, hardness, alkalinity, sulfide, and ammonia in overlying water will be conducted on the first and last day of the tests. Temperature will be measured daily, dissolved oxygen (DO)and pH will be measured three times per week, and conductivity measured weekly. Monitoring will be conducted for all test and reference sediment and negative controls. Parameter measurements must be within the limits specified for each bioassay. Measurements for each treatment will be made on a separate chemistry beaker set up to be identical to the other replicates within the treatment group, including the addition of test organisms.

6.3 Data Quality Indicators

All sample collection, field measurements, and laboratory analytical tests are designed to produce data of known and appropriate quality. Environmental laboratories use internal quality control checks to ensure the data they produce is of adequate quality. To ensure the data reported by the laboratory meets agreed-upon standards, Hart Crowser will assign an independent data quality reviewer to evaluate the internal quality control checks (including method blanks, matrix spikes, laboratory control samples, calibrations, performance evaluation samples, interference checks, etc.), for each data package.

Hart Crowser follows the procedures and quality control checks described in this section to verify that known and acceptable levels of accuracy and precision are maintained for each data package.

6.3.1 Precision

Precision is the degree of reproducibility or agreement between independent or repeated measurements. Analytical variability will be expressed as the relative percent difference (RPD) between laboratory replicates and between matrix spike and matrix spike duplicate. The RPD will be calculated by:

$$\mathrm{RPD}=\frac{(D_1-D_2)}{(D_1+D_2)/2}\times 100$$

Where,

D_1 = Sample value

D_2 = Duplicate sample value

6.3.2 Accuracy

Accuracy is the agreement between a measured value and its true or accepted value. It is not possible to determine absolute accuracy for environmental samples, so we use known standards and spiked samples to assess accuracy.

Laboratory accuracy will be assessed as the percent recovery of matrix spikes, matrix spike duplicates, surrogate spiked compounds (for organic analysis), and laboratory control samples. Accuracy will be defined as the percentage recoverable from the true value and is calculated by:

$$\%Recovery = \frac{(SSR - SR)}{SA} \times 100$$

Where

SSR = spiked sample result

SR = sample results (not applicable for surrogate recovery)

SA = amount of spike added

6.3.3 Representativeness

Representativeness expresses the degree to which the sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. The sampling program will be designed to ensure that: (a) sample locations are selected properly, (b) sufficient samples are collected to accurately reflect conditions at the site, and (c) samples are representative of sampling locations. We will collect a sufficient sample volume at each sampling point to minimize bias or errors associated with sample particle size and heterogeneity.

6.3.4 Completeness

Completeness is the percentage of measurements that are judged to be valid. Completeness will be calculated separately for each analytical group. Results must also contain all quality control check analyses required to verify the precision and accuracy of results to be considered complete. Data qualified as estimated during the validation process will be considered complete. Non-valid measurements will be results that are rejected during the validation review or samples for which no analytical results were obtained. Completeness will be calculated for each analysis using the following equation:

$$Completeness = \frac{valid data points obtained}{total data points planned} \times 100$$

The target goal for completeness is a minimum of 95 percent. Completeness will be monitored on an ongoing basis so that archived sample extracts can be reanalyzed, if required, without remobilization.

6.3.5 Comparability

Comparability is the degree to which data from separate data sets may be compared. Sample collection will be performed in a consistent manner by field personnel at all sampling locations to ensure all data collected as part of this study are comparable. Comparability is attained by careful adherence to standardized sampling and analytical procedures, based on rigorous documentation of sample locations (including depth, time, and date).

The use of standardized methods to collect and analyze samples, along with instruments calibrated against National Institute for Standards and Technology and EPA traceable standards will also ensure comparability, particularly for comparison of data collected from this study (within-study comparability).

Comparability also depends on other data quality characteristics. Only when data are judged to be representative of the environmental conditions, and when precision and accuracy are known, can data sets be compared with confidence.

6.4 Data Quality Assurance Review Procedures

A project chemist at Hart Crowser will perform an independent data quality review of the analytical results. The data quality review is based on the Quality Control Requirements previously described and follows the format of the EPA National Functional Guidelines for Inorganic (EPA 2010) Superfund Data Review modified to include specific criteria of individual analytical methods.

The data quality review will assess: the adequacy of the reported detection limits in achieving the project screening levels; the precision, accuracy, representativeness, and completeness of the data; and the usability of the analytical data for project objectives. Any exceedances of analytical control limits will be summarized and evaluated. Raw data (instrument tuning, calibrations, instrument printouts, bench sheets, and laboratory worksheets) will be available for review if any problems or discrepancies are discovered.

The data quality review process will include the following:

- Verify that sample numbers and analyses match the chain of custody request;
- Verify sample preservation and holding times;
- Verify that instrument tuning, calibration, and performance criteria were achieved;
- Verify that laboratory blanks were performed at the proper frequency and that no analytes were present in the blanks;

- Verify that laboratory duplicates, matrix spikes, surrogate compounds, and laboratory control samples were run at the proper frequency and that control limits were met; and

- Verify that required detection limits have been achieved.

The data reviewer will add qualifier flags to results that are outside the QC acceptance criteria. The qualifier flags are defined below.

U	The compound was analyzed for but was not detected. The associated numerical value is the sample reporting limit.
J	The associated numerical value is an estimated quantity because QC criteria were slightly exceeded.
UJ	The compound was analyzed for, but not detected. The associated numerical value is an estimated reporting limit because QC criteria were not met.
T	The associated numerical value is an estimated quantity because reported concentrations were less than the practical quantitation limit (lowest calibration standard).
R	Data are not usable because of significant exceedance of QC criteria. The analyte may or may not be present; resampling and/or reanalysis are necessary for verification.

7.0 DATA ANALYSIS, RECORDKEEPING, AND REPORTING REQUIREMENTS

7.1 Evaluation of Chemistry Data

The sampling and analysis activities conducted at Jacobson Terminals will be performed in accordance with the MTCA cleanup regulations (WAC 173-340-350) and following procedures specified by the sediment cleanup SMS for the state of Washington (Chapter 173-204 WAC).

7.1.1 Soil Data Analysis

To evaluate whether COC concentrations in soil are protective of surface water, screening levels were calculated using Ecology's Three-Phase Partitioning Model (WAC 173-340-474). Surface water screening values presented in Table 2B were used as input to the model to compute the soil screening levels presented in Table 2A. For COCs with no surface water screening value, MTCA Method A unrestricted or MTCA Method B direct contact screening levels were used.

7.1.2 Groundwater Data Analysis

Groundwater screening levels are based on the most conservative freshwater screening levels for consumption of organisms under the Federal Clean Water Act Section 304, National Toxics Rule 40 CFR 131, or MTCA Method B surface water criteria, whichever is lower. For COCs with no surface water screening value, MTCA Method A cleanup levels will be used. Groundwater screening levels can be found in Table 2B.

7.1.3 Sediment Data Analysis

Sediment chemistry results will be compared to the Washington State Freshwater Sediment Cleanup Objective Criteria and Freshwater Sediment Screening Levels as defined in WAC 173-204. Sediment Screening Levels are presented in Table 2C.

7.1.4 Sediment Bioassay Analysis

Data analysis will consist of endpoint comparisons to controls on an absolute percentage basis. Individual biological test failures will be identified as SCO or CSL failures depending on the extent of exceedances. Individual sample locations will also be identified as SCO or CSL based on two SCO failures or one CSL failure as described in the Washington State Sediment Management Standards (Chapter 173-204 WAC).

The control sample must meet performance criteria detailed in Table 11, for the results to be accepted. A technical report documenting the results and activities associated with sample analyses will be provided to Hart Crowser, which we will include in our summary report.

7.2 Recordkeeping Procedures

Project records will be transferred to Ecology at the end of the work assignment. Records will include:

- This Work Plan/SAP and related quality assurance documentation;
- Field notes including the date, time, and location of sample collection, along with other identifying information such as core depth, water levels, etc.;
- Names of field personnel, equipment, methods, and procedures;
- Laboratory analytical documentation; and
- Final report.

7.3 Laboratory Reporting Procedures

The laboratory will provide Level IV data packages containing complete documentation of analytical processes and all the raw data needed for independent data reduction and verification of analytical results. Each laboratory report will include:

- Case narrative identifying the laboratory analytical batch number, sample matrix, number of samples, analyses performed, analytical methods used, description of problems or exceedance of QC criteria, and corrective actions. The laboratory manager or designee must sign the narrative.
- Copy of COC forms for all samples in the analytical batch.

- Tabulated analytical results with units, data qualifiers, percent solids, sample weight or volume, dilution factor, laboratory batch and sample number, Hart Crowser sample number, and dates sampled, received, extracted, and analyzed all clearly labeled.
- All calibration, quality control, and sample raw data including quantitation reports and other instrument output data.
- Blank summary results indicating samples associated with each blank.
- MS/MSD result summaries with calculated percent recovery and relative percent differences.
- Surrogate compound recoveries, when applicable, with percent recoveries.
- Laboratory control sample results, when applicable, with calculated percent recovery.
- Electronic data package (EDD) formatted for upload into Ecology's EIM data system.

