Final Remedial Investigation and Feasibility Study Work Plan

31 August 2012

Glacier Northwest, Inc. – Reichhold, Inc. Site
5900 East Marginal Way SW
Seattle, WA

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List of Acronyms

AO	Agreed Order No. DE 6000
ARAR	applicable or relevant and appropriate requirement
ARI	Analytical Resources, Inc.
AXYS	AXYS Analytical Services, Ltd.
BEHP	bis(2-ethylhexyl)phthalate
bgs	below ground surface
bml	below mud line
BTEX	benzene, toluene, ethylbenzene, and xylene
CLARC	Cleanup Levels and Risk Calculation
cm	centimeter
COC	chain-of-custody
Companies, the	Glacier and Reichhold
COPC	constituent of potential concern
CSM	Conceptual Site Model
DCA	Disproportionate Cost Analysis
DGR	Data Gaps Report
DI	deionized
DOT	Department of Transportation
EDD	electronic data deliverables
EIM	Environmental Information Management
EPA	United States Environmental Protection Agency
FID	flame ionization detector
FS	Feasibility Study
Glacier	Glacier Northwest, Inc.
GP	direct push borings (Geoprobe®)
GPR	ground-penetrating radar
HASP	Health and Safety Plan
ID	identification
IDW	investigation-derived waste
LDW	Lower Duwamish Waterway
LOQ	limit of quantitation
MS	matrix spike
MSD	matrix spike duplicate
MTCA	Model Toxics Control Act
NPDES	National Pollutant Discharge Elimination System

PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PE	Professional Engineer
pH	acidity/alkalinity
PID	photoionization detector
PLP	Potentially Liable Party
PQL	practical quantitation limit
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RB	riverbank
Reichhold	Reichhold, Inc.
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
SEPA	State Environmental Policy Act
SMS	Sediment Management Standard
SOP	Standard Operating Procedure
SPU	Seattle Public Utilities
SVOC	semivolatile organic compound
SW-AL	Surface Water-Aquatic Life
SW-HH	Surface Water-Human Health
TBT	tributyltin
TPH	total petroleum hydrocarbon
TPH-D	diesel-range total petroleum hydrocarbons
TPH-G	gasoline-range total petroleum hydrocarbons
US	United States
USCS	Unified Soil Classification System
VOC	volatile organic compound
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety and Health Act

Section 1: Introduction

This *Final Remedial Investigation and Feasibility Study Work Plan* (Work Plan) was prepared to support remedial investigation/feasibility study (RI/FS) activities at the property located at 5900 West Marginal Way SW in Seattle, Washington, herein referred to as the "Site" (Figure 1). The purpose of this RI/FS Work Plan is to describe the planned RI/FS activities at the Site. This RI/FS Work Plan has been prepared in accordance with Washington Administrative Code (WAC) 173-340-350 and Agreed Order No. DE 6000 (AO) between Glacier Northwest, Inc. (Glacier), Reichhold, Inc. (Reichhold) (together, "the Companies"), and Ecology.

1.1 Background

Detailed Site background information, including the environmental setting, current and historical Site use, Site ownership, and previous investigations and remedial actions, is provided in the Draft Data Gaps Report (DGR) (ERM 2009a) as amended by comments provided by Ecology dated 28 June 2010.

The Site, owned and operated by Glacier since 1987, is currently a cement storage and distribution terminal. It encompasses approximately 18 acres in an industrial area of Seattle within King County, Washington. The Site is divided into an Uplands portion of 13.7 acres (Upland) and an adjoining embayment and shipping dock that covers 4.2 acres (the "Embayment") located adjacent to the Lower Duwamish Waterway (LDW). A current Site plan is provided as Figure 2.

This RI/FS Work Plan is primarily for the Uplands portion of the Site. A Work Plan for investigation of sediments in the Embayment was approved by Ecology in its 21 May 2012 letter, and ERM performed the work between 24 May and 1 June 2012. Based on the findings of the Embayment sediment sampling, Ecology may require additional sampling to be performed.

The Uplands portion of the Site includes historical contamination from several industrial facilities including a suspected log treatment area, a Whetlerite manufacturing facility (U.S. Army), and a resin and pentachlorophenol/sodium pentachlorophenate laboratory and manufacturer (Reichhold).

1.2 Regulatory Framework

On 28 July 2009, Glacier and Reichhold entered into Agreed Order No. DE 6000 (AO) with Ecology. As part of the AO, Glacier and Reichhold agreed to conduct an RI/FS and prepare a Draft Cleanup Action Plan (CAP) to address constituents of potential concern (COPCs) in soils, groundwater, seeps, surface water, and sediments under formal guidance provided by Ecology. The AO identifies the following deliverables to be submitted to Ecology:

- DGR
- RI/FS Work Plan
- RI Report

- FS Report
- Draft CAP.

The Draft DGR was submitted to Ecology in October 2009. Comments on the Draft DGR were received from Ecology on 28 June 2010 (see Appendix A). As suggested and approved by Ecology, a Final DGR was not prepared in order to accelerate the project schedule.

1.3 Objectives of the RI and FS

The purpose of a RI/FS is to collect, develop and evaluate sufficient information regarding a site to select a cleanup action under WAC 173-340-350 through 173-340-390. The investigation will focus on the following:

- Delineating the complete nature and extent of all hazardous substances at the Site.
- Characterizing Site COPCs.
- Evaluating Site COPCs, adjacent property COPCs, LDW COPCs, and the Embayment COPCs.

The overall objectives of the RI/FS are to:

- Obtain data of sufficient quality and quantity to describe the physical and chemical properties (including contaminants) of Site soil, groundwater, stormwater, riverbank soil, catch basin solids, LDW and Embayment sediments; and
- Use the results of the investigation to develop cleanup action alternatives and select a preferred remedial alternative under WAC 173-340-360 through 173-340-390.

The objectives of this RI/FS Work Plan and associated documents are to:

- Provide detailed sampling approaches to address all data gaps and complete characterization.
- Provide an FS approach to evaluate cleanup levels, applicable or relevant and appropriate requirements (ARARs), areas and media requiring remedial action, and cleanup alternatives.
- Present the general process for public involvement (in accordance with WAC 173-340-600).
- Provide a schedule for the RI/FS activities and remedial actions in accordance with the AO.

1.4 Work Plan Organization

This RI/FS Work Plan consists of the following sections:

- Section 2 provides a project management plan and schedule.

- Section 3 summarizes the preliminary Conceptual Site Model (CSM).
- Section 4 describes the remedial investigation tasks to be completed as part of RI/FS activities.
- Section 5 presents the feasibility study tasks.
- Section 6 presents the Sampling and Analysis Plan (SAP).
- A list of references is presented after Section 6.

Section 2: Project Management Plan

This section provides an overview of the project management plan for the RI/FS field activities. General project team requirements are identified below.

2.1 Anticipated Project Team

Ecology - Ecology, through its Toxics Cleanup Program, is the lead agency for the Site. Ms. Donna Ortiz de Anaya is the Site Manager for Ecology and will be responsible for overseeing implementation of activities under the AO. Ecology will provide technical review of work plans and reports and provide input on the results of, and proposed modifications to, the RI/FS program.

Glacier and Reichhold - Glacier and Reichhold are the potentially liable parties (PLPs) under the AO. Glacier and Reichhold are responsible for overall project direction and oversight. Glacier will provide Site access for investigation activities. Mr. Scott Isaacson of Glacier and Mr. John Oldham of Reichhold (or his representative, Ms. Carolyn Kossik of CH2M HILL) will be the PLP contacts during performance of the RI/FS activities.

Environmental Investigation Contractor – Ecology anticipates that an environmental investigation contractor will be retained on behalf of the Companies to implement the RI/FS activities, including preparation of documents and implementation of the field investigation program. Ecology anticipates that the project team will generally include the personnel listed below. The contractor will identify specific personnel before implementing the Work Plan.

As stated in the AO, work must be supervised as follows:

- All geologic and hydrogeologic work performed pursuant to this AO will be under the supervision and direction of a geologist licensed in the State of Washington or under the direct supervision of an engineer registered in the State of Washington, except as otherwise provided for by Chapters 18.220 and 18.43 RCW.

- All engineering work performed pursuant to this AO will be under the direct supervision of a professional engineer (PE) registered in the State of Washington, except as otherwise provided for by RCW 18.43.130.

- All construction work performed pursuant to this AO will be under the direct supervision of a PE or a qualified technician under the direct supervision of a PE. The PE must be registered in the State of Washington, except as otherwise provided for by RCW 18.43.130.

- Any documents submitted containing geologic, hydrologic, or engineering work will be under the seal of an appropriately licensed professional as required by Chapter 18.220 RCW or RCW 18.43.130.

- The PLPs will notify Ecology in writing of the identity of any engineer(s) and geologist(s), contractor(s) and subcontractor(s), and others to be used in carrying out the terms of this AO, in advance of their involvement at the Site.

The services of several subcontractors (e.g., drilling contractor, land surveyors, laboratory services, and sediment sampling services) will be necessary to perform the field investigation and implementation of project objectives. The Project Manager, with assistance from the Field Site Manager, as necessary and appropriate, will be the primary liaison between each of the subcontractors. Subcontractors are responsible for performing work according to the requirements in this RI/FS Work Plan and associated project plans.

The contractor will develop a Site-Specific Health and Safety Plan (HASP) to assign responsibilities, establish personal protection standards and mandatory safety procedures, and provide response procedures for unforeseen events that may arise while field activities are being conducted at the Site. The HASP will comply with Federal Health and Safety Regulations, as set forth in 29 Code of Federal Regulation 1910 and 1926, and WAC 173-340-810 and Washington Industrial Safety and Health Act (WISHA) Chapter 49.17 Revised Code of Washington and WAC 296-843, and other applicable local, state, or federal regulations as warranted).

2.2 Project Deliverables and Meetings

Project deliverables and meetings are scheduled to occur as part of this RI/FS effort. These deliverables are outlined below, and a schedule of activities is presented in Section 2.3.

2.2.1 Progress Reports

In accordance with the AO, progress reports will be submitted to Ecology via email, on behalf of Glacier and Reichhold, on the 15th of every month. If this day is a weekend or holiday, the progress report will be submitted to Ecology on the next business day. The frequency of progress reports may change to quarterly during periods of less work. Each progress report will include at a minimum:

- A description of the actions completed to comply with the AO during the previous period.
- Summaries of sampling reports and data collection reports.
- Summaries of deviations from approved work plans.
- Contacts with representatives of the local community, public interest groups, press, and federal, state, or tribal governments.
- Problems or anticipated problems in meeting the schedule or objectives set forth in the AO or work plans.
- Solutions developed and implemented or planned to address any actual or anticipated problems or delays.
- Changes in key personnel.
- Description of work planned for the next reporting period.

Progress reports will be submitted to Ecology until satisfaction of the AO is achieved.

Progress reports will include validated data within 60 days following the completion of each field sampling activity.

2.2.2 RI Report

The RI report will be prepared in accordance with WAC 173-340-350, Remedial Investigation and Feasibility Study; WAC 173-204-560, Cleanup Study; and WAC 173-340-840, General Submittal Requirements, following completion of the RI field activities and validation of all laboratory analytical data. In accordance with the requirements of the AO, a draft RI report will be submitted to Ecology for review and comment. The Companies will provide written responses to Ecology comments when required. When Ecology determines the comments have been sufficiently addressed, the RI Report will be finalized. The schedule of RI report activities is presented in Section 2.3. A description of the planned RI report content is presented in further detail in Section 4.

2.2.3 FS Report

The FS report will be prepared in accordance with WAC 173-340-350, Remedial Investigation and Feasibility Study; 173-340-355, Development of Cleanup Action Alternatives that include Remediation Levels; and 173-340-360, Selection of Cleanup Actions. Per the AO, the FS report will be prepared after completion of the Final RI report.

A Draft FS will be submitted to Ecology for review and comment. The Companies will provide written responses to Ecology's comments as appropriate. When Ecology determines the comments have been sufficiently addressed, a Draft Final FS will be prepared. Ecology will make the Draft Final FS report available for public review during a 30-day public comment period. The Companies will address public comments and provide written responses as applicable. A second Draft Final FS report will be submitted to Ecology for review and Ecology will provide written comments. The Companies will address the final comments and prepare a Final FS for submittal to Ecology. The schedule of FS activities is presented below in Section 2.3. A description of the FS report is presented in further detail in Section 5.

2.2.4 Meetings

Ecology may hold public meetings at key points during the investigation and cleanup process. Per the AO, Ecology will initiate a public review and comment period after the Draft Final FS is produced.

Technical team meetings will be held between the Companies and Ecology to discuss project documents, comments, and/or responses, as needed.

2.3 Project Schedule

The following is the anticipated schedule for implementing the RI/FS Work Plan as provided in the AO:

RI/FS Deliverable	Completion Times
Fieldwork completed	12 months after Ecology's approval of the Draft RI/FS Work Plan
Draft RI Report (including data validation)	120 Days after receipt of all validated data from RI Sampling
Final RI Report	60 calendar days after receipt of Ecology's review comments on the Draft RI report
Draft FS Report	120 days after completion of the Final RI Report
Draft Final FS Report	60 calendar days after receipt of Ecology's review comments
30-day Public Review and Comment Period	After submittal of Draft Final FS Report
2nd Draft Final FS Report	60 calendar days after completion of public comment period
Draft Responsiveness Summary	60 calendar days after completion of public comment period
Final FS Report	30 calendar days after receipt of Ecology's review comments
Final Responsiveness Summary	30 calendar days after receipt of Ecology's review comments
Draft Cleanup Action Plan	90 calendar days after completion of the Final FS Report

Section 3: Preliminary Conceptual Site Model

This section provides the preliminary Conceptual Site Model (CSM) for the Site. The Site is defined as the area where contamination has come to be located and may not be limited to the Glacier property boundary. The preliminary CSM is based on data collected to date, which was presented in detail in the Draft DGR (ERM 2009a) and Ecology's comments sent 28 June 2011.