7.3.1 Reports to Ecology

The results of this investigation will be provided as part of the Remedial Investigation and Feasibility Study Report, which is Task 3 for this project. Our report will include the sample collection procedures, maps depicting the sample locations, tabulated analytical data with comparisons to MTCA screening criteria, data quality review report, and complete laboratory analytical documentation. We will also submit analytical data to EIM.

8.0 SCHEDULE

The soil and groundwater investigation is planned for December 2014 and depends on subcontractor availability. The sediment investigation is planned for January 2014 when sampling locations will be accessible. Laboratory analytical results should be available 3 to 4 weeks following receipt of the samples at the laboratory, and a QA validation will be completed within 2 weeks of receipt of the laboratory results. The draft Remedial Investigation and Feasibility Study will be submitted 8 weeks after receipt of final analytical results.

9.0 PROJECT PERSONNEL AND RESPONSIBILITIES

Key staff members for this task order are listed below with their project functions.

- Mike Ehlebracht, LHG, Principal in Charge
- Phil Cordell, LG, Project Manager
- Roger McGinnis, PhD, Chemist, Sediment Quality Specialist
- Anne Conrad, Geochemist, Sampling and Field Coordination, Laboratory Coordination/Oversight, and Data Validation and Review

- Jamey Selleck, Fisheries Biologist
- Matt Smith, Environmental Scientist and Field Sampler
- Nick Galvin, Environmental Scientist/Toxicologist and Field Sampler

Subcontractors will include Bio-Marine Enterprises for collecting sediment samples and Holt Drilling and Environmental Services Northwest for drilling and soil sampling. Chemical analysis will be performed by Analytical Resources, Inc. (ARI), of Seattle, Washington.

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DRAFT Table 1A - Soil Sampling and Analysis Summary

Boring ID	VOCs	PCBs	Metals	Dx	TOC	Sampling Rationale
JT-US-39	X	X	X	X	X	Assess COCs near the petrolum area.
JT-US-40	X	X	X	X	X	Assess COCs near the petrolum area.
JT-US-41	X	X	X	X	X	Assess COCs near the petrolum area.
JT-US-42	X	X	X	X	X	Assess COCs near the petrolum area.
JT-US-43	X	X	X	X		Assess COCs near the petrolum area.
JT-US-44	X	X	X			Assess COCs downgradient of treatment wall.
JT-US-45	X	X	X		X	Assess COCs downgradient of treatment wall.
JT-US-46	X	X				Delineate PCB and chlorinated benzene concentrations around the PCB area.
JT-US-47	X	X				Delineate PCB and chlorinated benzene concentrations around the PCB area.
JT-US-48	X	X				Delineate PCB and chlorinated benzene concentrations around the PCB area.
JT-US-49	X	X				Delineate PCB and chlorinated benzene concentrations around the PCB area.
JT-US-50	X	X				Delineate PCB and chlorinated benzene concentrations around the PCB area.
JT-US-51	X	X				Delineate PCB and chlorinated benzene concentrations around the PCB area.
JT-US-52	X	X				Assess COC concentrations away from known areas of contamination at the site.
JT-US-53	X	X				Assess COC concentrations away from known areas of contamination at the site.
JT-MW-01S	X	X	X		X	Assess COCs downgradient of treatment wall.
JT-MW-02S	X	X	X			Assess COCs downgradient of treatment wall.
JT-MW-03D	X	X				Assess COC concentrations in deep aquifer downgradient of treatment wall.
JT-MW-04D	X	X				Assess COC concentrations in deep aquifer upgradient of treatment wall.
JT-MW-05S	X	X				Assess COCs concentrations at south end of wall.
JT-MW-06D	X	X				Assess COC concentrations in deep aquifer at south end of wall.
JT-MW-07S	X	X	X		X	Assess COC concentrations away from known areas of contamination at the site.
JT-MW-08S	X	X	X		X	Assess COC concentrations away from known areas of contamination at the site.
Total	22	22	10	5	7	

Notes:

Additional tests may be performed if field observations indicate the presence of contaminants.

Acronyms and Abbreviations:

PCBs = Polychlorinated biphenyls
VOCs = Volatile Organic Compounds
Dx = Diesel- and oil-range petroleum hydrocarbons
Metals = Arsenic, Cadmium, Chromium, Lead, and Mercury
COCs = Contaminants of Concern

DRAFT Table 1B - Groundwater Sampling and Analysis Summary

Well ID	PCBs	Metals		VOCs	Dx	Sampling Rationale
		Diss.	Total			
HC-MW-1	X	X	X	X	X	Assess petroleum, PCB, and VOC concentrations in the vicinity of the PCB/petroleum remediation area.
HC-MW-2	X	X	X	X	X	Assess petroleum, PCB, and VOC concentrations in the vicinity of the PCB/petroleum remediation area.
HC-MW-3	X	X	X	X	X	Assess petroleum, PCB, and VOC concentrations in the vicinity of the PCB/petroleum remediation area.
MW-4	X	X	X	X	X	Assess petroleum, PCB, and VOC concentrations in the vicinity of the PCB/petroleum remediation area.
IW-5S	X	X	X	X		Assess PCB and VOC concentrations west of PCB area.
IW-5D	X	X	X	X		Assess PCB and VOC concentrations west of PCB area.
SRW-1	X			X		Assess PCB and VOC concentrations in treatment wall.
SRW-2	X			X		Assess PCB and VOC concentration in treatment wall.
SRW-3	X			X		Assess PCB and VOC concentration in treatment wall.
JT-3	X	X	X	X		Assess PCB and VOC concentrations at north end of treatment wall.
JT-4	X	X	X	X		Assess PCB and VOC concentrations east of PCB and chlorinated solvent areas.
JT-5	X	X	X	X		Assess PCB and VOC concentrations in deep aquifer adjacent to the Lake Washington Ship Canal.
JT-6	X	X	X	X		Assess COC concentrations along shoreline.
JT-7	X			X		Assess PCB and VOC concentrations upgradient of south treatment wall.
JT-9	X	X	X	X		Assess PCB and VOC concentrations at north end of treatment wall.
JT-10	X			X		Assess PCB and VOC concentrations upgradient of treatment wall.
JT-11	X			X		Assess PCB and VOC concentrations upgradient of treatment wall.
JT-12	X	X	X	X		Assess COC concentrations at shoreline.
MW-100	X	X	X	X		Assess COC concentrations in deep aquifer downgradient of treatment wall.
MW-200	X	X	X	X		Assess COC concentrations in deep aquifer below source area.
JT-MW-01S	X	X	X	X		Assess COCs downgradient of treatment wall.
JT-MW-02S	X	X	X	X		Assess COCs downgradient of treatment wall.
JT-MW-03D	X	X	X	X		Assess COC concentrations in deep aquifer downgradient of treatment wall.
JT-MW-04D	X	X	X	X		Assess COC concentrations in deep aquifer upgradient of treatment wall.
JT-MW-05S	X	X	X	X		Assess COCs concentrations at south end of wall.
JT-MW-06D	X	X	X	X		Assess COC concentrations in deep aquifer at south end of wall.
JT-MW-07S	X	X	X	X		Assess PCB concentrations away from known areas of contamination at the site.
JT-MW-08S	X	X	X	X		Assess PCB concentrations away from known areas of contamination at the site.
Drums*	X	X	X	X	X	Sample groundwater drums for wastewater profiling.
Total	29	23	23	29	5	

Notes:

Additional tests may be performed if field observations indicate the presence of contaminants.

Gray shading indicates proposed well.

* = Drum sample will be analyzed for the MTCA 5 metals (As, Cd, Cr, Pb, and Hg).

Acronyms and Abbreviations:

PCBs = Polychlorinated biphenyls
VOCs = Volatile Organic Compounds
Dx = Diesel- and oil-range petroleum hydrocarbons
Metals = Arsenic, Cadmium, Chromium, Lead, and Mercury.
COCs = Contaminants of Concern

DRAFT Table 2A - Analytical Methods, Reporting Limits, and Cleanup Levels for Soil

Parameter	Prep Method	Analysis Method	Reporting Limits *	Screening Levels	Screening Criteria
SOIL					
POLYCHLORINATED BIPHENYLS (PCBs)			**mg/kg**	**mg/kg**	
Aroclor 1260	EPA 3546	EPA 8082A	0.004	0.0000787**	A
METALS, TOTAL			**mg/kg**	**mg/kg**	
Arsenic	EPA 200.8	EPA 200.8	0.5	7**	A
Cadmium	EPA 200.8	EPA 200.8	0.1	5.6	A
Chromium, Total	EPA 200.8	EPA 200.8	0.5	4.86E+06	A
Lead	EPA 200.8	EPA 200.8	0.1	250	B
Mercury	EPA 7471B	EPA 7471B	0.025	0.157	A
CHLORINATED ALIPHATIC COMPOUNDS			**mg/kg**	**mg/kg**	
Vinyl Chloride	EPA 5030	EPA 8260C	0.001	0.00076**	A
1,1-Dichloroethene (DCE)	EPA 5030	EPA 8260C	0.001	0.0011	A
trans-1,2-Dichloroethene (DCE)	EPA 5030	EPA 8260C	0.001	2.7	A
cis-Dichloroethene (DCE)	EPA 5030	EPA 8260C	0.001	na	
Trichloroethene (TCE)	EPA 5030	EPA 8260C	0.001	0.0042	A
Tetrachloroethene (PCE)	EPA 5030	EPA 8260C	0.001	0.0018	A
CHLORINATED BENZENES			**mg/kg**	**mg/kg**	
Chlorobenzene (CB)	EPA 5030	EPA 8260C	0.001	0.87	A
1,3-Dichlorobenzene (1,3-DCB)	EPA 5030	EPA 8260C	0.001	1.06	A
1,4-Dichlorobenzene (1,4-DCB)	EPA 5030	EPA 8260C	0.001	0.22	A
1,2-Dichlorobenzene (1,2-DCB)	EPA 5030	EPA 8260C	0.001	1.01	A
1,2,4-Trichlorobenzene (1,2,4-TCB)	EPA 5030	EPA 8260C	0.005	0.0054	A
1,2,3-Trichlorobenzene (1,2,3-TCB)	EPA 5030	EPA 8260C	0.005	na	
OTHER VOLATILE ORGANIC COMPOUNDS (VOCs)			**mg/kg**	**mg/kg**	
Chloroform	EPA 5030	EPA 8260C	0.001	0.13	A
Benzene	EPA 5030	EPA 8260C	0.001	0.0064	A
Toluene	EPA 5030	EPA 8260C	0.001	5.45	A
Xylenes	EPA 5030	EPA 8260C	0.001	na	
1,2,4-Trimethylbenzene (1,2,4-TMB)	EPA 5030	EPA 8260C	0.001	na	
1,3,5-Trimethylbenzene (1,3,5-TMB)	EPA 5030	EPA 8260C	0.001	na	
n-Butylbenzene	EPA 5030	EPA 8260C	0.001	na	
Hexachlorobutadiene (HCB)	EPA 5030	EPA 8260C	0.005	12.82	C
Naphthalene	EPA 5030	EPA 8260C	0.005	6.88	A
TOTAL PETROLEUM HYDROCARBONS (TPH)			**mg/kg**	**mg/kg**	
Diesel Range Organics	EPA 3550B	NWTPH-Dx	50	2000	B
Heavy Oil Range Organics	EPA 3550B	NWTPH-Dx	50	2000	B
CONVENTIONALS			**mg/kg**		
Total Organic Carbon (TOC)	---	Plumb	0.02%	---	
Total Solids	---	EPA 160.3M/SM 2540B	0.05	---	

Notes:

* Reporting limits from Analytical Resources, Inc. (ARI), laboratory in Tukwila, Washington.

** Screening level based on regional natural background for Puget Sound (Ecology 1994).

A - Value provided is the Three-Phase Partitioning Model screening level calculated with MTCA equation 747-1 using the lowest surface water level for protection of human health considering food ingestion only (WAC 173-340-474). The cleanup levels provided are based on potential for groundwater migration to surface water.

B - MTCA Method A Soil Unrestricted Land Use Table Value.

C - MTCA Method B Soil Unrestricted Land Use Direct Contact Formula Value, Carcinogen.

Table 2B - Analytical Methods, Reporting Limits, and Cleanup Levels for Groundwater

Parameter	Prep Method	Analysis Method	Reporting Limits *	Screening Levels	Screening Criteria
GROUNDWATER					
POLYCHLORINATED BIPHENYLS (PCBs)			**μg/L**	**μg/L**	
Total PCBs	EPA 3510C	EPA 8082A	0.01	0.000064**	A
METALS, TOTAL			**μg/L**	**μg/L**	
Arsenic	EPA 200.8	EPA 200.8	0.5	0.098	D
Cadmium	EPA 200.8	EPA 200.8	0.1	40.5	C
Chromium (Total)	EPA 200.8	EPA 200.8	0.5	2.44E+05	C
Lead	EPA 200.8	EPA 200.8	0.1	15	E
Mercury	EPA 7470	EPA 7470	0.1	0.15	A
TOTAL PETROLEUM HYDROCARBONS (TPH)			**μg/L**	**μg/L**	
Diesel Range Organics	EPA 3510	NWTPH-Dx	0.1	500	E
Lube Oil Range Organics	EPA 3510	NWTPH-Dx	0.2	500	E
CHLORINATED ETHENE COMPOUNDS			**μg/L**	**μg/L**	
Vinyl Chloride	EPA 5030	EPA 8260C	0.2	2.4	A
1,1-Dichloroethene (DCE)	EPA 5030	EPA 8260C	0.2	3.2	B
trans-1,2-Dichloroethene (DCE)	EPA 5030	EPA 8260C	0.2	10,000	A
cis-1,2-Dichloroethene (DCE)	EPA 5030	EPA 8260C	0.2	na	A
Trichloroethene (TCE)	EPA 5030	EPA 8260C	0.2	12.7	D
Tetrachloroethene (PCE)	EPA 5030	EPA 8260C	0.2	3.3	A
CHLORINATED BENZENE COMPOUNDS			**μg/L**	**μg/L**	
Chlorobenzene	EPA 5030	EPA 8260C	0.2	1,600	A
m-Dichlorobenzene (1,3-DCB)	EPA 5030	EPA 8260C	0.2	960	A
p-Dichlorobenzene (1,4-DCB)	EPA 5030	EPA 8260C	0.2	190	A
o-Dichlorobenzene (1,2-DCB)	EPA 5030	EPA 8260C	0.2	1,300	A
1,2,4-Trichlorobenzene (1,2,4-TCB)	EPA 5030	EPA 8260C	0.5	1.96	D
1,2,3-Trichlorobenzene (1,2,3-TCB)	EPA 5030	EPA 8260C	0.5	na	A
OTHER VOLATILE ORGANIC COMPOUNDS (VOCs)			**μg/L**	**μg/L**	
Chloromethane	EPA 5030	EPA 8260C	0.5	na	A
Dibromomethane	EPA 5030	EPA 8260C		na	A
1,1-Dichloroethane (DCA)	EPA 5030	EPA 8260C	0.2	na	A
1,2-Dichloroethane (DCA)	EPA 5030	EPA 8260C		na	A
1,1,2-Trichloroethane (TCA)	EPA 5030	EPA 8260C	0.2	16	A
1,1,2,2-Tetrachloroethane (TeCA)	EPA 5030	EPA 8260C	0.2	4	A
Benzene	EPA 5030	EPA 8260C	0.2	22.7	D
Toluene	EPA 5030	EPA 8260C	0.2	15,000	A
Ethylbenzene	EPA 5030	EPA 8260C	0.2	2,100	A
Total Xylenes	EPA 5030	EPA 8260C	0.2	na	A
Naphthalene	EPA 5030	EPA 8260C	0.5	4,938	C
1,3,5-Trimethylbenzene (TMB)	EPA 5030	EPA 8260C	0.2	na	A
1,2,4-Trimethylbenzene (TMB)	EPA 5030	EPA 8260C	0.2	na	A
Chloroform	EPA 5030	EPA 8260C	0.2	470	A
CONVENTIONALS					
Total Organic Carbon (TOC)	---	SM 5310	---	---	---

Notes:

* Reporting limits from Analytical Resources, Inc. (ARI), laboratory in Tukwila, Washington.

** The screening level is lower than the method PQL; MTCA detaults the screening level up to the PQL.

A - Clean Water Act S304 Freshwater Screening Level for Consumption of Organisms based on groundwater migration to surface water.

B - National Toxics Rule 40 CFR 131 Freshwater Screening Level for Consumption of Organisms based on groundwater migration to surface water.

C - MTCA Method B, Non-Carcinogen, Surface Water Screening Level, standard formula value.

D - MTCA Method B, Carcinogen, Surface Water Screening Level, standard formula value.

E - MTCA Method A Cleanup Levels for Groundwater.

na - Not applicable

Table 2C - Analytical Methods, Reporting Limits, and Cleanup Levels for Sediment

Parameter	Prep Method	Analysis Method	Sediment Practical Quantitation Limit *	WA Freshwater Sediment Management Standard Sediment Cleanup Objective (SCO)	WA Freshwater Sediment Management Standard Cleanup Screening Level (CSL)
SEDIMENT					
POLYCHLORINATED BIPHENYLS (PCBs)			**μg/kg (dry weight)**	**μg/kg**	**μg/kg**
Aroclor 1260	EPA 3546	EPA 8082	4	na	na
Total PCBs			**4**	110	2500
METALS, TOTAL			**mg/kg (dry weight)**	**mg/kg (dry weight)**	**mg/kg (dry weight)**
Arsenic	EPA 200.8	EPA 200.8	5.0	14	120
Cadmium	EPA 200.8	EPA 200.8	0.2	2.1	5.4
Chromium	EPA 200.8	EPA 200.8	0.5	72	88
Lead	EPA 200.8	EPA 200.8	2.0	360	>1300
Mercury	EPA 7470A	EPA 7470A	0.025	0.66	0.8
VOLATILE ORGANIC COMPOUNDS (VOCs)			**mg/kg**		
Benzene	EPA 5035A	EPA 8260C	0.001	na	na
Toluene	EPA 5035A	EPA 8260C	0.005	na	na
Ethylbenzene	EPA 5035A	EPA 8260C	0.001	na	na
m,p-Xylenes	EPA 5035A	EPA 8260C	0.002	na	na
o-Xylene	EPA 5035A	EPA 8260C	0.001	na	na
Total Xylenes	EPA 5035A	EPA 8260C	na	na	na
Methyl tert-butyl ether (MTBE)	EPA 5035A	EPA 8260C	0.001	na	na
Naphthalene	EPA 5035A	EPA 8260C	0.001	na	na
1,2-Dibromoethane (EDB)	EPA 5035A	EPA 8260C	0.001	na	na
1,2-Dichloroethane (EDC)	EPA 5035A	EPA 8260C	0.001	na	na
CHLORINATED BENZENES			mg/kg		
Chlorobenzene (CB)	EPA 5035A	EPA 8260C	0.001	na	na
1,3-Dichlorobenzene (1,3-DCB)	EPA 5035A	EPA 8260C	0.001	na	na
1,4-Dichlorobenzene (1,4-DCB)	EPA 5035A	EPA 8260C	0.001	na	na
1,2-Dichlorobenzene (1,2-DCB)	EPA 5035A	EPA 8260C	0.001	na	na
1,2,4-Trichlorobenzene (1,2,4-TCB)	EPA 5035A	EPA 8260C	0.005	na	na
1,2,3-Trichlorobenzene (1,2,3-TCB)	EPA 5035A	EPA 8260C	0.005	na	na
CONVENTIONALS					
Total Organic Carbon in %	---	Plumb (1981)	0.10%	na	na
Ammonia	---	EPA 350.3	0.1 mg/kg	230	300
Total Sulfides	---	PSEP	10 mg/kg	39	661