A CSM is a representation of Site conditions, which summarizes information about the sources, contaminant fate and transport, exposure pathways, and potential receptors. The CSM is a dynamic document that is intended to be refined and updated as new information becomes available. It is a key component of the Site assessment process, as it provides the framework for assessing potential environmental impacts associated with Site contaminants.

Based on the preliminary CSM, several constituents were identified as COPCs. A COPC is a constituent potentially related to a historical Site operation (including filling episodes) that requires further evaluation to determine whether the constituent will be addressed as necessary in the FS and subsequent remedial actions.

The CSM incorporates the following principal components:

- Source areas and COPCs.
- Fate and transport mechanisms.
- Potential receptors.

3.1 Site Geology

As described in the Draft DGR, most of the ground surface on the southern portion of the Site is unpaved and covered with a layer of gravel and crushed rock approximately 1 to 3 feet thick. The remainder of the southern portion of the Site is overlain by a surface layer of fill material, which consists of silt, sand, gravel, and concrete debris. This fill layer (i.e., uppermost fill layer) extends to a depth of approximately 3 to 5 feet below ground surface (bgs).

The uppermost fill material is underlain by a silty sand/sandy silt fill layer (i.e., dredged fill layer) approximately 8 to 13.5 feet thick. The silty sand/sandy silt layer is typically wet from 5 to 6 feet bgs. This layer of fill material is defined as fine to medium sandy silt, well to poorly-graded sandy silt, with a color ranging from gray to black. The lithology, high organic content, and elevation of this subsurface relative to the LDW indicate that this layer is consistent with dredge material placed as fill at the Site.

At approximately 8.5 to 15.5 feet bgs, a silt layer is present, approximately 5.5 to 6.5 feet thick. This geologic layer is believed to be the uppermost native material at the Site. The silt is slightly clayey, low to medium plasticity, contains some organic material, and is usually dry to moist. The silt layer appears to act as an aquitard and may inhibit groundwater movement between the shallow (uppermost fill/dredged fill layers) and the lower saturated (sand layer) units.

The silt layer is underlain by a sand layer that is at least 11.5 feet thick. This lower sand layer is encountered at 15 to 18 feet bgs and consists of well to poorly-graded sands defined as black, fine to coarse sand. This lower sand layer is moist to wet.

Existing data indicate that site geology in the northern portion of the site is similar to that in the southern portion, with the exception of the uppermost fill (gravel) layer. The gravel fill layer is not present on the northern portion of the Site. Borings for soil sampling and groundwater wells will take into consideration that additional depth will be needed in the southern portion of the site to reach a similar lithologic layer as the northern portion. Target sample locations are based on lithologic units, not specific depths.

Existing tidal study data collected by Remediation Technologies in 1996 (RETEC 1996) for the Site indicates that the shallow unconfined, saturated layers (upper unit) above the silt aquitard at the Site may not be influenced by the Duwamish River tidal cycles. The deeper confined, saturated layer (lower unit) is strongly influenced by tides in the Duwamish River. Groundwater elevation monitoring in 2009 indicated that the confined deeper saturated unit is subject to tidal influences from the Lower Duwamish Waterway.

3.2 Source Areas and COPCs

Based on review of historical operations at the Site and historical data collected at the Site, the initial COPCs for RI/FS activities were reviewed. Some of the Site COPCs and associated Site areas identified for further investigation during this RI within the Uplands and Embayment area were provided in the Draft DGR (ERM 2009a) as amended by comments provided by Ecology dated 28 June 2010.

This investigation will include a comprehensive evaluation of the potential contaminants in suspected areas throughout the Site.

3.2.1 Description of Preliminary Screening Levels

The sections below summarize the soil and groundwater preliminary screening levels that were presented in the Draft DGR and used for comparison and screening of existing Site data to develop the preliminary CSM. Comparisons to the screening levels presented throughout the preliminary CSM are for preliminary data screening purposes.

A thorough evaluation of all potential contaminants will be performed for RI purposes. As this Site has the potential to include contaminants that have migrated beyond the property boundary, all potential screening levels will be evaluated. Preliminary screening levels for pathways that are protective of Upland and in-water receptors will be developed in the RI report, and proposed cleanup levels for the Site will be refined and established in the FS report.

3.2.1.1 Soil Preliminary Screening Levels

Soil analytical data summarized in the Draft DGR were screened against the Model Toxics Control Act (MTCA) Cleanup Levels obtained from Ecology's online Cleanup Levels and Risk Calculation (CLARC) website and have been updated in this RI/FS Work Plan. These MTCA Cleanup Levels are provided for purposes of preliminary data screening. Although the Site and some surrounding areas are used for industrial/commercial purposes, surrounding areas also include recreational uses and undeveloped land (greenbelts).

MTCA Method A soil cleanup levels for unrestricted or industrial use generally do not apply, and All ARARS (including standards for the protection of surface water and groundwater) are applicable to the Site.

MTCA Method B cleanup levels for unrestricted use are appropriate for this Site, as land use has not been restricted by an approved environmental covenant. Method C cleanup levels may apply after all requirements for using Method C industrial values have been met (WAC 173-340-706 (1). This includes WAC 173-340-745 (1)(a)(i)(E), WAC 173-340-745 (1)(a)(ii), and WAC 173-340-745 (1)(a)(iii). Hazardous substances remaining at the property after remedial action would not pose a threat to human health or the environment at the Site or in adjacent nonindustrial areas including WAC 173-340-745 (1)(a)(iii)(D). The potential for significant adverse effects on wildlife caused by residual hazardous substances will also be evaluated.

COPCs will be screened using all regulations required under MTCA (which are based on RCW Chapter 70.105D or WAC Chapter 173-340 and include all applicable State and federal laws). Cleanup levels will be defined when the investigation is complete. Following the RI, a FS will be prepared that incorporates cleanup levels into the alternatives.

All cleanup levels established for soil will be protective of direct contact and other soil pathways that exist on the Site. If direct contact levels are not as protective as applicable soil cleanup levels for protection of air, groundwater, surface water and sediments, then Site soil cleanup levels will be adjusted to provide protection of human health and the environment in all media. The most stringent of the relevant soil cleanup values will be selected as the final cleanup level.

A small area of terrestrial habitat is present on and adjacent to the Site. Additionally, King County, the Port of Seattle, the City of Seattle, and other agencies are developing plans to establish terrestrial and shoreline habitat along the LDW. The Site is located across the street from a large undeveloped area that provides habitat for terrestrial ecological receptors. Soil cleanup levels for the future protection of terrestrial species will be included in the evaluation for this Site.

A significant exposure pathway involves soil leaching to groundwater with discharge to surface water. The Site adjoins the LDW, and any contaminants leaching to groundwater could reach surface water. Soil cleanup levels protective of groundwater/surface water beneficial uses will be implemented, including protection of aquatic organisms and human health through consumption; these cleanup levels are typically more stringent than for protection of direct contact of terrestrial species (including an industrial worker).

Direct transport of eroded soil into the adjacent LDW is another significant pathway to evaluate. Contaminated soil transported in this manner could affect river and embayment sediment. The appropriate cleanup levels for soil protective of this pathway include, but may not be limited to, the Sediment Management Standards and the standards developed for protection of water through leaching.

3.2.1.2 Groundwater and Surface Water Preliminary Screening Levels

The potability of Site groundwater has not been determined at this time. Therefore, the Site will be screened using potable screening levels until Ecology has made a determination that the groundwater is non-potable. Both the unconfined upper and the confined lower saturated units will be evaluated using screening criteria for surface and marine water quality, including protection of aquatic organisms and human health through organism consumption (including modified fish consumption standards based upon tribal ingestion rates).

Protection of surface water and sediment from COPCs present in groundwater will be evaluated in the RI.

Groundwater screening levels include, but are not necessarily limited to, the following:

- MTCA Method B screening levels for carcinogenic and non-carcinogenic risk (Method B).
- All ARARs (including federal).

Surface water screening levels will address all applicable state and federal guidelines and ARARs including, but not necessarily limited to, the following:

- Water Quality Criteria for chronic exposure of aquatic life (SW-AL) from the WAC 173-201A, Water Quality Standards for Surface Waters of the State of Washington.
- Water Quality Criteria for human health in marine environments (SW-HH) from the Federal Clean Water Act (WAC not established).
- MTCA Method B surface water cleanup levels.
- The EPA National Toxics Rule (40 CFR 131).
- All ARARs (including federal).

Surface water screening will incorporate the appropriate water quality standards for human health at this Site which are protective of Site-specific fish consumption from the LDW Site. The LDW Site has established fish consumption rates for Tulalip tribal members that are greater than the MTCA default consumption rates. Stormwater discharging from this Site must be protective of surface water and sediment.

For all RI sampling results, constituents will be screened to the lowest applicable State or federal standard or ARAR.

3.2.2 Constituents of Potential Concern

The Uplands portion of the Site covers approximately 13.7 acres and is divided into two operational portions, one for the Cement Terminal and one for maintenance and storage. These two operational areas have been separated by a chain-link fence since at least 1987. The northern section includes the Cement Terminal. The southern portion of the Site consists of the warehouse, and truck and employee parking.

Past operations considered when developing Site-specific sampling requirements presented in this Work Plan include:

- Wood treatment in the south-central portion of the Site by suspected log treatment activities.
- Whetlerite manufacturing (i.e., carbon from charcoal produced on Site, typically impregnated with hexavalent chromium and other materials for gas masks used in combat) in the northern portion of the Site by the U.S. Army and Crown Zellerbach Corporation.
- Manufacture of resins, phenol glues, pentachlorophenol, and sodium pentachlorophenate in the northern central portion of the Site by Reichhold Chemical, Inc.
- Cement unloading and distribution by Kaiser Cement Company, Lone Star Northwest, Inc. (later renamed to Glacier Northwest, Inc.), and Ash Grove Cement West, Inc.
- Several episodes of fill placement from 1940 to 1970, as well as the original Site development with dredge spoils in the 1910s to 1920s.

Site areas related to historic uses by previous Site occupants are shown on Figure 2.

COPCs associated with the historic Site operations generally include:

- Volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) - Both VOCs and SVOCs have been detected in soil and groundwater samples collected at the Site including, but not necessarily limited to, naphthalene, pentachlorophenol and other associated phenols, bis(2-ethylhexyl)phthalate (BEHP), and di-n-butyl phthalate. Consequently, VOCs and SVOCs need further investigation. Additionally, VOCs and SVOCs are considered adjacent Site COPCs in groundwater, both north and south of the Site.
- The analytical method list for all SVOCs will be analyzed for the RI. SVOC analyses will be performed using methods that enable comparison to all applicable screening levels (including protection of surface water and protection of sediments). This will require the use of EPA Method 8270D analytical techniques in selected ion monitoring (SIM) mode.
- Pentachlorophenol – Pentachlorophenol (PCP) and other phenol-related materials (tetrachlorophenol, trichlorophenol) and breakdown products (0-cresol, resorcinols, dioxins) are associated with former Reichhold operations. PCP concentrations exceed MTCA Method B and screening levels (SW-AL and SW-HH) in groundwater samples. PCP was detected in soil and groundwater in several areas, including the Former PCP Pilot Plant Area and the Former PCP Washwater Impoundment Area. Additionally, soil samples collected near the former phenate process plant and groundwater samples collected downgradient of the tank farm, south of the drainage ditch, near the former boiler house and in the former Kaiser Bentonite area all contained detectable levels of PCP. The extent of PCP and its breakdown products has not been fully defined in soil and groundwater and will be further evaluated during the RI. As a result, products, byproducts and breakdown products from PCP manufacturing will be sampled in and around areas known to have production, storage and treatment.

- Total Petroleum Hydrocarbons (TPH) were detected at concentrations up to 10,000 mg/kg in a soil sample near the old tank farm and were also detected in 11 shallow soil samples collected from the Site. As several potential sources for TPH and other chemical parameters related to TPH [benzene, toluene, ethylbenzene, and total xylenes (BTEX), specific aromatic hydrocarbons] have not been tested for in soil or groundwater, additional sampling will be performed, especially in areas known to have above- and underground storage tanks.

- Polychlorinated biphenyls (PCBs) - PCBs have been detected at several orders of magnitude greater than the current criteria, and further sampling will be required. PCBs have not been sampled for in groundwater. PCBs may be associated with prior transformers and the heat transfer fluid (Dowtherm) used for the boilers and will be included in the analyte list for boiler use and storage areas in addition to all suspected polycholorinated biphenyl (PCB) locations.

- Metals - Metals were detected in Site soil and groundwater as follows:

    - Chromium - According to historical literature, chromium VI was used in the Whetlerite manufacturing process. Chromium is also known to be associated with shipyard operations. Chromium was also observed in the adjacent sediments above human health human consumption criteria. As chromium was historically used at the Site but not characterized in soil or groundwater, this constituent is considered a COPC and will be evaluated in the RI/FS.
    - According to literature, silver was used in the Whetlerite manufacturing process by the U.S. Army. Silver will be will be included in the analyte list for soil and groundwater.
    - Zinc is known to be associated with shipyard operations. In addition, zinc is noted as one of the metals used in the former wood treatment area, which is also a likely source of arsenic contamination in the south-central portion of the Site. Because of the presence of zinc in Site media and its use in past industrial activities, zinc will remain a COPC for the Site.
    - Copper is associated with shipyard operations, and copper was reported in literature as being used in the Whetlerite manufacturing process by the U.S. Army. In addition, copper is noted as one of the metals used in the former wood treatment area, which may be associated with the arsenic concentrations in the south-central portion of the Site. Copper will remain a COPC for the Site.
    - Historical and current arsenic data for soil and groundwater in the southern and eastern portions of the Site exceed screening levels. Dissolved arsenic in shallow groundwater in the southern portion of the Site was treated in situ by hydrogen peroxide injections, with two rounds of field injections in 2002. The hydrogen peroxide injections were intended to result in the geochemical fixation of arsenic. Initially, arsenic concentrations in groundwater after treatment were reduced by as much as two orders of magnitude. After the in situ treatment, the Site likely reverted to reducing conditions, and arsenic concentrations rebounded in the groundwater at several monitoring wells. Elevated concentrations of arsenic in soil and groundwater are seen throughout the Site except on the southwestern portion of the Site. Therefore, arsenic is a COPC. High concentrations of arsenic in the southern portion of the Site may originate from the suspected former lumber treatment facility operations. Samples will be analyzed and screened to the lowest practical quantitation limits (PQLs).