Notes:

* Reporting limits from Analytical Resources, Inc. (ARI), laboratory in Tukwila, Washington.

na - Not applicable

Table 3 – Soil Sample Containers, Preservation, and Holding Times

Analysis	Preservation	Holding Time [1]	Container
Volatile Organic Compounds (EPA 8260C)	5mL methanol (2 vials) 5 mL $NaHSO_4$ (2 vials) Cool 0 - 6°C	14 Days (2 Days if Unpreserved)	2 – pre-weighed 40 mL VOA vials containing methanol 2 – pre-weighed 40 mL VOA vials containing stir and $NaHSO_4$ 1 – 2 ounce glass jar with septa lid for total solids
Polychlorinated Biphenyls (EPA 8082)	Cool 0 - 6°C	14 Days	1 – 8-oz. glass jar
Metals (EPA 200.8/7471A)	Cool 0 - 6°C	6 Months	1 – 8-oz. glass jar
Diesel- and Oil-Range Petroleum Hydrocarbons (NWTPH-Dx)	Cool 0 - 6°C	14 Days	1 – 4oz glass jar
Total Organic Carbon (TOC) (Plumb)	Cool 0 - 6°C	14 days	1 – 4oz jar

1. Holding times are from date of sample collection.

Some analyses may be combined.

Table 4 – Groundwater Sample Containers, Preservation, and Holding Times

Analysis	Preservation	Holding Time [1]	Container
Volatile Organic Compounds (EPA 8260C)	HCl to pH < 2 Cool 0 - 6°C	14 Days	3 – 40 mL VOA vials
Polychlorinated Biphenyls (EPA 8082)	Cool 0 - 6°C	7 Days	2 – 1 L AG bottles
Total Metals (EPA Methods 200.8/7470)	HNO_3 to pH < 2 Cool 0 - 6°C	6 Months	1 – 500 mL HDPE bottles
Dissolved Metals (EPA Methods 200.8/7470) Field Filtered	HNO_3 to pH < 2 Cool 0 - 6°C	6 Months	1 – 500 mL HDPE bottles
Diesel- and Oil-Range Organics (NWTPH-Dx)	HCl to pH < 2 Cool 0 - 6°C	14 Days	1 - 1L AG bottle
Total Organic Carbon (SM5310)	H_2SO_4 to pH < 2 Cool 0 - 6°C	28 Days	1 – 250 mL AG bottle

1. Holding times are from date of sample collection.

Table 5 – Sediment Sample Containers, Preservation, and Holding Times

Analysis	Preservation	Holding Time [1]	Container
Volatile Organic Compounds (EPA 8260C)	5mL methanol (1 vial) 5 mL $NaHSO_4$ (2 vials) Cool 0 - 6°C	14 Days (2 days if unpreserved)	2 – pre-weighed 40 mL VOA vials containing methanol 2 – pre-weighed 40 mL VOA vials containing stir and $NaHSO_4$ 1 – 2 ounce glass jar with septa lid for total solids
Polychlorinated Biphenyls (EPA 8082)	Cool 0 - 6°C	14 Days	1 – 8-oz. glass jar
MTCA 5 Metals (except Mercury) (EPA 200.8/7470)	Cool 0 - 6°C	6 Months	1 – 8-oz. glass jar
Mercury	Freeze, - 18°C	28 Days	Included in metals container
Ammonia (EPA 350.3)	Cool 0 - 6°C	7 days	500 mL HDPE
Total Sulfides (PSEP protocol)	1N Zinc Acetate Cool 0 - 6°C	7 days	1 – 4 oz. glass jar
Total Organic Carbon (Plumb 1981)	Cool 0 - 6°C	14 Days	1 – 4 oz. glass jar
Bioassay	Cool 0 - 6°C	6 months	6 – 1L HDPE bottles

1. Holding times are from date of sample collection.

Some analyses may be combined.

Table 6 – Quality Control Procedures for Volatile Organic Compound Analysis

VOCs – EPA 8260C			
Quality Control Check	**Frequency**	**Acceptance Criteria**	**Corrective Action**
Laboratory Quality Control			
Instrument Tuning	Prior to initial calibration and every 12 hours	See Method 8260C	Retune and recalibrate instrument
Initial Calibration	See Method 8260C	< 20% relative percent difference	Laboratory to recalibrate and reanalyze affected samples
Continuing Calibration	Every 12 hours	See Method 8260C < 20% percent difference	Laboratory to recalibrate if correlation coefficient or response factor does not meet method requirements
Method Blanks	One per sample batch or every 20 samples, whichever is more frequent, or when there is a change in reagents	Analyte concentration < PQL	Laboratory to eliminate or greatly reduce laboratory contamination due to glassware or reagents or analytical system; reanalyze affected samples
Analytical (Laboratory) Replicates and Matrix Spike Duplicates	One duplicate analysis with every sample batch or every 20 samples, whichever is more frequent; Use analytical replicates when samples are expected to contain target analytes. Use matrix spike duplicates when samples are not expected to contain target analytes	Compound- and matrix-specific RPD ≤ 40 % applied when the analyte concentration is > PQL	Laboratory to reanalyze samples if analytical problems suspected, or to qualify the data if sample homogeneity problems suspected and the project manager consulted
Matrix Spikes	One per sample batch or every 20 samples, whichever is more frequent; spiked with the same analytes at the same concentration as the LCS	Performance based intralaboratory control limits	Matrix interferences should be assessed and explained in case narrative accompanying the data package.

Table 6 – Quality Control Procedures for Volatile Organic Compound Analysis

VOCs – EPA 8260C			
Quality Control Check	**Frequency**	**Acceptance Criteria**	**Corrective Action**
Surrogate Spikes	Added to every organics sample as specified in analytical protocol	Performance based intralaboratory control limits	Follow corrective actions specified in Method 8260C.
Laboratory Control Samples (LCS), Certified or Standard Reference Material	One per analytical batch or every 20 samples, whichever is more frequent	Compound-specific, recovery and relative standard deviation for repeated analyses should not exceed the control limits specified in the method or performance-based intralaboratory control limits, whichever is lower	Laboratory to correct problem to verify the analysis can be performed in a clean matrix with acceptable precision and recovery; then reanalyze affected samples

Table 7 – Quality Control Procedures, Criteria, and Corrective Actions for PCB Analysis

PCBs – EPA 8082			
Quality Control Procedure	**Frequency**	**Control Limit**	**Corrective Action**
Instrument Quality Assurance/Quality Control			
Initial Calibration	See Method 8082, Section 11.4	See Method 8082, Section 11.4	Laboratory to recalibrate and reanalyze affected samples
Continuing Calibration	Every 12 hours or every 10 samples See Method 8082, Section 11.6.2	± 20 % difference See Method 8082, Section 11.6.2	Laboratory to recalibrate if correlation coefficient or response factor does not meet method requirements
Analyte confirmation	Second, dissimilar GC column confirmation for all detected analytes	Concentration percent difference < 40%	Qualify data
Method Quality Assurance/Quality Control			
Method Blanks	One per sample batch or every 20 samples, whichever is more frequent, or when there is a change in reagents	Analyte concentration < PQL	Laboratory to eliminate or greatly reduce laboratory contamination due to glassware or reagents or analytical system; reanalyze affected samples
Analytical (Laboratory) Replicates and Matrix Spike Duplicates	One duplicate analysis with every sample batch or every 20 samples, whichever is more frequent; Use analytical replicates when samples are expected to contain target analytes. Use matrix spike duplicates when samples are not expected to contain target analytes	Compound- and matrix-specific RPD ≤ 35 % applied when the analyte concentration is > PQL	Laboratory to reextract and reanalyze samples if analytical problems suspected, or to qualify the data if sample homogeneity problems suspected and the project manager consulted
Matrix Spikes	One per sample batch or every 20 samples, whichever is more frequent; spiked with the same analytes at the same concentration as the LCS	Compound- and matrix-specific	Matrix interferences should be assessed and explained in case narrative accompanying the data package.
Surrogate Spikes	Added to every organics sample as specified in analytical protocol; See Method 8082, Section 7.10	Performance-based intralaboratory control limits	Re-extract and reanalyze sample unless interferences are present
Laboratory Control Samples (LCS), Certified or Standard Reference Material	One per analytical batch or every 20 samples, whichever is more frequent	Compound-specific, recovery and relative standard deviation for repeated analyses should not exceed the control limits specified in the method or performance-based intralaboratory control limits, whichever is lower	Laboratory to correct problem to verify the analysis can be performed in a clean matrix with acceptable precision and recovery; then reanalyze affected samples

Table 8 – Quality Control Procedures, Criteria, and Corrective Actions for Metals Analysis

Metals – EPA 200.8/6010/7470			
Quality Control Procedure	**Frequency**	**Control Limit**	**Corrective Action**
Instrument Quality Assurance/Quality Control			
Initial Calibration	Daily	Correlation coefficient ≥0.995	Laboratory to optimize and recalibrate the instrument and reanalyze any affected samples
Initial Calibration Verification	Immediately after initial calibration	90 to 110 % recovery for ICP-AES and ICP-MS (80 to 120 % for mercury)	Laboratory to resolve discrepancy prior to sample analysis
Continuing Calibration Verification	After every 10 samples or every 2 hours, whichever is more frequent, and after the last sample	90 to 110 % recovery for ICP-AES; 85-115 % recovery for ICP-MS (80 to 120 % for mercury)	Laboratory to recalibrate and reanalyze affected samples
Initial and Continuing Calibration Blanks	Immediately after initial calibration, then 10 percent of samples or every 2 hours, whichever is more frequent, and after the last sample	Analyte concentration < PQL	Laboratory to recalibrate and reanalyze affected samples
ICP Interelement Interference Check Samples	At the beginning and end of each analytical sequence or twice per 8 hour shift, whichever is more frequent	80 to 120 percent of the true value	Laboratory to correct problem, recalibrate, and reanalyze affected samples
Method Quality Assurance/Quality Control			
Method Blanks	One per sample batch or every 20 samples, whichever is more frequent	Analyte concentration ≤ PQL	Laboratory to redigest and reanalyze samples with analyte concentrations < 10 times the highest method blank
Analytical (Laboratory) Replicates and Matrix Spike Duplicates	One duplicate analysis with every sample batch or every 20 samples, whichever is more frequent	RPD ≤ 20 % applied when the analyte concentration is > PQL	Laboratory to redigest and reanalyze samples if analytical problems suspected, or to qualify the data if sample homogeneity problems suspected and the project manager consulted

Table 8 - Quality Control Procedures, Criteria, and Corrective Actions for Metals Analysis

Metals – EPA 200.8/6010/7470			
Quality Control Procedure	**Frequency**	**Control Limit**	**Corrective Action**
Matrix Spikes	One per sample batch or every 20 samples, whichever is more frequent	75 to 125 % recovery applied when the sample concentration is < 4 times the spiked concentration for a particular analyte	Laboratory may be able to correct or minimize problem; or qualify and accept data
Laboratory Control Samples, Certified or Standard Reference Material	Overall frequency of 5 percent of field samples	80 to 120 % recovery	Laboratory to correct problem to verify the analysis can be performed in a clean matrix with acceptable precision and recovery; then reanalyze affected samples

Table 9 – Quality Control Procedures, Criteria, and Corrective Actions for NWTPH-Dx Analysis

TPH - NWTPH-Dx GC/FID			
Quality Control Check	**Frequency**	**Acceptance Criteria**	**Corrective Action**
Laboratory Quality Control			
Method blank	1 per batch of every 20 or fewer samples	All analytes < reporting limit	Re-extract and reanalyze associated samples unless concentrations are > 5 x blank level
Initial calibration	6-point external calibration prior to analysis of samples	%Difference < 15% to true value, correlation coefficient of ≥0.99	Recalibrate instrument
Continuing calibration	Every 10 samples with mid-range standard	% Difference ≤ 20% of initial calibration	Recalibrate instrument or perform maintenance and reanalyze affected samples
System monitoring compounds (surrogates)	Every lab and field sample	o-Terphenyl 50 – 150% recovery	Evaluate data for usability
Laboratory control sample	One per batch of every 20 or fewer samples	Laboratory control chart limits	Evaluate data for usability

Table 10 – Quality Control Procedures, Criteria, and Corrective Actions for Conventionals Analysis

Ammonia 150.3, Total Sulfides (PSEP), and TOC by Plumb			
Quality Control Check	**Frequency**	**Acceptance Criteria**	**Corrective Action**
Laboratory Quality Control			
Initial calibration	Daily or each time instrument is set up		
Initial calibration verification	Following each instrument calibration	90 to 110% of initial calibration	Recalibrate instrument
Continuing calibration verification	Every 10 analytical samples or every 2 hours and at the beginning and end of each run	90 to 110% of initial calibration	Recalibrate instrument and re-analyze affected samples
Method blank	1 per batch of every 20 or fewer samples	All analytes < reporting limit	Re-extract and reanalyze associated samples unless concentrations are > 5 times the blank level
Matrix spike	1 per batch of every 20 or fewer samples	75 to 125% recovery	Evaluate data for usability
Laboratory control sample	If performed, 1 per batch of every 20 or fewer samples	80 to 120% recovery	Evaluate data for usability

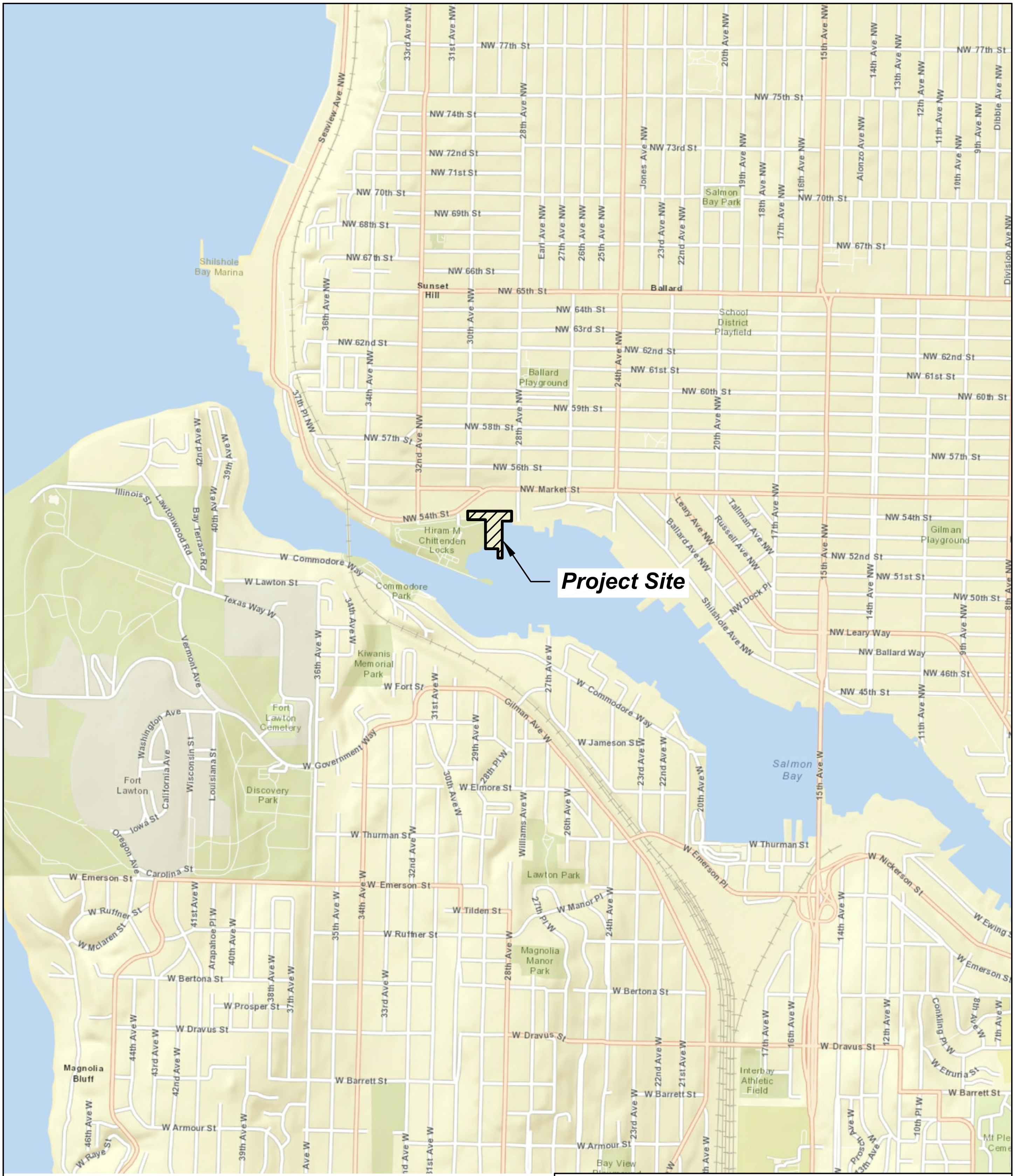
Table 11 – Quality Assurance and Adverse Effects Levels for Biological Tests