  - To characterize other metals that may be present in Site soil and groundwater, EPA Priority Pollutant Metals (13 metals) will be analyzed throughout the Site to evaluate whether past industrial activities, including filling, might have resulted in releases of commonly occurring metals.

- Tributyltin (TBT), known to occur in adjacent sediments and associated with historical shipyard activities, will be included in the analyte list for soil and groundwater.

- Dioxins/Furans – Dioxins are associated with contaminants known to have been manufactured or used at this Site. A full 17 congener analysis will be performed.

- pH will be sampled in all soil and water samples as part of general chemistry.

3.3 Pathways and Mechanisms

This section briefly summarizes the primary fate and transport processes that may affect the occurrence and distribution of COPCs at the Site and other contaminants in the Embayment and LDW.

Potential transport pathways that could result in mobilization and/or transport of soil or groundwater COPCs include, but are not limited to, the following:

- Soil erosion – Erosion of soil along eastern stream banks.

- Stormwater – Particulates collected from runoff migrating to soil, groundwater and surface water.

- Soil leaching – Leaching of COPCs in soil to groundwater.

- Groundwater migration – Migration of dissolved-phase constituents in groundwater. The Upland groundwater-bearing zones are potentially connected to the Embayment through seeps (shallow saturated unit) and direct hydraulic connection (deeper confined saturated unit). Utility trenches, historical drainage ditches and corridors have the potential to serve as preferential migration pathways for groundwater and associated dissolved-phase COPCs.

- Surface water transport – Transport of COPCs in surface water from the site (stormwater runoff) to waters of the state.

The potential for vapor intrusion from VOCs to indoor air will be initially evaluated during the RI through the tiered approach outlined in Ecology's *Guidance for Evaluating Soil Vapor Intrusion in Washington State, Draft* - 2009. Factors that may influence mobilization and/or transport of COPCs include infiltration, groundwater flow, wind, stormwater flow, surface water flow (tidal), sloughing, erosion, ship propeller action and geochemical processes.

3.4 Potential Receptors

Identification of exposure pathways and potential receptors is a critical step in development of the CSM. The components of the CSM discussed above were used to develop a preliminary conceptual Site exposure model. An exposure pathway, which is the route a COPC takes from its source to its end point, can identify how a receptor (human or ecological) may be exposed to that COPC. The preliminary Site exposure model is illustrated on Figure 3.

3.4.1 Human Exposure Pathways and Receptors

The three primary routes of exposure are breathing (inhalation), eating or drinking (ingestion), or contact with the skin (dermal contact). Typical exposure pathways include:

- Groundwater/Surface water: Receptors can contact COPCs through ingestion of contaminated drinking water and by direct contact such as swimming or wading.
- Soil, Sediment, and Dust: Receptors can contact COPCs by breathing particulate matter or through direct contact to soil or through ingesting soil (incidental).
- Food: Receptors can ingest food that has had direct exposure to COPCs (e.g., plants grown in contaminated soil) or by ingesting an animal that has bioaccumulated a COPC within its fatty tissue (fish, shellfish).
- Air: Receptors can inhale a COPC if it becomes volatile or absorbs into particulate matter. VOCs have not yet been sampled at this Site.

As described in the Draft DGR as modified by Ecology's comments, although the Site is located in an industrial area and zoned for industrial use, a greenway is located across the street from the Site, and the waterway is open to the public for subsistence (fishing/clamming) and recreation. Therefore, human receptors include potential current/future on-Site workers, such as construction workers, and potential on-Site recreational and subsistence users. Potential off-Site receptors include, but are not limited to, subsistence and recreational anglers.

3.4.2 Ecological Exposure Pathways and Receptors

Terrestrial and aquatic wildlife species are susceptible through multiple exposure routes (direct and indirect) due to their activity and proximity to the Upland area, Embayment and LDW. Based on the environmental setting, exposure pathways relevant for upland and aquatic systems typically include:

- Ingestion of surface water/soil/sediments by wildlife
- Dermal contact to surface water/soil/sediments by wildlife
- Uptake from soil/surface water from plants on the upland portion of the Site
- Inhalation from disturbed surface soils by terrestrial wildlife
- Uptake from surface water/sediments by freshwater aquatic/emergent plants and subsequent ingestion by herbivorous wildlife;

- Uptake from sediments by sediment-dwelling invertebrates and subsequent ingestion by invertebrate-consuming wildlife

- Uptake from water/sediment into amphibians/other large prey and subsequent ingestion by carnivorous wildlife (fish, mammals).

Thus, exposure pathways associated with the Site include ingestion of sediments, soil, vegetation and surface water, consumption of constituents that may accumulate in food items, dermal contact and inhalation. Ecological receptors include benthic (i.e., sediment-dwelling) organisms, fish, and other wildlife using upland and streambank vegetation and the Duwamish River. These are the typical exposure pathways, and others may be identified as the RI progresses.

3.5 Summary of Preliminary Conceptual Site Model

A number of unknowns regarding suspected contaminant releases and location are still outstanding. Under MTCA regulation, both upland media and aquatic/sediments must be evaluated during the RI. As part of the FS, the CSM will be updated, including a schematic representation of exposure pathways, appropriate cleanup levels will be identified for affected media, and a remedial solution that addresses all affected media will be identified.

Historical operations and data collected at the Site were reviewed to identify COPCs in the Uplands portion of the Site. Surface and subsurface sediment samples have been collected in the Embayment as well as the LDW near the Embayment. Investigations have included sediment sampling along the near shoreline of the Embayment. Primary constituents detected in the Embayment above Sediment Management Standards (SMS) criteria include arsenic and other metals, polycyclic aromatic hydrocarbons (PAHs), dioxin/furans, PCBs, and phthalates.

Further analysis during this investigation will define nature and extent of contamination at the Site and all potential exposure pathways and receptors will be evaluated.

Unknowns at the Site include, but are not necessarily limited to, the following:

- At least two layers of fill have been deposited above the original industrial Upland soil layers. This fill is known to contain contaminants and has not been fully characterized.

- Several areas of old liquid storage tank areas have been located and still require investigation to determine the nature and extent of chemical impacts.

- Investigations will take into consideration the difference in depth of the known contaminants. Depths differ by several feet from the southern end (additional gravel placement) to the northern end (concrete surface). Sample depths will be based on lithologic units, not specific depths.

- Dioxins were identified in a Reichhold patent and have not been fully characterized.

- A log treatment operation that reportedly took place in the southern area of the Site in the late 1930s used arsenic, copper, and zinc and potentially other metals and operated experimentally.

- Stormwater pipes in the southern portion of the property may serve as conduits for transport of any groundwater CPOCs and will be investigated prior to cutting and plugging to ensure that this pathway is investigated.

- Stormwater and related sediment solids have not yet been characterized. Stormwater characterization will be performed as part of the RI.

- The lower saturated unit shows signs of metals contamination and has not been fully characterized. Soils related to the historical log treatment operation likely lie in the aquitard layer and directly above the saturated lower unit. Both soil and groundwater in the saturated upper unit contained metals at concentrations above screening levels.

- PCP and related phenols have been identified as COPCs in soil and groundwater. The full nature and extent of phenol impacts to soil and groundwater has not yet been investigated.

- In general, arsenic in soil has been identified throughout the Site in varying concentrations above screening levels. The nature and extent of arsenic impacts to soil and groundwater have not been fully characterized.

- The extent of contamination, especially along property boundaries, has not been fully characterized.

Primary upland COPCs for the Site include, but are not necessarily limited to, VOCs, TPH, PCBs, PCP, priority pollutant metals, dioxins/furans, and SVOCs. Further investigation will be performed for additional parameters.

Section 4: RI Tasks

Field investigation and data collection activities will be conducted to provide sufficient additional information to more adequately define the nature and extent of known and suspected contamination at the Site.

This section summarizes the strategy and approach of the RI field activities. Detailed descriptions of the appropriate methods and procedures to be used during implementation of the RI field activities are provided in the SAP (Section 6). Field sampling will be conducted in a safe and protective manner, consistent with a Site-specific Site Health and Safety Plan. Data quality objectives and quality control procedures are discussed in the SAP (Section 6)**.**

Areas of interest for the RI are listed in Table 1 for each sampling location and include the following:

- Former Army Operations (including Northern Property Boundary).
- Former above and underground storage tanks.
- Former washwater impoundment area.
- Former Reichhold production area.
- Former suspected log treatment area.
- Fill areas throughout the Site.
- General southern area and former Kaiser bentonite area.
- Former drainage ditches and drainage features.
- Former electrical transformers.
- Western portion of the Site.

4.1 RI Field Investigation Tasks

Proposed RI tasks will be conducted in coordinated field efforts and will consist of:

- Direct-push soil boring installation and sampling.
- Groundwater monitoring well construction and development.
- Groundwater gradient monitoring.
- Groundwater sampling.
- Riverbank soil sampling.

- Catch basin stormwater solids and stormwater sampling [at National Pollutant Discharge Elimination System (NPDES) sampling point].

- Drainage ditch ground-penetrating radar (GPR) survey and follow-up soil sampling.

- Supplemental sediment sampling in the Embayment area.

Proposed sampling locations are identified on Figures 4 through 7, and further detail is presented below. The proposed schedule for completing these field events is summarized in Section 2.3. Collected samples will be evaluated for Site COPCs, as described in Tables 2 (soil/stormwater solids) and 3 (water).

The investigation also includes abandonment of the Site historical stormwater pipe that was previously investigated and documented in a report submitted to Ecology (ERM 2009b) (refer to Figure 5). Specifically, the RI will summarize available information and/or collect additional information necessary to identify whether or not historical piping may be a source of contaminants to the Site. Abandonment of the pipe will comply with the City of Seattle's Planning Department protocol. A camera survey of the abandoned sections of pipe is required to map potential pathways for stormwater/groundwater that may convey contaminants from a source area to a receptor.

(Note: Any deviation from Work Plan activities will be approved by Ecology in advance. If advance approval is not possible due to the nature of the activity, Ecology will be notified before leaving the Site on the same day sampling is performed.)

4.1.1 Direct Push Soil Investigation

Soil samples will be collected by direct-push drill rig at the locations shown on Figures 4 and 7 and listed in Tables 1 and 2 ("GP" borings). The area of interest each boring will evaluate is presented in Table 1.

Most boreholes will be advanced into the top portion of the sand layer underlying the silt aquitard layer, typically to approximately 16 to 24 feet bgs, although boring depths will be based on target lithologic units, not specific depths. Select borings (refer to Table 1) will be advanced to approximately 30 feet bgs or deeper, depending on conditions encountered. Soil samples will be collected for laboratory analysis from each boring based on lithologic conditions (i.e., specified layer), visual conditions (i.e., evidence of chemical impacts) and/or field-screening observations as described in Tables 1 and 2. Drilling and sampling methods are described in detail in the SAP (Section 6).

4.1.2 Monitoring Well Installation

Groundwater monitoring wells will be installed as part of the RI field activities to supplement the existing on-Site groundwater monitoring wells. Wells will be installed in the shallow and deep saturated upper and lower unit. Wells installed in the deep saturated lower unit will be installed in the sand unit below the silt aquitard, and also at greater depths to meet RI objectives. Existing and proposed new monitoring well depths and screen intervals are listed in Table 3, and existing and proposed new monitoring well installation locations are shown on Figures 4 and 7. Table 1 shows the area of interest to be evaluated for each new monitoring well location.

Soil samples will be collected for laboratory analysis during monitoring well installation as described in Tables 1 and 2, and soils will be evaluated for visual observations, field screening, and lithologic logging.

After completion of well construction activities, monitoring wells will be developed at least 48 hours after well installation and at least 2 weeks before collection of groundwater samples. Well development procedures are described in further detail in the SAP (Section 6).

4.1.3 Groundwater Gradient Monitoring

Quarterly groundwater elevation monitoring has been performed at the Site since 2009, and groundwater contour maps have been submitted to Ecology after each quarterly event. During the RI, the potentiometric surface of both shallow and deeper groundwater zones will continue to be evaluated on a quarterly basis in order to characterize Site conditions, including fate and transport processes.

Groundwater level measurements from existing and new wells, including a measurement from the Glacier dock, will be collected using a water level indicator. The data will be tabulated and groundwater elevations will be calculated. A groundwater elevation contour map will be prepared for each of the semiannual monitoring events. Groundwater elevation monitoring will be performed during both high and low tide conditions to evaluate tidal influences. Groundwater gradient monitoring methods are provided in the SAP (Section 6).

4.1.4 Groundwater Sampling

Groundwater samples will be collected during four quarterly sampling events from existing and newly installed monitoring wells as shown on Figures 4 and 7. Groundwater sampling methods are explained in the SAP (Section 6).

Each monitoring well will be sampled for parameters as described in Table 3. Water quality data including pH, specific conductance, turbidity, dissolved oxygen, temperature, and oxidation-reduction potential will be collected during purging of each well.

4.1.5 Riverbank Soil Sampling

Riverbank soil samples (identified as "RB" in Tables 1 and 2 and on Figure 6) will be collected from the eastern edge of the property. Riverbank sample locations are positioned at the terminus of former drainages to evaluate potential data gaps related to historic site drainage ditches. Riverbank sample locations may be altered based on the results of the GPR survey (refer to Section 4.1.7).

Riverbank soil samples will be collected from exposed, potentially erodible soil with a higher elevation than the mean high water level in the Embayment. In addition, samples will be collected from native material beneath the former drainage ditches. Samples will be collected at depths sufficient to characterize soils potentially affected by former drainages.

Riverbank sample intervals are listed in Table 1 and chemical analyses for the riverbank samples are described on Table 2. Surface soil sampling methods are provided in the SAP (Section 6).

4.1.6 Stormwater Evaluation

As part of the RI field activities, catch basin solids, water tank solids, pipe solids, conveyance ditch fines, and stormwater outfall samples (collected at the NPDES sampling point) will be collected to characterize stormwater discharge from the Site to the LDW. Existing stormwater management practices and available monitoring data will also be reviewed as part of the stormwater evaluation. In addition, a historical stormwater pipe located on the southern portion of the Site will be abandoned as part of RI field activities. The sections below describe the stormwater evaluation activities.

4.1.6.1 Catch Basin Solids Sampling

Samples of solid material in stormwater catch basins, pipes, ditches, and holding tanks will be collected as part of the stormwater evaluation. Catch basin solids sampling locations are shown on Figure 5. Catch basin solids will analyzed for the constituents described in Table 2. Methods for collecting catch basin solids are provided in the SAP (Section 6).

4.1.6.2 Stormwater Sampling

Stormwater grab samples will be collected from the NPDES sampling point as shown on Figure 5 during seven separate precipitation events. The stormwater samples will be collected during the first 2 hours of the first precipitation event following 48 hours of dry weather and during low tide. The stormwater samples will be analyzed for the constituents described in Table 3. Stormwater sampling methods are explained in the SAP (Section 6).

4.1.6.3 Historical Stormwater Pipe Abandonment

During 2009, a field effort was completed to verify the as-built stormwater drawing for the Site, which shows a 15-inch-diameter concrete stormwater pipe with five catch basins in the southern portion of the Site. The stormwater pipe tie-in location shown on Figure 5 was verified using an in-pipe camera survey and field trenching completed in 2009 (ERM 2009b). At that same time, a number of shallow excavations were completed in an effort to field-locate the five catch basins shown on historical Site drawings, but none were located. A video camera survey will be completed on the network of pipes proposed for abandonment.

As recommended in the *Historical Stormwater Pipe Investigation Technical Memorandum* (ERM 2009b) submitted to Ecology, the historical stormwater pipe will be abandoned in-place in accordance with applicable City of Seattle codes after sample and follow-on characterization (if needed). For planning purposes, it is expected that the stormwater pipe will be exposed up-flow of the location where it ties into the 48-inch Seattle Public Utilities (SPU) stormwater pipe near the south entrance of the property. The 15-inch pipe will be cut and the end capped at the connection. After capping, both exposed ends will be filled with concrete to eliminate the connection to the Site. Any appropriate permits identified by the City of Seattle will be obtained before completing the abandonment.

4.1.7 Drainage Ditch GPR Survey

Multiple drainage ditches have been historically located on the Site. The approximate locations of the ditches, based on historical maps and aerial photographs, are shown on Figure 6. Before the soil boring, well installation, and riverbank sampling described above, the locations of the former drainage ditches will be evaluated using GPR techniques. This will include surveying multiple transects perpendicular to the expected storm line orientation to assess the presence and depth of former ditches as depicted on Figure 6.

Based on the results of the GPR survey and locations of the drainage ditches, the locations of some proposed boring and riverbank samples may be moved, or additional sample locations may be added to evaluate these potential sources of COPCs.

The results of the GPR survey and any proposed changes or additions to the sample locations will be submitted to Ecology in a letter report for review and approval before beginning the soil sampling program.

4.1.8 Supplemental Sediment Sampling

Ecology may require supplemental sediment sampling in the Embayment after reviewing the May/June 2012 sediment sampling results provided by ERM. If required, supplemental sediment sampling will consist of collecting shallow and deeper sediment samples. The proposed sampling locations (SS-04/SC-04; SS-06/SC-06; SS-09/SC09) are shown on Figure 5, but these locations may change after review of the May/June 2012 data.

Sediment sampling will be performed using the procedures identified in the Ecology-approved sediment sampling Work Plan (included in Appendix C), with the following modifications.

Additional surface sediment samples will be collected using a double Van Veen grab sampler at locations SS-04, SS-06, and SS-09 (or other locations to be determined). A Van Veen grab sample is considered acceptable if:

1. The sediment was collected from 0 to 10 centimeters (cm) below mud line (bml).
2. Upon retrieval, the jaws of the sampler are completely closed and not leaking sediment.
3. Sediment does not extend over the top of the sampler.

Additional subsurface sediment samples will be collected using a hydraulic Vibracore sampler at locations SC-04, SC-06, and SC-09 (or other locations to be determined). A Vibracore sample is considered acceptable if:

1. The core penetrated native sediments.
2. Sediment retention is at least 90 percent of penetration depth.
3. Sediment in the core does not extend over the top of the core and appears to be intact.
4. No obstructions are present in the core that would inhibit entry of sediment into the core tube.

If the sediment sampling does not produce samples meeting the above criteria, up to two additional attempts shall be made within 10 feet of the designated sample location.

4.2 Survey Data

After completion of data collection activities, the RI sample locations will be surveyed for horizontal and vertical position by a licensed land surveyor. Surveying activities will be conducted in compliance with the accuracy specifications stated in the AO.

4.3 RI Data Analysis and Reporting

This section summarizes the tasks to be completed for preparation of the RI report after completion of the field investigation. The RI report will be prepared and organized in accordance with WAC 173-340-350. The following sections describe the scope of the RI report.

4.3.1 Data Management

Data management will be completed after the field investigation to consistently record, evaluate, and access the data generated.

The contracted analytical laboratory(ies) will submit analytical data reports for each sample collected during the RI. The data reports will be provided in both hard-copy format and as electronic data deliverables (EDDs) that can be entered easily into the project database. Field data will also be entered into the project database. The project database will allow efficient management of data received from the laboratories and export of validated electronic data for submittal to Ecology in accordance with the Environmental Information Management (EIM) System per the AO and WAC 173-340-840.

Data management also includes color photographs with or without sampling or analysis, the field logs and photographs generated during the investigation, which will include detailed information on sample collection methods, sample locations, sample features (odor, color, sheen, etc.), quality assurance/quality control field samples, etc. Detailed information on field data entry onto the field logs is provided in the SAP (Section 6).

4.3.2 Quality Assurance/Quality Control (QA/QC)

Analytical data collected during the RI will be validated and submitted to Ecology in electronic format, as specified in the AO, after the completion of data validation. The QA/QC Manager will conduct a Level II data review of the analytical data in accordance with the EPA Contract Laboratory Program National Functional Guidelines for Data Review and the QC criteria specified in this document. Data will be reviewed and flagged with the appropriate data qualifiers. Based on data validation/review, the QA/QC Manager will determine whether the quality assurance criteria have been met, and will establish and document data usability. Data quality objectives and quality control procedures are outlined in the Quality Assurance Project Plan (QAPP) in Appendix C.

4.3.3 Reporting

The RI report will be prepared to evaluate the results of the field investigations conducted during the RI in accordance with WAC 173-340-350. The RI data will be reported and summarized in tabular form with maps and plots to present the information and data collected. In general, the RI report will include the following elements:

- Environmental setting, geology, and hydrogeology of the Site.
- A description of the RI investigations conducted.
- A description of deviations from the RI/FS Work Plan. (Note: Any deviations from the Work Plan will be discussed in advance with Ecology or before leaving the Site the day the specific activity is performed).
- An assessment of data adequacy to meet data quality objectives.
- An update to the CSM.
- Assessments of potential contamination sources to various media (i.e. surface water, sediment).
- A summary of the nature and extent of contamination identified.
- Characterization of potential contaminant migration pathways.
- Evaluation of contaminant fate and transport.
- Calculation of preliminary screening levels and pathways that are protective of Upland and in-water receptors.
- Recommendations for COPCs and pathways to be evaluated in the FS.
- Submittal of all analytical and other required site data (including but not limited to survey data) in the appropriate format to Ecology's EIM database.

All analytical data will be provided to Ecology within 60 days after field sampling based on the requirements of the AO. Proposed cleanup levels for the Site will be refined and established in the FS as discussed in Section 5.

Section 5: FS Tasks

The purpose of the feasibility study is to develop and evaluate cleanup action alternatives to enable a cleanup action to be selected for the Site.

The FS process involves identifying applicable regulatory requirements, establishing cleanup action objectives and cleanup standards that are protective of human health and the environment, identifying and evaluating potentially applicable cleanup technologies, and incorporating the cleanup technologies into cleanup action alternatives to address Site contamination. The cleanup action alternatives are then evaluated against specific criteria dealing with effectiveness, implementability, and cost to assist selection of a preferred remedy. The following sections describe the primary elements to be included in the FS.

5.1 FS Report

The FS report will be prepared after Ecology's approval of the Final RI report to document the FS process. The FS will be conducted in accordance with the AO, WAC 173-340-350, and 173-340-360, and will incorporate the components presented in the following sections.

5.1.1 Determination of Cleanup Levels and Applicable Laws

Cleanup levels for soil and groundwater will be developed in accordance with the MTCA. The cleanup levels selected will be protective of human health and aquatic and terrestrial ecological receptors.

Cleanup levels for sediments will be developed in accordance with the SMS, WAC 173-204, WAC 173-340 including all applicable State and federal requirements, and will take into consideration cleanup levels derived for the Lower Duwamish Waterway FS and Record of Decision.

Cleanup levels for catch basin solids and stormwater chemical constituents will be based on values determined to be protective of surface water and soil under the Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A), Sediment Management Standards, and WAC 173-340 and ARARs.

The FS will also identify ARARs in accordance with MTCA regulations (WAC 173-340-350, -360 and -710). Per WAC 173-340-350(8), the purpose of a FS is to develop and evaluate cleanup action alternatives to enable a cleanup action to be selected for the Site.

5.1.2 Technology Identification and Screening

Remediation technologies will be identified to meet the cleanup action objective for each medium.

The remediation technology identification will consist of evaluating technologies that, individually or in combination, will meet Site cleanup action objectives and cleanup standards and will form the basis for identifying the groups of possible cleanup technologies and process elements applicable to the Site.

The technologies that may be considered during the technology evaluation include, but are not limited to, removal, in situ treatment, ex situ treatment, institutional controls, containment or other engineering controls, and natural attenuation. Each technology or combination will be evaluated and screened for applicability to the Site based on documented success for the particular media and COPC.

5.1.3 Development of Remedial Alternatives

After the technology evaluation and screening, cleanup action alternatives will be developed consistent with Ecology requirements (WAC 173-340-370). Each cleanup action alternative is a group of remedial technologies and process elements intended to achieve cleanup action objectives and standards. Alternatives will be constructed from remediation technologies and process components retained from the screening process as presented in Section 5.1.2, with the goal of identifying alternatives that have a high probability of meeting Site cleanup action objectives and cleanup standards. In addition, development of cleanup alternatives will take into account a Disproportionate Cost Analysis (DCA) and the current and planned future land use (i.e., a Site that is zoned industrial use and is likely to remain as such).

Finally, the FS will include at least one permanent cleanup action alternative (WAC 173-340-200). This alternative is the baseline against which other alternatives are evaluated.

5.1.4 Detailed Analysis of Alternatives

This section provides the scope for the detailed alternatives evaluation using MTCA criteria. These criteria govern the evaluation of remedial alternatives and the identification of preferred alternatives. The detailed analysis is governed by the following evaluation components:

- MTCA threshold requirements (evaluation criteria and remedy selection process) [WAC 173-340-360(2)(a)].
- Presentation of each alternative and how it addresses other MTCA criteria [WAC 173-340-360(2)(b)].

MTCA also provides specific requirements regarding groundwater cleanup actions, cleanup actions for soils, institutional controls, releases and migration, dilution and dispersion, and remediation levels. These requirements will be considered in the FS during the analysis of cleanup action alternatives.

5.1.4.1 MTCA Threshold Requirements

Cleanup actions selected under MTCA must comply with several basic requirements. Alternatives that do not comply with these criteria cannot be considered valid cleanup actions under MTCA. MTCA [WAC 173-340-360(2)(a)] identifies four threshold requirements for cleanup actions. Cleanup actions must:

- Protect human health and the environment.

- Comply with cleanup standards.

- Comply with applicable laws.

- Provide for compliance monitoring.

Alternatives will be designed and selected to meet the threshold requirements presented above.

5.1.4.2 Other MTCA Criteria

When selecting from alternatives that meet the threshold requirements, the selected alternative must also address the following three criteria:

- Use permanent solutions to the maximum extent practicable: Preference will be given to actions that are “permanent solutions to the maximum extent practicable.” The costs and benefits of each of the project alternatives will be balanced using a “disproportionate cost analysis.”

- Provide for a reasonable restoration time frame. Preference will be given to alternatives that, while equivalent in other respects, can be implemented in a shorter period of time.

- Consider public concerns. Ecology will consider public comment received during the RI/FS process in making its preliminary selection of a cleanup alternative for the Site. Ecology’s preliminary decision will then be presented for public review in a Draft Cleanup Action Plan.

5.1.5 Comparative Evaluation of Alternatives

A comparative evaluation will be prepared to describe the strengths and weaknesses of each alternative using the MTCA DCA, which is used to identify preferred alternative(s) that are permanent to the maximum extent practicable [WAC 173-340-360(3)(e)].

Each selected alternative will be assessed for the following:

- Protectiveness of human health and the environment.

- Permanence of the alternative.

- Disproportionate costs to implement the alternative.

- Effectiveness over the long term.

- Management of short-term risks related to construction and implementation of the alternatives.

- Technical and administrative implementability.

- Consideration of public concerns.