Biological Test/Endpoint	Performance Standard	Sediment Cleanup Objective (SCO)	Cleanup Screening Level (CSL)
	Control		
Hyalella azteca			
28-day mortality	$M_C \le 20\%$	M_T-$M_C > 10\%$[a]	M_T-$M_C > 25\%$
28-day growth	$MIG_C \le 0.15$ mg/individual	$(MIG_C - MIG_T)/MIG_C > 0.25$	$(MIG_C - MIG_T)/MIG_C > 0.4$
Chironomus dilutus			
10-day mortality	$M_C \le 30\%$	M_T-$M_C > 20\%$	M_T-$M_C > 30\%$
10-day growth	$MIG_C \ge 0.48$ mg/individual	$(MIG_C - MIG_T)/MIG_C > 0.2$	$(MIG_C - MIG_T)/MIG_C > 0.3$

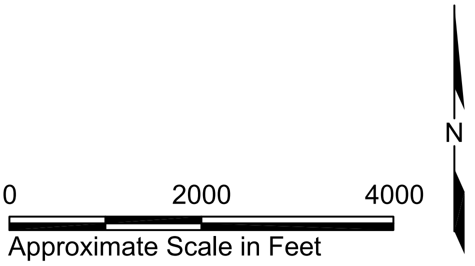
Notes:

(a) For example, the observed effect is required to be both statistically significant and greater than 10% mortality above the control to be considered a positive indication of toxicity (hit).

M = Mortality; C = Control; T = Test; F = Final; MIG = Mean Individual Growth at time final; mg = milligrams.
An exceedance of the SCO and CSL requires statistical significance at $p = 0.05$. Bioassay procedures will consider use of a control (instead of a reference sample). Comparison of test sediments to control is shown for SCO and CSL since it is rare to find appropriate reference sites.



Source: Base map prepared from ArcGIS Online, 2013.



Jacobson Terminals
Seattle, Washington

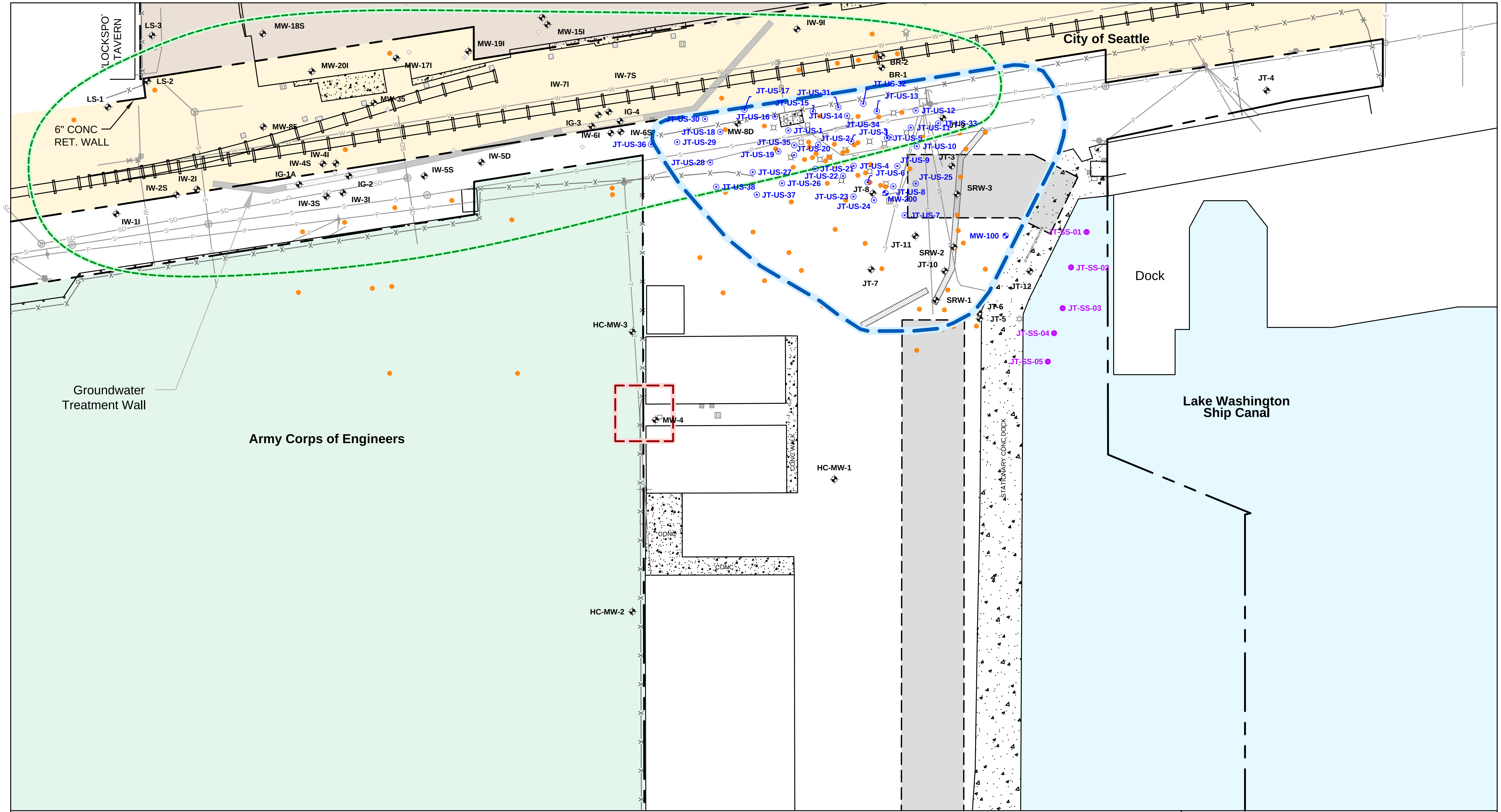
Vicinity Map

17800-56 11/14

HARTCROWSER

Figure
1

EAL 11/4/14 1780056-001.dwg



Existing Monitoring Well

Former Monitoring Well, Recovery Well, or Piezometer (Abandoned)

Injection Well

Pre-RI Soil Boring

Note: Labels removed from several borings in "IP" area for clarity. Refer to "Interim Cleanup Action Summary", Hart Crowser, July 18, 2002.

Property Boundary

Concrete Surface

Cement-Bentonite Groundwater Treatment Wall

Permeable Iron/Sand Gate

—P— Overhead Power

—S— Sanitary Sewer Line

—W— Water Line

—U— Utility Line

Iron/GAC Groundwater Treatment Wall

Boat Storage Rack

Notes:

1. Base map prepared from AutoCAD file "020030-02.dwg," provided by Aspect Consulting, 10/08/13.

2. Utility locations are approximate.

JT-SS-01 ● 2014 Sediment Sampling Location and Number

JT-US-1 ⊙ 2014 Push Probe Sampling Location and Number

PCB and Chlorinated Benzene Area

Petroleum Area

Chlorinated Ethene Area

0 50 100

Scale in Feet

N

Jacobson Terminals

Seattle, Washington

Existing Exploration Location Plan

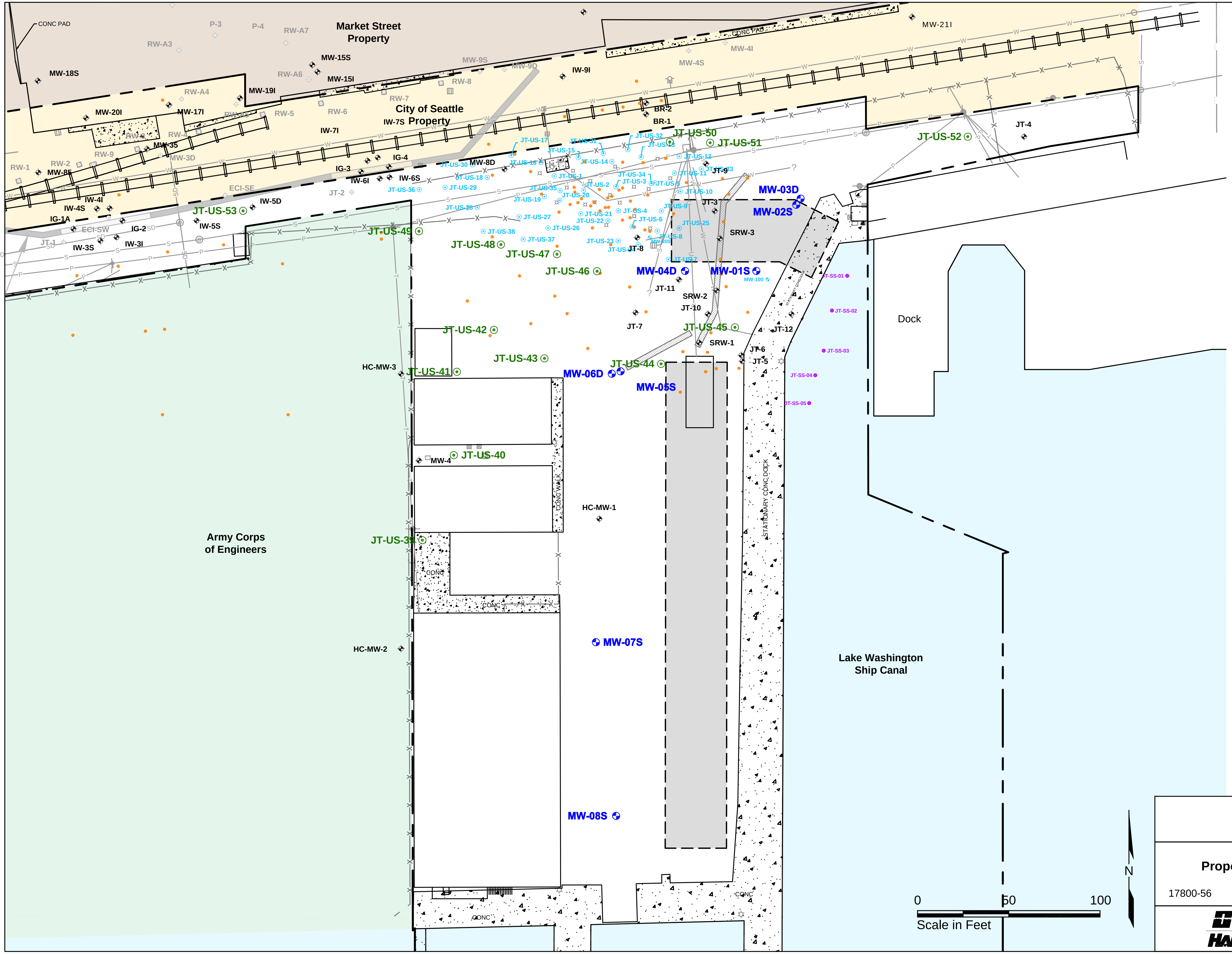
17800-56 11/14

HARTCROWSER

Figure

2

EAL 11/4/14 1780056-002.dwg



⊕	Existing Monitoring Well
⊕	Former Monitoring Well, Recovery Well, or Piezometer (Abandoned)
¤	Injection Well
●	Pre-RI Soil Boring Note: Labels removed from several borings in "IP" area for clarity. Refer to "Interim Cleanup Action Summary", Hart Crowser, July 18, 2002.
JT-SS-01 ●	2014 Sediment Sampling Location and Number
JT-US-1 ⊙	2014 Push Probe Sampling Location and Number
JT-US-39 ⊙	Proposed Push Probe Sampling Location and Number
MW-01-S ⊕	Proposed Monitoring Well Location and Number
▨	Concrete Surface
▬	Cement-Bentonite Groundwater Treatment Wall
▭	Permeable Iron/Sand Gate
——P——	Overhead Power
——S——	Sanitary Sewer Line
——W——	Water Line
——U——	Utility Line
━━━	Property Boundary
▨	Iron/GAC Groundwater Treatment Wall
▭	Boat Storage Rack

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

Jacobson Terminals
Seattle, Washington

Proposed Soil Boring Location Plan

17800-56 11/14

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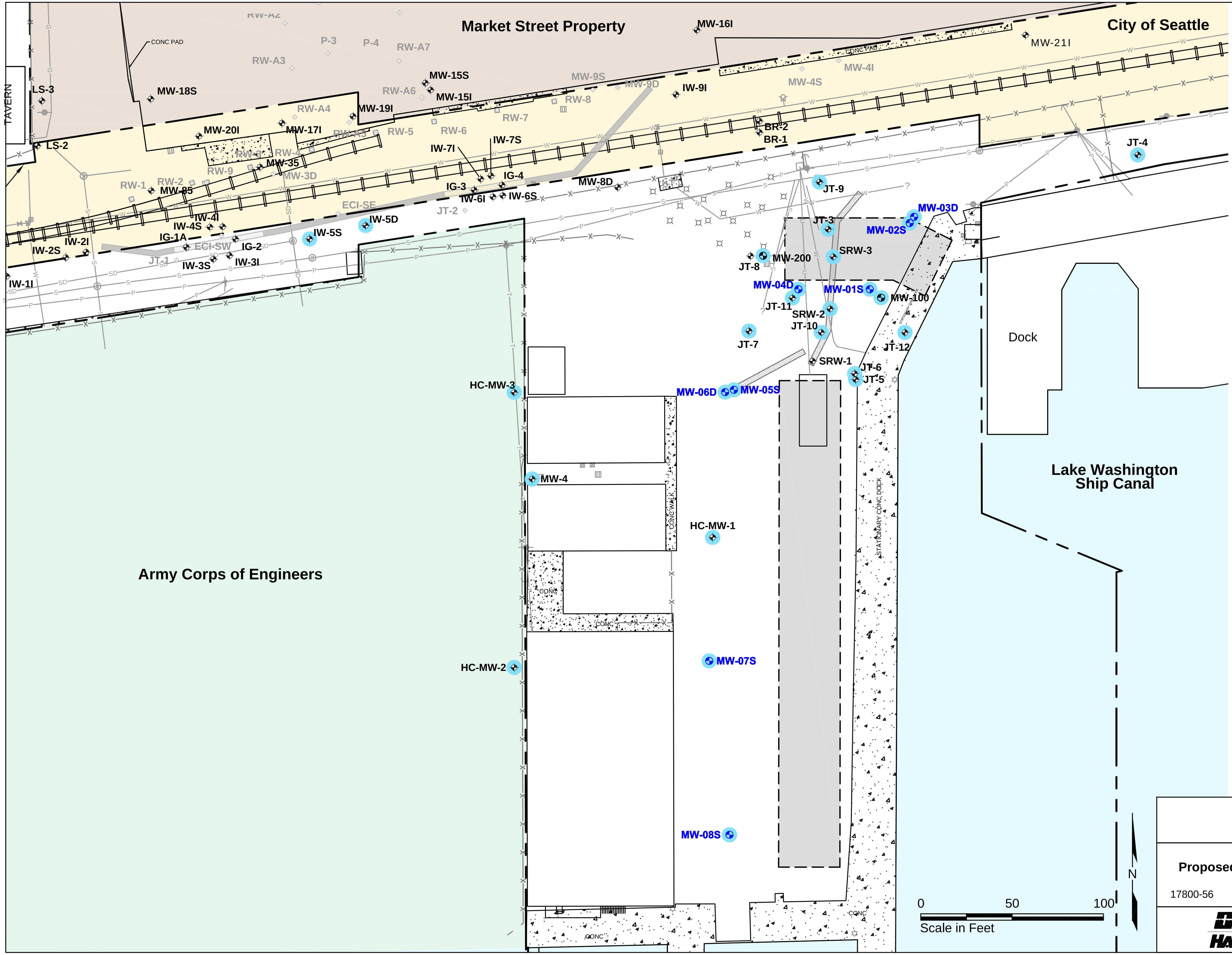
Figure
3

EAL 11/4/14 1780056-003.dwg



MW-8D	Monitoring Well to be Sampled
MW-01S	Proposed Monitoring Well
MW-18S	Existing Monitoring Well
RW-2	Former Monitoring Well, Recovery Well, or Piezometer (Abandoned)
IP-5	Injection Well
	2014 Sediment Sampling Location and Number
	2014 Push Probe Sampling
▨	Concrete Surface
▬	Cement-Bentonite Ground-water Treatment Wall
▨	Permeable Iron/Sand Gate
—P—	Overhead Power
—S—	Sanitary Sewer Line
—W—	Water Line
—U—	Utility Line
—	Property Boundary
🟨	City of Seattle Property
▨	Iron/GAC Groundwater Treatment Wall
▭	Boat Storage Rack

Notes:

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

Jacobson Terminals
Seattle, Washington

Proposed Groundwater Sampling Locations

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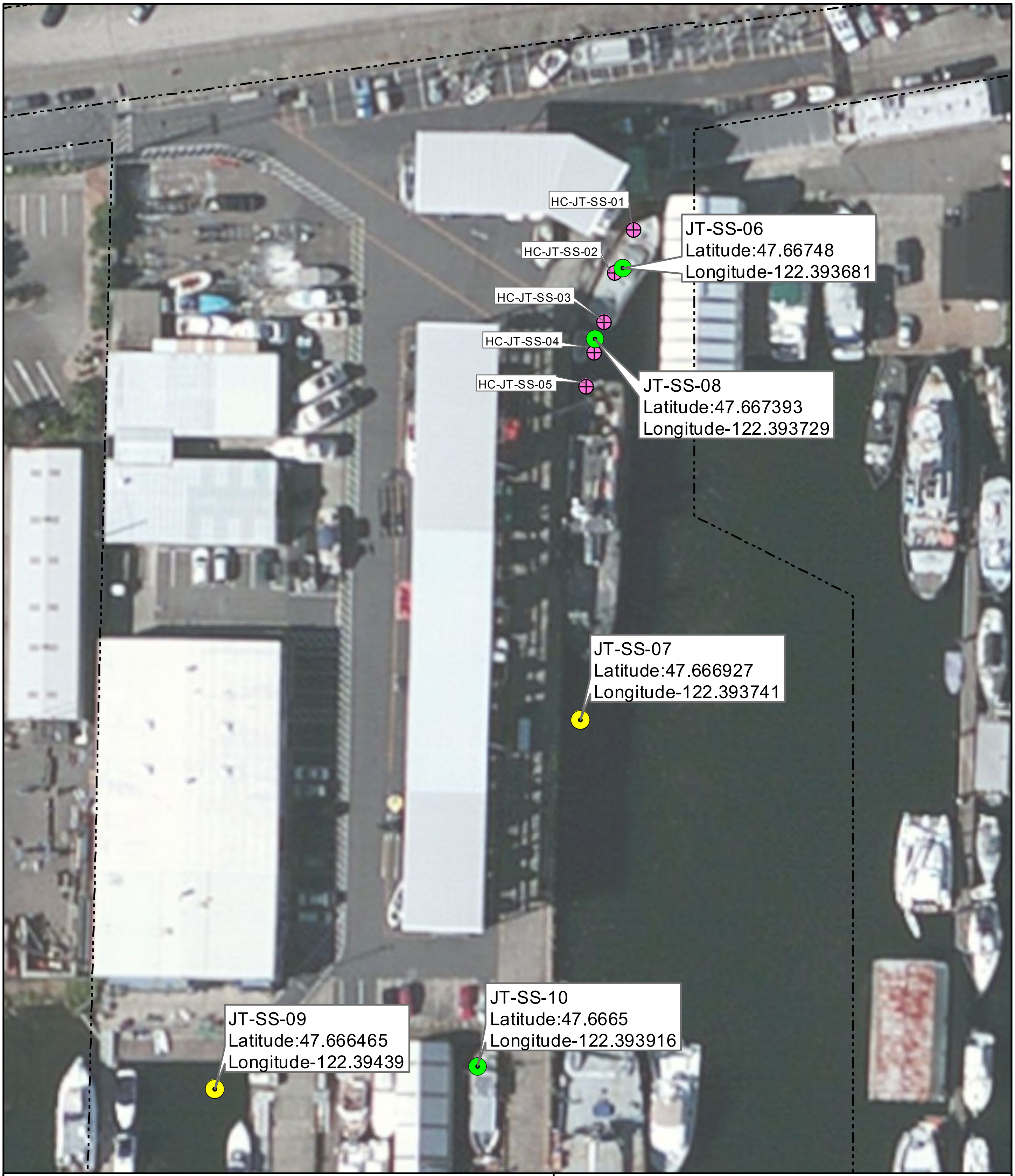
Figure
4

EAL 11/4/14 1780056-004.dwg



🟢 Proposed Sediment and Bioassay Sample

🟡 Proposed Sediment Sample

⊕ 2014 Hart Crowser Sediment Sample

-··-··- Approximate Property Lines

0 30 60 120 Feet

N

Jacobson Terminals Property
Seattle, Washington

Proposed Sediment Sampling Locations

17800-56 10/14

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Figure

5

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APPENDIX A
Field Forms and Chain of Custody Form

HARTCROWSER Groundwater Sampling Data - Well I.D. ______

PROJECT ______________________
DATE/TIME SAMPLED ______________
JOB NO. ______________________
TIDALLY INFLUENCED YES ______ NO ______
PROJECT MANAGER ______________________
WELL DEPTH IN FEET ______________
FIELD REPS ______________________
SCREENED INTERVAL IN FEET ______________

① *Purging Data/Field Measurements:* *All Measurements Relative to Top of Casing (TOC)*

WELL DEPTH ______________________
CASING VOLUME IN GALLONS ______________
DEPTH TO SEDIMENT (DTS) IN FEET ______________
[2" diam = x .163 gal/ft 4" diam = x .653 gal/ft]
DEPTH TO WATER (DTW) IN FEET ______________
PURGE VOLUME IN GALLONS ______________
(DTS – DTW) ______________________
ACTUAL PURGE IN GALLONS ______________

	Time	No. of Gallons Purged	pH	Temp in °C	Conduct in ______	Diss. Oxygen in ______	Turbidity	ORP in ______	Comments: quality, recovery, color, odor, sheen, accumulated silt/sand
sample:									

Comments: ____
____

	Method	Pumping Rate in GPM	Depth of Equip. in Feet
Purge			
Sample			

Boils dry? Yes ______ No ______
At no. of casing volumes ______________
Purge Water Disposal Method/Volume
____
____
____

② *Sampling Data*

Bottle Type	# of Containers	Analyses	Preserv.	Filter

Total number of Bottles ______________

Duplicate Sample I.D. ______________
Field Blank I.D. ______________
Rinseate Sample I.D. ______________

③ *Field Equipment*

Type/Brand/Serial No./Material Units

Pump Type/Tubing Type ______________________
Temp/pH/E.C. meter ______________________
Bailer Type ______________________
Water Level Probe ______________________
Filter Type ______________________
Other ______________________

④ *Well Conditions*

OK ☐ Not OK ☐ Explain ______________________________

Well Development Data

Project ______ Job No. ______

Field Rep. ______ Date ______

WELL NUMBER	DATE DEVELOPED	WELL DEPTH IN FEET	BEFORE DEVELOPMENT	DEVELOPMENT AFTER		CASING VOLUME IN GALLONS	METHOD OF DEVELOPING	DEVELOPING VOLUME IN GALLONS	COMMENTS
			DEPTH TO WATER IN FEET	DEPTH TO SEDIMENT IN FEET	SEDIMENT THICKNESS IN FEET				

HARTCROWSER

WELL TAG #________________

Boring Location

Elevation _______ Datum _______

Obs. Well Install. ☐ Yes ☐ No

Boring ________________ Date ____________ Sheet ___ of ___

Job ______________________________ Job No. ________

Logged By ________________ Weather ________________

Drilled By ______________________________

Drill Type/Method ______________________________

Sampling Method ______________________________

Bottom of Boring ________________ ATD Water Level Depth ________ ☐ No

Size (%)			PID or other	DEPTH		SAMPLE		Sample Recovery	Penetration Resistance	DESCRIPTION: Den., moist, color, minor, MAJOR CONSTITUENT, NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS: Drill Action, drill and sample procedures, water conditions, heave, etc.	SUMMARY LOG (Water and Date)
G	S	F		From	To	Type	Number					
Max.	Range	Att. Limits										
								0				
								1				
								2				
								3				
								4				
								5				
								6				
								7				
								8				
								9				
								0				
								1				
								2				
								3				
								4				
								5				
								6				
								7				
								8				
								9				
								0				

HARTCROWSER

Sediment Sampling Form

Project ______________________

Job No. ______________________

Subcontractor ______________________

Date ______________________

HC Reps ______________________

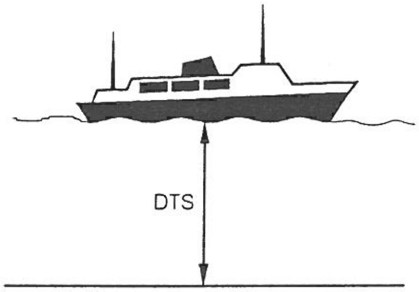
Conditions ______________________

Sample Location ______________________

Sample Method ______________________

Proposed Coordinates N: ______________

E: ______________



Elevation of Water ______________________

Tide ______________________

Elevation of Sediment ______________________

SAMPLE ACCEPTABILITY CRITERIA:
1. Overlying water is present
2. Water has low turbidity
3. Sampler is not overfilled
4. Surface is flat
5. Desired penetration depth

Run #	Time	Northing	Easting	Sampling Accepted Y/N	Comments (ie: penetration depth, biota, disturbance)

Sediment Description

0-10 ______________________

10-20 ______________________

20-30 ______________________

30-40 ______________________

____

____

____

____

Sample Container Type ______________________

Volume Filled ______________________

Analysis ______________________

Sample Custody Record

Samples Shipped to: ____________________

HARTCROWSER

Hart Crowser, Inc.
1700 Westlake Avenue North, Suite 200
Seattle, Washington 98109-6212
Office: 206.324.9530 • **Fax** 206.328.5581

JOB ____________________ LAB NUMBER ____________________

PROJECT NAME ____________________

HART CROWSER CONTACT ____________________

SAMPLED BY:

LAB NO.	SAMPLE ID	DESCRIPTION	DATE	TIME	MATRIX	REQUESTED ANALYSIS													NO. OF CONTAINERS	OBSERVATIONS/COMMENTS/ COMPOSITING INSTRUCTIONS

RELINQUISHED BY	DATE	RECEIVED BY	DATE
SIGNATURE		SIGNATURE	
PRINT NAME	TIME	PRINT NAME	TIME
COMPANY		COMPANY	

RELINQUISHED BY	DATE	RECEIVED BY	DATE
SIGNATURE		SIGNATURE	
PRINT NAME	TIME	PRINT NAME	TIME
COMPANY		COMPANY	

SPECIAL SHIPMENT HANDLING OR STORAGE REQUIREMENTS:

COOLER NO.:

STORAGE LOCATION:

See Lab Work Order No. ____________________ for Other Contract Requirements

TOTAL NUMBER OF CONTAINERS

SAMPLE RECEIPT INFORMATION

CUSTODY SEALS:
☐YES ☐NO ☐N/A

GOOD CONDITION
☐YES ☐NO

TEMPERATURE ____________________

SHIPMENT METHOD: ☐HAND
☐COURIER ☐OVERNIGHT

TURNAROUND TIME:

☐ 24 HOURS ☐ 1 WEEK
☐48 HOURS ☐STANDARD
☐72 HOURS OTHER ____________________

White and Yellow Copies to Lab   Pink to Project Manager   Lab to Return White Copy to Hart Crowser   Gold to Sample Custodian