The DCA compares the relative environmental benefits of each alternative against those provided by the most permanent alternative. These benefits can be qualitative as well as quantitative. Costs are considered disproportionate to benefits if the incremental costs of the more permanent alternative exceed the incremental degree of benefits achieved by the other lower-cost alternative [WAC 173-340-360(e)(i)]. Where the quantitative and qualitative benefits of two alternatives are equivalent, the less costly alternative will be selected [WAC 173-340-360(e)(ii)(c)].

5.1.6 Recommended Remedial Alternative

This section will identify and justify the alternative that is determined to be the most effective in meeting the cleanup action objectives.

5.2 State Environmental Policy Act Checklist

Per the AO, the Companies are responsible for complying with State Environmental Policy Act (SEPA) rules. The Companies will complete a SEPA review to determine its applicability to the recommended remedial alternative components and, if required, will prepare a draft SEPA environmental checklist.

5.3 RI and FS Public Comment and Community Involvement

Per the AO, Ecology will hold a public comment period before issuing the Final FS. Typically, the public comment period is a 30-day period for submittal of public comment and may include a public meeting led by Ecology with assistance from the Companies, as required by the AO and the Public Participation Plan.

After the public comment period is completed, a Draft Responsiveness Summary that addresses public comments and a second Draft Final FS report that addresses public comments will be prepared for Ecology's review and comment.

Section 6: Sampling and Analysis Plan

This section presents the SAP in support of RI/FS activities at the Site described in previous sections. This SAP provides procedures for field sampling, data gathering methods, and laboratory analysis activities being performed as part of the RI at the Site.

This SAP defines field-sampling procedures and data gathering methods to ensure that the data collected during the project are of known quality to meet their intended use, and that all components of data acquisition are thoroughly documented, verifiable, and defensible.

In addition to the procedures identified herein, the parties implementing the Work Plan will submit Site-specific Standard Operating Procedures (SOPs) to Ecology that provide details regarding the specific means and methods to be used during implementation of this Work Plan. Ecology's approval of the SOPs will be required before performing the work.

The sampling intervals and suite of analytical tests for each sample location are described in the following sections. The sampling program is designed to collect data necessary to characterize current Site conditions and therefore includes a wide range of required analyses.

In some cases, historical data may indicate that the depth interval has already been sufficiently characterized for the analytes in the proposed analytical program. In these cases, the specific analyses may be excluded from the analytical program with formal prior approval from Ecology. At a minimum, this will include a formal request by the Companies to exclude a compound (or compounds) at a particular location. Ecology will notify the Companies within 5 working days whether or not the request will be granted.

6.1 GPR Survey

A GPR survey will be performed at the Site with the purpose of identifying the location and configuration of historical drainage ditches in the central and southern portions of the Site. The GPR survey will consist of surveying multiple transects (refer to Figure 6) perpendicular to the location of the suspected historical drainage ditch locations that were been identified using aerial photographs or historical maps. Additional transects may be added in the field as needed to confirm the location, depth and orientation of the ditches.

The results of the geophysical survey will be summarized in a standalone report and presented with GPR logs showing stratigraphic conditions and horizontal coordinates along each transect. The GPR survey report will be provided to Ecology no less than 10 work days before the start of the soil boring investigation described below. The Companies shall adjust boring and riverbank sample locations in the vicinity of historical drainage ditches to ensure that these areas are adequately characterized. The report will include an interpretation of the GPR data and provide a map of proposed modifications to soil boring locations and riverbank locations (as presented in the Work Plan) for complete characterization of the vertical and horizontal impacts of COPCs in soil. Before performance of the soil investigation identified in Section 6.2, Ecology will provide written approval of the proposed boring location modifications.

6.2 Sampling Design, Locations, and Frequency

This section describes the sampling design that will generate data for use in the RI and FS Reports. Proposed sampling activities include collection of soil, groundwater, riverbank soil, catch basin solids, stormwater ditch solids, historical stormwater pipe solids, sediment, and stormwater samples for various constituents of potential concern for the Site based on proximity to areas of historical operations and activities as described in Table 1. Sampling locations are identified on Figures 4 through 7.

It is important to note that depths for soil sampling of different stratigraphic layers may differ across the Site due to fill placement. The sample intervals listed in Table 1 are based on targeted lithologic units, not specific depths.

6.2.1 Soil Boring Sampling

Direct-push soil borings (designated “GP-“) and new monitoring well soil borings will be drilled and sampled to evaluate data gaps in areas of historical operations and activities as described in Section 4. The proposed sampling locations are shown on Figures 4 and 7. The rationale for placement of the soil borings is based on historical industrial uses and placement of potentially contaminated fill. As noted above, the location of some soil borings may vary based on GPR survey results or other field information developed during the RI. Supporting information for soil boring location placement is presented in the previous sections of the Work Plan.

The areas of interest represented by each boring and well location are listed in Table 1. The placement of borings and wells relative to historical Site features within the areas of interest are shown on Figure 4. All soil boring and well locations are also shown on Figure 7 with a recent aerial photograph of the Site.

The depths, sampling intervals, and list of soil analyses for each boring and well are presented in Tables 1 and 2. General soil boring installation field methods and sampling/logging procedures are presented in Section 6.3.1.

6.2.2 Riverbank Soil Sampling

Riverbank soil samples will be collected adjacent to the Embayment as shown on Figure 6. Riverbank boring samples will be collected at the terminus of former drainage ditches adjacent to the Embayment. Locations of some Riverbank samples may be shifted based on the results of the GPR survey (Section 6.1).

Riverbank sample depth intervals are listed in Table 1 and analyses are shown in Table 2. The field methods and riverbank soil sampling procedures are presented in Section 6.3.2.

6.2.3 Monitoring Well Installation

New monitoring wells will be installed in both the saturated upper and lower units as part of the RI field activities at the locations shown on Figure 4 and 7. Details regarding the area of interest targeted by each well locations and the approximate depths and screen intervals are listed in Tables 1 and 3.

Well construction details and monitoring well installation methods are presented in Section 6.3.3.

6.2.4 Catch Basins, Stormwater Ditches, Stormwater Sumps, Stormwater Tanks and Stormwater Pipe Solids Sampling

Samples of solid material (if present) will be collected in three catch basins (CB-01 through CB-03), two stormwater sumps (SMP-01 and SMP-02), three settling/storage tanks (TANK-01 to TANK-03), treatment ditches (SWD-01 and SWD-02) and the historical 15-inch pipe in the southern end of the Site (SWP-01) as part of the Site stormwater solids evaluation. Sampling locations are shown on Figure 5.

Analytical tests to be performed for stormwater solids are shown in Table 2. Catch basin solids sampling methods and procedures are described in Section 6.3.4.

The sample from the historical stormwater pipe (SWP-1) will be collected before performing pipe abandonment.

6.2.5 Stormwater Sampling

Seven stormwater samples (STW-01) will be collected from the existing NPDES stormwater sampling point (i.e., the discharge point of compliance for Site stormwater) (Figure 5). Samples will be collected during seven storm events. Samples will be analyzed after each event, and the analytical results will be validated as the data become available. If seven qualifying storm events cannot be captured during the designated sampling period, the Companies will consult with Ecology on whether to continue stormwater sampling.

Storm events are roughly categorized as a 24-hour period with at least 0.15 inch of rain over a 5-hour period, preceded by at least 24 hours of no more than a trace (0.04 inch) of precipitation. Efforts will be made to sample storm events covering a range of precipitation amounts. The sampling duration must include at least 75 percent of the storm event hydrograph, or at least 75 percent of the first 24 hours if the storm event lasts longer than 24 hours. The total volume of stormwater collected must be sufficient to complete all chemical analyses.

The stormwater sample will be analyzed for the analytes shown in Table 3. Stormwater sampling methods and procedures are outlined in Section 6.3.5.

6.2.6 Groundwater Level Measurements and Surface Water Tide Elevation

The potentiometric surface of the groundwater will be evaluated quarterly to understand Site fate and transport processes. Groundwater elevations will be measured during both high and low tidal conditions for each monitoring event.

Groundwater level measurements from the existing and new wells will be collected using an electronic water level indicator. The data will be tabulated and groundwater elevations will be calculated. A groundwater elevation contour map will be prepared for each quarterly monitoring event to evaluate groundwater gradients and flow directions.

Tidal stage data will be collected periodically during the water level monitoring. The tidal data will be collected by measuring the depth to water in the Embayment from a control point on the existing Glacier dock. This control point will be surveyed (or existing survey data will be verified) by a licensed surveyor. Tidal stage data will be correlated with high and low tidal information obtained for Elliot Bay and with river flow rate and river stage information obtained from the United States Geological Survey or the National Oceanic and Atmospheric Association. Water level collection method, equipment, and procedures are presented in Section 6.3.6.

6.2.7 Groundwater Sampling

Groundwater samples will be collected during four quarterly sampling events from new and existing monitoring wells as shown on Figures 4 and 7 and listed in Table 3**.**

Based on the existing Site groundwater monitoring data, historical activities, and data gaps, the groundwater sample analyses will include the analytes listed in Table 3. Field water quality parameters, including acidity/alkalinity, pH, specific conductance, turbidity, dissolved oxygen, temperature, and oxidation-reduction potential, will be recorded during the purge of each well.

Groundwater sampling methods are presented in Section 6.3.7.

6.3 Field Methods and Sampling Procedures

This section summarizes the general procedures for collecting samples in support of the RI field efforts. Before performance of field activities identified herein, the Companies will provide Site-specific SOPs for the various field tasks identified in the Work Plan.

6.3.1 Direct Push, Hollow Stem Auger, and/or Sonic Soil Sampling

Direct-push borings and new monitoring wells will be installed at the locations shown on Figures 4 and 7. Direct-push borings will be advanced using direct-push technology (i.e., Geoprobe® or similar). Borings for installing monitoring wells will be advanced using hollow-stem auger and/or sonic drilling methods. A Washington State-licensed drilling contractor(s) will perform all drilling activities. A geologist or hydrogeologist licensed in the State of Washington will provide oversight of the drilling activities.

The appropriate service to locate publicly owned underground utilities will be contacted before intrusive activities. In addition, Site-owned underground utilities will be evaluated by reviewing as-built drawings of underground Site utilities, interviewing Site personnel cognizant of utility locations and, as needed, by hiring a private utility location company to locate Site-owned utilities and features. If drilling at the planned boring locations may interfere with utilities, the borings will be relocated as close as possible to the original sample locations.

Drilling and borehole abandonment methods will follow WAC-173-160. All field equipment will be thoroughly decontaminated prior to re-use. In general, direct-push soil cores will be collected continuously using a 4-foot or 5-foot macro-core, and hollow stem auger/sonic drilling borings will be sampled continuously to the designated completion zone (see Table 1).

Logs describing the subsurface soils encountered at each boring will be prepared by the on-Site geologist and recorded based on visual inspection of recovered soil from the core or split-spoon sample. Descriptions of soil sample texture, composition, color, consistency, moisture content, recovery, odor, photoionization detector (PID) readings, and staining will be documented using the Unified Soil Classification System (USCS).

Upon completion of drilling activities, coordinates and elevations of boring locations will be surveyed by a licensed surveyor. Lateral coordinates and ground surface elevation will be surveyed to the nearest 0.1 foot.

Soil samples collected during the RI activities will be collected from the southern and northern sections of the Site as described below. In addition, the Companies will submit a site-specific SOP to Ecology for approval before performing soil sampling at the Site. Analytical requirements are described in Table 2 and locations are shown on Figures 4 and 7.

The northern portion of the Site is more likely to have experienced releases from the U.S. Army Whetlerite manufacturing, shipyard production, and resin and PCP experimentation and production. The southern portion of the Site is more likely to have experienced releases from the resin and PCP production and the log treatment operation. More recent layers of potentially contaminated fill could be found in both portions of the Site.

As previously discussed, soil sampling intervals are based on lithologic units, not specific depths. The targeted lithologic intervals for soil samples are listed in Table 1. In general, depths to the targeted intervals will be greater on the southern portion of the site where surface fill is thicker.

In general, shallow borings (estimated 16 to 24 feet) will be advanced into the upper portion of the sand unit (lower saturated unit) underlying the silt aquitard unit. Deep borings will be advanced to at least 10 feet below the base of the silt aquitard unit. All borings will be advanced to greater depths if field observations (see below) indicate the potential presence of contaminants.

Minimum sampling requirements are listed in Table 1. These include samples required for initial laboratory analysis and collection of additional samples for archival and possible follow-on analyses. Archived samples will be submitted for laboratory analysis for any analytes detected at concentrations above the PQL (see Section 6.7.1) in a vertically adjacent sample. Soil samples for either initial analysis or archival will be collected with at least one sample for every 2 feet of boring depth, including samples collected from saturated zones.

Field-screening to be performed at each boring and well location includes characterization of lithology and suspected contamination based on observations, including visual (changes in particle size, color and type of materials), olfactory (odor consistent with changes or contaminants), and on-Site field measurements (PID, pH).

All samples will be placed in laboratory-supplied sample jars appropriate for the given analysis, labeled, and stored at 4 degrees Celsius in a cooler. QA/QC samples will be collected as described in Table 4**.** Sample handling procedures are presented in Section 6.7. After sample collection, the samples will be transported to a Washington State-certified laboratory under standard chain-of-custody (COC) protocol (see Section 6.7.3.3).

6.3.2 Riverbank Soil Sampling

Riverbank soil samples will be collected from the eastern portion of the Site as shown on Figure 6 (locations may be modified based on GPR survey results). Samples collected at riverbank sampling location will include shallow and deeper samples as described below.

- One sample will be collected for laboratory analysis from the upper 1 foot (0- to 1-foot interval) for initial laboratory analysis. Additional samples will be collected at 1-foot depth intervals to the bottom or former surface of the ditch and archived for possible follow-on analysis. Archived samples will be submitted for laboratory analysis for any analytes detected at concentrations above the PQL (see Section 6.7.1) in a vertically adjacent sample. The bottom of the ditch will be determined based on GPR survey results and field observations.

- One sample will be collected for laboratory analysis from the uppermost 1 foot of soil located immediately below the bottom or former surface of the ditch. Additional samples will be collected at 1-foot depth intervals to the bottom of the boring and archived. Archived samples will be submitted for laboratory analysis for any analytes detected at concentrations above the PQL (see Section 6.7.1) in a vertically adjacent sample. Riverbank borings will be advanced to at least 5 feet below the base of the former ditch, or deeper if field observations indicate the potential presence of contaminants.

Riverbank soil samples may be collected using hand tools or by direct-push drilling techniques. Soil for each discrete 1-foot interval will be homogenized in the field by mixing in a clean stainless steel bowl using a clean stainless steel spoon before being placed in sample containers. The samples will be placed in laboratory-supplied sample jars, labeled, and stored at 4 degrees Celsius. QA/QC samples will be collected as described in Table 5**.** The soil samples will be transported to a Washington State-certified laboratory under standard COC protocol (see Section 6.7.3.3) for analysis of the parameters described in Table 2.

After completion of sampling at each location, non-disposable sampling equipment will be thoroughly decontaminated to remove possible residual contamination.

6.3.3 Monitoring Well Installation

Proposed new monitoring well locations are shown on Figures 4 and 7. Approximate new monitoring well depths are summarized in Table 3.

Monitoring well boreholes will be advanced using hollow-stem auger or sonic drilling methods. Shallow monitoring wells (designated as "S" wells) will be installed within the shallow silty sand/sandy silt fill upper unit, which is approximately 8 to 13.5 feet thick. The water table in the upper unit is typically encountered at 5 to 6 feet bgs. The bottom of the shallow wells will be placed approximately 6 inches below the top of the silt aquitard (encountered at approximately 10.5 to 17.5 feet bgs).

Deep monitoring wells will be installed in the sand layer that underlies the silt aquitard (i.e., in the lower unit). This includes wells with screen intervals within 2 feet of the base of the silt aquitard (designated as "D" wells) and wells with screen intervals 10 to 15 feet below the silt aquitard (designated as "DD" wells).

The lower unit is typically encountered at 15 to 18 feet bgs and below the silt aquitard. The lower unit consists of well- to poorly-graded sands defined as black, fine to coarse sand. Step-down drilling methods will be used at the deeper wells to prevent communication between saturated zones and vertical movement of contaminants between the upper unit into the lower unit. A conductor casing will be installed in the upper unit, and the borehole will be advanced to the lower unit through the conductor casing. Borehole advancement at the deeper wells will penetrate the silt aquitard. Step-down drilling methods are described below:

- The borehole will be advanced to the top of the underlying silt aquitard using a larger diameter casing/augers. The casing/augers will be seated in the upper foot of the silt aquitard identified through soil sampling. Residual formation water inside the augers (temporary conductor casing) will be removed before placing bentonite chips within the casing/augers.

- The large-diameter casing/augers will be left in place to act as a temporary conductor casing. Five to 10 feet of bentonite chips will be poured into the bottom of the conductor casing/augers and allowed to hydrate with potable water for at least 30 minutes.

- Standard-diameter casing/augers will be advanced through the conductor casing to the final depth.

Soil samples will be logged continuously while advancing the borehole as described. Soil samples will be collected in a manner similar to that described for direct-push borings (Section 6.3.1) at the lithologic intervals described in Table 1. Soil samples will be submitted for laboratory analysis for the suspected Site contaminants as shown in Table 2. QA/QC samples will be collected at frequencies identified in Table 4**.**

All monitoring wells will be constructed of new 2-inch factory-threaded, PVC well construction materials. Shallow monitoring wells will be constructed with 7 to 10 feet of 0.010-inch slotted screen. Shallow wells will be constructed such that the entire saturated thickness of the upper unit is screened and the screen extends 1 to 3 feet above the water table, consistent with existing Site monitoring wells. As previously discussed, shallow wells will be screened to the top of the silt aquitard.

The deep monitoring wells ("D" wells) will be constructed with 5 feet of 0.010-inch slotted screen. The proposed deep wells will be screened within the lower unit such that the screen zone is fully submerged and the top of the screen is within 2 feet of the bottom of the silt aquitard.

The deeper monitoring wells ("DD" wells) will be constructed with 5 feet of 0.010-inch slotted screen within the lower unit. The screen interval for the "DD" wells will be at least 10 feet below the bottom of the silt aquitard.

The new monitoring wells will be completed using a sand pack that extends 2 feet above the screened interval with 10/20 silica sand or equivalent. A seal of hydrated bentonite chips will be installed above the sand pack. The seal will be at least 2 feet thick for the shallow monitoring wells and will extend through the silt aquitard for the deep well. The chips will be poured slowly into the annulus and tamped or sounded periodically to confirm that there is no bridging. The remainder of the annulus will be filled with bentonite grout that is injected through a tremmie pipe. The wells will be completed with flush-mount traffic-rated well boxes and equipped with a locking expandable cap.

Upon completion of the monitoring well installations, each well will be developed at least 2 days after installation to allow time for the grout to cure. Sampling will take place at least 2 weeks after development of the well or earlier, with approval of Ecology.

The monitoring wells will be developed using a combination of over-pumping and surging using a vented surge block. Development will be discontinued after at least 10 well volumes of groundwater have been removed and the groundwater is free of visible turbidity. During development, purge water will be monitored for pH, specific conductance, turbidity, and temperature. Groundwater purged during development will be collected in drums or tanks to prevent contact with the ground surface and disposed at a permitted facility.

6.3.4 Stormwater Solids Sampling

Stormwater solids sampling locations include catch basins (CB), stormwater ditches (SWD), sumps (SMP), stormwater tanks (TANK), and stormwater pipes (SWP). Sampling locations are shown on Figure 5.

Catch basin, sump, and tank samples will consist of a composite of solids collected from the entire accumulated sediment thickness within each catch basin, sump, or tank. Samples will be collected from catch basins when there is no precipitation or accumulated water to support collection of all grain sizes present in the catch basin. Because standing water may be present in the sumps and tanks, an effort will be made to prevent mobilization of the solids while collecting these samples. Each sample will be described in the field notebook or field form using USCS methods.

Stormwater ditch samples will be collected along the existing site drainage ditches to characterize solids related to the stormwater system, as shown on Figure 5. Samples will be collected from the current stormwater treatment ditch where stormwater is directed in a ditch before discharge to the NPDES outfall. The samples should target surface sediment fines that have dropped out during stormwater ponding. Additional ditch sampling locations may be added based on the result of the GPR survey.

Stormwater pipe solids will be collected in the 15-inch stormwater pipe draining the southern acreage of the Site and discharging into the City of Seattle 48-inch main.

Sediment sample materials collected from the accumulated sediment sequence at each location will be homogenized in the field by mixing in a clean stainless steel bowl using a clean stainless steel spoon before being placed in sample containers. The samples will be placed in laboratory-supplied sample jars, labeled, and stored at 4 degrees Celsius. The soil samples will be transported to a Washington State-certified laboratory under standard COC protocol (see Section 6.7.3.3) for analysis of the parameters described in Table 2. After completion of sampling at each location, non-disposable sampling equipment will be thoroughly decontaminated to remove possible residual contamination.

All stormwater solid samples will be submitted for laboratory analysis as shown in Table 2. QA/QC samples will be collected at frequencies identified in Table 4.

6.3.5 Stormwater Sampling

Because stormwater sampling may need to be conducted with little warning, the sampler will be prepared for mobilization with minimal notice with all equipment, rain gear, and sample bottles stored and ready for sampling. Sampling will be conducted using procedures consistent with the stormwater sampling guidance (Ecology 2009). An SOP for stormwater sampling will be submitted to Ecology for approval before performing any stormwater sampling.

QA/QC samples will be collected at frequencies identified in Table 4. The samples will be transported to a Washington State-certified laboratory under standard COC protocol for analysis of the parameters described in Table 3. Detailed records of the field sampling activities conducted during stormwater sampling will be kept in a field notebook.

6.3.6 Groundwater Level Measurements and Surface Water Tide Elevation

Before beginning semiannual groundwater sampling activities and during each of the quarterly groundwater level measurement events, depth to groundwater will be measured in each monitoring well during high and low tidal conditions. Water level elevation will be measured using an electronic depth sounder, and depth measurements will be recorded to the nearest 0.01 foot.

Surface water tide elevation will be determined three times per day during groundwater sampling events. Surface water measurements from the Embayment will be collected at the surveyed measuring point on the Glacier dock. The height from the measuring point to the water surface will be measured using an electronic water-level indicator that is sensitive to the nearest 0.01 foot.

Both water level depth and tide measurements will be recorded in a field log book. Water level elevations will be calculated for each location and provided to Ecology in tabular format along with the quarterly monitoring reports.

Where not already performed, each wellhead will be surveyed by a licensed surveyor in Washington State to determine the elevation of the top of casing and horizontal position. Well elevation surveys will be accurate to the nearest 0.01 foot.

6.3.7 Groundwater Sampling

Groundwater sampling for all constituents listed in Table 3 (except dioxins and furans) will be performed using U.S. Environmental Protection Agency (EPA) low-flow well purging/ sample collection techniques to obtain representative groundwater samples from existing and new monitoring wells. Low-flow purging procedures are designed to minimize the volume of purge water and disturbance of the water column and to maximize the contribution of formation water from a given interval of interest (EPA 1996).

Low-flow purging is based on the theory that water moving through the well intake is representative of formation water surrounding the intake, and assumes that pumping at a low flow rate isolates the column of standing water so that only formation water is drawn into the intake. Typical flow rates for this method are on the order of 0.1 to 0.5 liter per minute.

The low-flow groundwater purging/sampling technique employs the use of a flow-through cell equipped with a meter for measuring groundwater quality parameters such as pH, temperature, specific conductivity, dissolved oxygen and oxidation/reduction potential (such as a YSI-556 flow-through cell).

When the well has been purged using the low-flow methods and monitored parameters are stabilized in accordance with low-flow purging guidelines, samples will be collected from the discharge of the pump into appropriate laboratory-supplied sample containers**.** The order in which sample bottles for each analysis will be filled is presented below:

- VOCs
- Gasoline-range total petroleum hydrocarbons (TPH-G)
- Total organic carbon
- SVOCs
- Diesel-range total petroleum hydrocarbons (TPH-D)
- Alkalinity
- Total suspended solids
- Hardness, pH
- Anions
- Ammonia
- TBT
- Total metals
- Dissolved metals.

Filtered metals samples will be field-filtered using an in-line, disposable, 0.45-micron filter. Samples for these analyses will be collected at the same time the sample bottles are being filled for laboratory analyses.

The sampling procedure differs slightly for sampling for dioxins and furans. Because these constituents have low solubility, are highly hydrophobic, and are consequently extremely sensitive to bias from even very low levels of artificially suspended solids in sample water, samples to be analyzed for dioxins and furans will be collected before purging the well in an attempt to minimize potential bias from sampling-induced turbidity.

After water levels are measured, the tubing from a peristaltic pump will be lowered gently to the water surface and lowered until the bottom of the tube is within the middle portion of the screened interval. Using a low pumping rate (0.025 to 0.05 liter per minute or less), samples will be withdrawn and the sample container for dioxins/furans analysis filled from the end of the pump discharge tubing. After sufficient sample water has been obtained, the pump will be stopped, the low-flow cell added to the discharge line, and the well will be purged and sampled as described above.

Groundwater samples will be placed in laboratory-supplied sample jars, labeled, and stored in a chilled cooler at 4 degrees Celsius. QA/QC samples will be collected as described in Table 4**.** The samples will be transported to a Washington State-certified laboratory under standard COC protocol for analysis of the parameters shown in Table 3.

6.4 Equipment Decontamination Procedures

All reusable sampling equipment will be thoroughly decontaminated before re-use. Equipment to be decontaminated includes drilling rods and augers for drilling, hand-sampling tools for solids collection, homogenizing/compositing containers such as stainless steel bowls and spoons, and all other reusable sampling equipment. After completing the decontamination process, the equipment will be positioned to preclude inadvertent contamination prior to reuse.

All borehole drilling equipment will be decontaminated using steam and/or high-pressure water.

Non-disposable sampling equipment that comes into contact with samples (such as a water level meter and mixing materials) will be decontaminated to prevent the introduction of extraneous material into samples and to prevent cross-contamination between samples. All non-disposable sampling equipment used at multiple locations will be decontaminated by steam cleaning or washing with a non-phosphate detergent such as Liquinox™ or equivalent. Decontamination water will be collected in appropriate 55-gallon drums or equivalent.

The following procedures will be used to decontaminate non-disposable sampling equipment:

1. If mud or soil adheres to the sampling equipment, rinse with potable water. This step will decrease the gross contamination and reduce the frequency at which the non-phosphate detergent and water solution need to be changed.

2. Wash with the non-phosphate detergent and water solution. This step will remove remaining contamination from the equipment. Dilute the non-phosphate detergent as directed by the manufacturer.

3. Rinse with clean potable water. Change the water frequently.

4. Rinse with distilled water. This step will rinse any detergent solution and potable water residues. Rinsing by applying the distilled water from a clean squeeze bottle (or equivalent) while holding equipment over a bucket.

6.5 Investigation-Derived Waste Handling

Investigation-derived waste (IDW) associated with the RI/FS field activities is expected to include solid materials such as soil cuttings from drilling activities and liquids such as purge water and decontamination water.

IDW will be stored in 55-gallon, metal, open-top drums [Department of Transportation (DOT) 17-H] or an equivalent DOT-approved container for transporting wastewater. Drums will be sealed after use and properly labeled prior to disposition. An IDW sample will be collected and analyzed to assess the appropriate off-Site disposal method/facility.

6.6 Field Instrument Maintenance and Operation

Equipment to be used to evaluate samples will be inspected, tested, and calibrated to ensure that it is operating properly before use. These checks will be performed in accordance with manufacturer recommendations. Instruments operating below minimum standards will not be used to evaluate project samples. A qualified technician will repair the instrument before it is used. All checks and inspections will be documented properly.

Preventive maintenance generally involves the routine replacement or adjustment of equipment and instrument components as specified by the manufacturer to prevent failures. Preventive maintenance will be performed in accordance with the manufacturer’s manual to facilitate timely and accurate sample collection and analysis. The goal is to reduce downtime or loss of time due to equipment or instrument failure or inaccuracy. The following sections describe project instruments and calibration methods.

6.6.1 Field Instruments

Field meters will be used during groundwater sampling and drilling activities. Expected field instruments include:

- A PID or flame ionization detector (FID) will be used for air monitoring during drilling activities.

- An in-line flow cell and water quality meter will be used while purging wells before groundwater sampling. The water quality meter will measure temperature, pH, specific conductance, dissolved oxygen content, redox potential, and turbidity.

- Soil samples collected during drilling activities will be analyzed for organic vapors using a PID or equivalent.

6.6.2 Calibration

This section summarizes calibration procedures for field instrumentation. Calibration is an integral part of ensuring that results are quantified correctly. Instruments that are not calibrated to manufacturer specifications are likely to produce unreliable results. Proper procedures must be followed and sufficient documentation maintained to assure that calibrations are performed correctly.

Before a field instrument can be used to test samples, the calibration will be verified using standard reference materials. The calibration verification may range from a single point to multiple points. The concentration of the standard, reference identification number, instrument response, instrument identification number, date, and time will be recorded on a standard equipment calibration record. The calibration will be verified at the start of each sampling event, or more frequently as warranted by the sensitivity of the equipment. Instruments that do not meet minimum requirements for calibration will not be used and will be replaced by a properly calibrated instrument.

The following field instruments and equipment will require calibration verification:

- FIDs and/or PIDs
- Water quality meters (temperature, pH, oxidation-reduction potential, turbidity, and specific conductivity meters).

6.7 Sample Handling Procedures

This section describes container and preservative requirements, field sample collection procedures and how individual samples will be handled, labeled, tracked, stored, and transported to the laboratory for analysis.

6.7.1 Chemical Analyses

The soil, solids, sediment, groundwater, and stormwater samples will be analyzed for the parameters identified in Tables 2 and 3.

Samples will be submitted to two laboratories for analysis. All analyses, except dioxins/furans, will be performed by Analytical Resources Inc. (ARI) in Seattle, Washington, or by another suitable laboratory with prior written approval from Ecology. AXYS Analytical Services, Ltd. (AXYS) in Sidney, British Columbia, Canada will perform analysis of dioxins/furans. The laboratories will provide a Level II data packages for all analytes except dioxins/furans, which will be reported as a Level IV data package.

The Site will be screened for potential contaminants to the lowest method PQLs. PQLs identified in the QAPP (Appendix C) are compared to the limits of quantitation (LOQs) provided by ARI in Table 6. For each analyte, the lower of the PQL or LOQ is preferred. For analytes where the ARI LOQ is lower than the PQL, the LOQ will be used. For analytes where the PQL is lower than ARI's LOQ, the lab will be asked to report to the lower PQL.

The analytical methods indicated herein have the lowest technically reliable PQLs, minimizing the possibility that the PQLs will exceed future potential Site cleanup levels (see MTCA WAC 173-340).

Analytical methods for soil, sediment, and water samples are listed in Tables 1 through 5.

The laboratory will certify, pre-clean and prepare sample containers according to EPA protocols. The contract laboratory performing the chemical analyses will provide appropriate sample containers, both preserved and non-preserved. Table 5 provides summarizes all sample containers, preservatives, and holding times.

6.7.2 Field Quality Control Samples

It is essential to demonstrate that data used for decision-making purposes are of known and appropriate quality. Data of questionable quality may not be suitable for decision-making. Thus it is essential to define proper QC procedures and specify limits of acceptability before sample collection.

Data quality is assessed or monitored by performing routine QC checks or analyzing QC samples at various phases of the project. QC procedures are used to evaluate data quality as it relates to a specific set of data. QC activities provide methods for monitoring, verifying, or quantifying the consistency of data against established goals.

Data quality will be monitored in both the field and the laboratory using QC samples. QC samples will be collected in the field and submitted to the laboratory for analysis. Results for QC samples will be analyzed to ensure field procedures are not compromising data quality.

Field QA/QC samples will include field duplicates, equipment rinsate blanks, temperature blanks, matrix spike/matrix spike duplicates, field blanks, and trip blanks. Field QA/QC samples will be submitted to the analytical laboratory to assess the quality of the monitoring data. The QA/QC samples to be analyzed for each event are summarized in Table 4**.**

This section describes the various QC samples that will be collected and analyzed to ensure project data are of acceptable quality and can be used for decision-making purposes.

6.7.2.1 Field Duplicates

Field duplicate pairs consist of two samples of the same matrix (a primary and a duplicate) collected, to the extent possible, at the same time and location, using the same sampling techniques. The purpose of field duplicate samples is to evaluate the variability of the contaminant distribution in the sampled matrix. Field duplicate samples will be collected at a frequency of 10 percent, or one for every 10 primary samples.

Field blanks will be analyzed for the same parameters as the associated project samples (excluding water quality/general chemistry parameters).

Field duplicates will be submitted blind to the laboratory, with sample identifications (e.g., DUP102110) that are indistinguishable from primary samples. The duplicate samples will be collected consecutively for the same parameters and will be cross-referenced in the notes with the primary sample location and relative depth.

6.7.2.2 Equipment Rinsate Blanks

Equipment rinsate blanks are used to evaluate the effectiveness of the decontamination procedure and identify potential cross-contamination during sampling events. Equipment rinsate blank samples will be collected whenever any non-dedicated equipment is used.

Equipment rinsate blanks will be collected at a frequency of one for every 20 primary samples.

The rinsate blanks will be prepared by slowly pouring deionized (DI) water over decontaminated sampling equipment and into appropriate sample containers. The rinsate blanks will be analyzed for the same parameters as the associated project samples (excluding water quality/general chemistry parameters).

Sample identifiers for equipment rinsate blanks will be identified as "EB" and the date collected; for example, "EB060511 on 5 May 2011."

6.7.2.3 Temperature Blanks

Each cooler will be shipped with a temperature blank. A temperature blank is a sample container filled with tap water and stored in the cooler during sample collection and transportation. The laboratory will record the temperature of the temperature blank immediately upon receipt of the samples.

6.7.2.4 Matrix Spike and Matrix Spike Duplicates

The laboratory will analyze project-specific matrix spike/matrix spike duplicate (MS/MSD) samples at a rate of 5 percent, or one for every 20 samples. The MS/MSD assesses the accuracy and precision of the laboratory analytical methods. In order for the laboratory to prepare a project-specific MS/MSD, field personnel will collect extra sample volumes for the designated samples.

6.7.2.5 Field Blanks

Field blank samples will be collected at a rate of 5 percent, or one for every 20 samples collected for VOCs and/or TPH-G. The field blanks will be collected to check for potential contamination associated with ambient conditions at the Site. Field blanks will be collected by slowly pouring DI water directly into appropriate sample containers in the vicinity of one of the sampling locations.

Sample identifiers for field blanks will be the same as the primary sample collected at the location where the field blank was prepared, followed by an "F." For example, "MW2-2-070711-F" represents a field blank prepared at well MW2-2 on 7 July 2011.

6.7.2.6 Trip Blanks

One trip blank will be included in each sample cooler containing samples for VOC and/or TPH-G analysis. Trip blank samples will be collected to check for potential contamination associated with sample packaging and transport. The trip blanks will be prepared by the laboratory using reagent (contaminant-free) water.

Sample identifiers for trip blanks will include the designation "TB" followed by the date and the sequential trip blank number submitted on that date. For example, “TB070711-2” represents the second trip blank submitted on 7 July 2011.

6.7.3 Sample Documentation, Handling, and Custody

This section describes procedures for documentation and sample management in the field, including field documentation, sample documentation, and sample packaging and shipping procedures.

6.7.3.1 Sample Identification, Numbering, and Labeling

Sample labels will be filled out with indelible ink and affixed to each sample container. If non-waterproof labels are used, each sample label will be covered with clear tape to keep it dry. Sample containers will be placed in resealable plastic bags to protect the sample from moisture during transportation to the laboratory. Each sample container will be labeled with the following, at a minimum:

- Sample identification (ID)
- Sample collection date (month/day/year)
- Time of collection (24-hour clock)
- Project number
- Sampler’s initials
- Analysis to be performed
- Preservation (if any)
- Location (i.e., Glacier-Reichhold Site).

All samples submitted to the analytical laboratory will be uniquely numbered with the location and sample ID according to the following:

- The sample method will be identified by two or three letters: GP for direct push or similar, MW for monitoring well (groundwater), RB for riverbank, CB for catch basin, SED for sediment, and STW for stormwater.

- Sediment samples will further be identified as surface sediment (SED-SS) or subsurface sediment (SED-SC).
- Solids samples will include the location ID and the sampling interval in feet. For example, the sample ID for a soil sample collected from 8 to 10 feet deep from location GP-30 would be GP-30-8-10.
- Stormwater and groundwater samples will include the location ID and will be appended with a date to distinguish each sampling event. For example, a sample ID for a groundwater sample collected from MW-1S on 25 April 2011 would be MW-01S-042511.

6.7.3.2 Field Documentation

Data collection activities performed at the Site will be documented in field notebooks and/or on COC records using waterproof, indelible ink. The pages of the field notebooks will be sequentially numbered, the field notebooks will be bound, have a water-resistant cover, and be assigned to individual field personnel for the duration of field activities. Entries will be as detailed and as descriptive as possible so that a particular situation can be recalled without relying solely on the sampler's memory. Field log entries will be dated and signed. Information entered in the field notebook will include, at a minimum, the following items:

- Project name and number
- Dates and times of entries
- Weather conditions
- Names of personnel performing the activities
- A description of sample locations, including sample name and type
- Depths of samples if relevant
- Sample descriptions (including odor and staining)
- Sample collection methods
- Preservatives (if appropriate)
- Parameters for analysis
- Field instrument calibration information
- Field instrument readings
- Health and safety information.

Field notebooks will be stored in the project file when not in use. In addition, digital photographs will be taken to document field activities. The digital photographs will be included in the final report.

At the beginning of each daily entry, the date, start time, weather, names of all sampling team members present, and the signature of the person making the entry will be entered. The names of visitors to the Site, field sampling or investigation team personnel, and the purpose of their visit will also be recorded in the field logbook.

Measurements made and samples collected will be recorded. Whenever a sample is collected, a detailed description of the sample collection location will be recorded. The ID number of any photographs taken at the Site will also be noted.

Equipment used to collect samples will be noted, along with the time of the sampling, sample description, depth at which the sample was collected, volume, and number of containers. Decontamination procedures will also be recorded. Field QC samples collected will also be recorded, documenting the location and time of the sample collection.

6.7.3.3 Chain-of-Custody Procedures

A COC record will be completed for every sample. In addition to providing a custody exchange record for the samples, the COC record serves as a formal request for sample analyses. After completion of the COC, the sample coordinator will retain one copy for project files, and the original will be sent to the analytical laboratory with the sample shipment.

The COC record will be the controlling document to ensure that sample custody is maintained. Upon collecting a sample, sampling personnel will initiate the COC record in the field. Each individual who has the sample(s) in his/her possession will sign the COC. Whenever sample custody is transferred, the former custodian will sign the COC on the "Relinquished by" line, and the new custodian will sign the COC on the "Received by" line. The date, time, and the name of their project or company affiliation will accompany each signature.

After the laboratory receives the samples, the sample custodian will inventory each shipment before signing for it and note on the original COC record any discrepancy in the number of samples, temperature of the cooler, or broken samples. The Project Manager will be notified immediately of any problems identified with shipped samples and will determine the appropriate course of action.

The waybill number or courier name will be recorded on the COC when a commercial carrier is used. The shipping container will be secured with a custody seal, thereby allowing custody to be maintained by the shipping personnel until receipt by the laboratory.

The laboratory will initiate an internal COC that will track the sample within the various areas of the laboratory and subcontracted laboratories. The relinquishing signature of the sample custodian and the custody acceptance signature of the laboratory personnel transfer custody of the sample. This procedure is followed whenever a sample changes hands.

6.7.3.4 Sample Preservation, Packaging, and Shipment

After collection, samples will be immediately labeled and stored in a chilled cooler with ice or a frozen ice pack to maintain a temperature of 4°C. Table 5 lists appropriate sample containers, preservation techniques, and holding times for samples collected during the investigation.

Samples shipped to the analytical laboratory by land delivery services will comply with DOT regulations. International Air Transportation Association regulations will be adhered to when shipping samples by air courier services. Transportation methods will be selected to ensure that the samples arrive at the laboratory in time to permit testing according to established holding times and project schedules. The receiving laboratory will not accept samples without a properly prepared COC record and properly labeled and sealed shipping container(s).

Packaging of sample containers will be based on the level of protection a sample requires during handling, shipping, and storage. Protection may vary according to sample type, sample media, suspected amount of hazardous substances, required testing, and handling and storage conditions. Proper packaging will include:

- Inner packing: plastic bags, absorbent packing material, and ice for preservation.
- Over packing: Metal or plastic coolers.
- Over pack sealing: Strapping tape and custody seals.
- Marking and labeling of over pack: Laboratory address, any appropriate DOT Hazard Class Labels, and handling instructions.

Sample labels will be affixed to each sample container before sample collection. If non-waterproof labels are used, each sample label will be covered with clear tape to keep the label dry. All sample bottles will be placed in a resealable plastic bag to keep the container dry. All glass sample containers will be protected with bubble wrap or other protective packaging material. A temperature blank will be placed with the samples in every cooler.

The COC will be filled out and a copy of the COC form will be retained for documentation. Samples will be packed in a sample cooler with ice in sufficient quantity to keep the samples cooled to $4\ {}^{\pm}2$ ºC for the duration of the shipment to the laboratory. Saturday deliveries will be coordinated with the laboratory.

If samples are picked up by a laboratory courier service, the COC form will be completed and signed by the laboratory courier. The cooler will then be released to the courier for transportation to the laboratory.

If a commercial carrier is used, the COC form will include the shipping carrier in the "transfers accepted by" column and will be sealed in a resealable bag. The COC form will then be taped to the inside of the sample cooler lid. Cooler drain spouts will be taped from the inside and outside of the cooler to prevent leakage. The cooler will be taped shut with strapping tape, and a custody seal will be taped across the cooler lid. Clear tape will be applied to the custody seals to prevent accidental breakage during shipping. The samples will then be shipped to the analytical laboratory. A copy of the courier air bill will be retained for documentation.

6.7.3.5 Sample Archiving

The laboratory will archive the samples and maintain their custody as required by the contract or until further notification from the Project Chemist, at which time the samples will either be returned to the project for disposal or disposed of by the laboratory. All soil samples will be archived by freezing to allow possible future analyses of organic and inorganic compounds for up to 12 months after collection.

6.8 QA/QC Requirements

This section summarizes QA/QC requirements. Laboratory QA/QC standards are described in greater detail in the QAPP (Appendix C). Table 4 summarizes QA/QC samples to be collected with each matrix.

6.8.1 QA and QC

Field QC samples are described in this SAP, and laboratory QC samples are described in the QAPP (Appendix C).

6.8.2 Data Validation Review

The Project Chemist will conduct a Level II data review of the analytical data. The data review will be in accordance with the EPA Contract Laboratory Program National Functional Guidelines for Data Review and the QC criteria specified in this document. Data will be reviewed and flagged with the appropriate data qualifiers.

Based on data validation/review, the Project Chemist will determine whether the QA criteria have been met and will establish and document data usability.

6.8.3 Record Keeping

The project file will include copies of the RI/FS Work Plan, SAP, and QAPP, which document the proposed collection and sample analyses approaches. Additionally, records that document any departures from the SAP and QAPP (such as Site logbooks) will be maintained in the project file. The results of all analyses, including laboratory reports and summary tables or interpretive reports, will also be retained.

The contract laboratory will submit analytical data in both hard-copy format and as EDDs. The EDD will be in a format recognized by Ecology’s EIM. Records on physical, chemical, and biological analyses and measurements are retained in the EIM. Supplementary information about the data (metadata) is also stored, including information about environmental studies, monitoring locations, and data quality. EDDs of validated data will be submitted to Ecology.

6.8.4 Project Schedule

The RI/FS field activities will be initiated upon submittal of the Final RI/FS Work Plan and completed within 1 year after initiation. A detailed summary of the project schedule is presented in the RI/FS Work Plan (Section 2.3).

Ecology will be notified 14 days in advance of sampling. During active sampling at the Site, Ecology will be notified at least 1 business day in advance when sampling is cancelled or moved to a different day for changes due to weather or other circumstances. The method of notification will be via phone call, email, or other written notification.

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Tables

TABLE 1

REMEDIAL INVESTIGATION WORK PLAN
SOIL AND CATCH BASIN SOLIDS SAMPLING AREAS AND FREQUENCIES

Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW, Seattle, Washington

Location ID	Minimum Approximate Boring Depth (feet bgs or as noted) [2]	Soil Sampling Intervals and Sampling Frequency [1]										Area of Interest										
		Shallow Fill	Dredge Fill	Contact between Dredge Fill and Aquitard (included bottom of dredge fill and upper few inches of aquitard)	Silt Aquitard	Bottom of Aquitard (within lower foot)	Top of Sand Below Aquitard (within 2 feet of bottom of aquitard)	Sand below Aquitard to Bottom of Boring (collect samples at 3-foot intervals for analysis and/or to be archived as noted)	River Bank upper 1 foot	River Bank below Fill Layer (collect samples at 1-foot intervals beginning at base of fill layer)	Composite of Accumulated Sediment Thickness (representative of entire sediment sequence)	Former Army Operations (Incl northern prop boundary)	Former Above/ Underground Storage Tanks	Former Washwater Impoundment Area	Former Reichhold Production Area	General Southern Area and Southern Property Boundary including Former Kaiser Bentonite Area and Former Mineralized Cell	Former Ditches/Outfalls/ Waste Treatment Tank	Former Electrical Transformers	Western Portion	Adjacent Site COIs	River Bank	Stormwater Sediment (CB/Pipe/Ditch/Tank)
		1 Sample Minimum[3] Remainder Archived[4]	1 Sample Minimum[3] Remainder Archived[4]	1 Sample	2 Samples Minimum Archived[5]	1 Sample	1 Sample	2 Samples Minimum Remainder Archived[6]	1 Sample Minimum Remainder Archived[7]	1 Sample Minimum Remainder Archived[8]	1 Sample											
Soil Borings[2,9]																						
GP-26	16 - 24	X	X	X	X		X					X										
GP-27	16 - 24	X	X	X	X		X					X	X									
GP-28	16 - 24	X	X	X	X		X					X	X									
GP-29	16 - 24	X	X	X	X	X	X					X			X							
GP-30	16 - 24	X	X	X	X	X	X					X			X		X					
GP-31	16 - 24	X	X	X	X		X					X										
GP-32	16 - 24	X	X	X	X		X					X						X				
GP-33	16 - 24	X	X	X	X		X					X										
GP-34	16 - 24	X	X	X	X		X					X										
GP-35	16 - 24	X	X	X	X		X					X	X		X							
GP-36	16 - 24	X	X	X	X		X					X	X		X							
GP-37	16 - 24	X	X	X	X		X											X	X			
GP-38	16 - 24	X	X	X	X		X											X				
GP-39	16 - 24	X	X	X	X		X											X				
GP-40	16 - 24	X	X	X	X		X												X			
GP-41	16 - 24	X	X	X	X		X												X			
GP-42	16 - 24	X	X	X	X		X										X		X			
GP-43	30+	X	X	X	X	X	X	X								X	X			X		
GP-44	16 - 24	X	X	X	X		X							X								
GP-45	16 - 24	X	X	X	X		X							X			X					
GP-46	16 - 24	X	X	X	X		X							X								
GP-47	30+	X	X	X	X	X	X	X								X	X			X		
GP-48	16 - 24	X	X	X	X		X					X	X		X		X					
GP-49	16 - 24	X	X	X	X		X						X		X							
GP-50	16 - 24	X	X	X	X		X						X		X							
GP-51	16 - 24	X	X	X	X		X									X	X					
GP-52	16 - 24	X	X	X	X		X					X										
GP-53	16 - 24	X	X	X	X		X					X										
GP-54	16 - 24	X	X	X	X		X					X										
GP-55	16 - 24	X	X	X	X		X								X							
GP-56	30+	X	X	X	X		X	X				X	X									
GP-57	16 - 24	X	X	X	X		X									X	X			X		
GP-58	30+	X	X	X	X		X	X				X			X		X					
GP-59	30+	X	X	X	X		X	X								X				X		
GP-60	16 - 24	X	X	X	X		X					X			X							
GP-61	16 - 24	X	X	X	X		X					X										
GP-62	16 - 24	X	X	X	X		X					X			X		X					
GP-63	8	X	X	X	X							X										
GP-64	8	X	X	X	X							X										
GP-65	8	X	X	X	X							X										
GP-66	16 - 24	X	X	X	X		X					X										
GP-67	30+	X	X	X	X	X	X	X												X		
GP-68	16 - 24	X	X	X	X		X									X	X			X		
GP-69	16 - 24	X	X	X	X		X									X	X			X		
GP-70	30+	X	X	X	X		X	X								X	X		X			
GP-71	30+	X	X	X	X	X	X	X							X	X						
GP-72	16 - 24	X	X	X	X		X					X			X							
GP-73	16 - 24	X	X	X	X		X					X			X							
GP-74	16 - 24	X	X	X	X		X					X			X							

TABLE 1

REMEDIAL INVESTIGATION WORK PLAN
SOIL AND CATCH BASIN SOLIDS SAMPLING AREAS AND FREQUENCIES

Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW, Seattle, Washington

Location ID	Minimum Approximate Boring Depth (feet bgs or as noted) $^{(2)}$	Soil Sampling Intervals and Sampling Frequency $^{(1)}$										Area of Interest										
		Shallow Fill	Dredge Fill	Contact between Dredge Fill and Aquitard (included bottom of dredge fill and upper few inches of aquitard)	Silt Aquitard	Bottom of Aquitard (within lower foot)	Top of Sand Below Aquitard (within 2 feet of bottom of aquitard)	Sand below Aquitard to Bottom of Boring (collect samples at 3-foot intervals for analysis and/or to be archived as noted)	River Bank upper 1 foot	River Bank below Fill Layer (collect samples at 1-foot intervals beginning at base of fill layer)	Composite of Accumulated Sediment Thickness (representative of entire sediment sequence)	Former Army Operations (incl northern prop boundary)	Former Above/ Underground Storage Tanks	Former Washwater Impoundment Area	Former Reichhold Production Area	General Southern Area and Southern Property Boundary including Former Kaiser Bentonite Area and Former Mineralized Cell	Former Ditches/Outfalls/ Waste Treatment Tank	Former Electrical Transformers	Western Portion	Adjacent Site COIs	River Bank	Stormwater Sediment (CB/Pipe/Ditch/Tank)
		1 Sample Minimum$^{(3)}$ Remainder Archived$^{(4)}$	1 Sample Minimum$^{(3)}$ Remainder Archived$^{(4)}$	1 Sample	2 Samples Minimum Archived$^{(5)}$	1 Sample	1 Sample	2 Samples Minimum Remainder Archived$^{(6)}$	1 Sample Minimum Remainder Archived$^{(7)}$	1 Sample Minimum Remainder Archived$^{(8)}$	1 Sample											
Monitoring Wells $^{(10)}$																						
MW-3DD	30-35	X	X	X	X	X	X	X								X				X		
MW-14DD	30-35	X	X	X	X		X	X								X				X		
MW-21D	25	X	X	X	X		X	X								X	X					
MW-36D	25	X	X	X	X		X	X											X			
MW-37S	12	X	X	X	X		X					X					X			X		
MW-38D	25	X	X	X	X		X	X				X			X							
MW-39D	25	X	X	X	X	X	X	X						X		X	X			X		
MW-40S	12	X	X	X	X		X						X		X							
MW-41S	12	See MW-41D for sampling intervals										X										
MW-41D	25	X	X	X	X		X	X				X										
MW-42S	12	See MW-42D for sampling intervals											X		X							
MW-42D	25	X	X	X	X		X	X					X		X							
MW-43S	12	See MW-43D for sampling intervals														X	X					
MW-43D	25	X	X	X	X		X	X								X	X					
MW-44S	12	X	X	X	X		X												X			
River Bank Area																						
RB-01	5' below ditch								X	X							X				X	
RB-02	5' below ditch								X	X							X				X	
RB-03	5' below ditch								X	X							X				X	
RB-04	5' below ditch								X	X							X				X	
RB-05	5' below ditch								X	X							X				X	
RB-06	5' below ditch								X	X							X				X	
RB-07	5' below ditch								X	X							X				X	
Catch Basin Solids																						
CB-01	sediment										X											X
CB-02	sediment										X											X
CB-03	sediment										X											X
SMP-01	sediment										X											X
SMP-02	sediment										X											X
SWD-01	sediment										X											X
SWD-02	sediment										X											X
SWP-01	sediment										X											X
Tank-01	sediment										X											X
Tank-02	sediment										X											X
Tank-03	sediment										X											X

Notes:

1) Minimum required samples to be submitted for laboratory analysis and/or archived. Additonal samples to be collected if potential PCOC impacts are indicated by field screening$^{(11)}$ results to fully characterize potential impacts.
2) Depths are approximate. Borings to be advanced to greater depth if potential PCOC impacts are indicated by field screening$^{(11)}$ results, and additional samples collected as described in Note #1.
3) Samples from fill units to be collected regardless of water table elevation (i.e. samples will be collected from saturated soil). Sample locations are based on lithology, not specific depths.
4) Archived samples from fill units to be submitted for laboratory analysis if PCOCs are detected at concentrations above method PQL at vertically adjacent samples.
5) Samples collected from silt aquitard to be archived and submitted for laboratory analysis if PCOCs are detected at concentrations above method PQL in vertically adjacent samples.
6) A minimum of two (2) samples from the sand unit below the aqitard to be selected for laboratory analysis based on field screening$^{(11)}$ results. Additonal samples to be submitted for laboratory analysis if if potential PCOC impacts are indicated by field screening results. Archived samples from sand unit to be submitted for laboratory analysis if PCOCs are detected at concentrations above method PQL in vertically adjacent samples.
7) A minimum of one (1) River Bank sample will be collected from the uppermost one foot for laboratory analysis. Subsequent samples to be collected at 1-foot intervals to the base of the fill layer and archived. Archived River Bank samples to be submitted for laboratory analysis if PCOCs are detected at concentrations above method PQL in vertically adjacent samples.
8) A minimum of one (1) River Bank sample will be collected from just below the fill layer and submitted for laboratory analysis. Subsequent samples to be collected a 1-foot intervals to at least 5 feet below the base of the fill layer. and archived. Archived River Bank samples to be submitted for laboratory analysis if PCOCs are detected at concentrations above method PQL in vertically adjacent samples.
9) 16-24 foot borings to be advanced into the upper portion of the sand layer beneath the aquitard. All borings to be advanced to greater depths where warranted based on field screening observations (see Note #1).
10) Well depths are approximate. Actual depths to be based on specific lithologic conditionas at well locations:
    - Shallow wells (~12 feet) to be installed with bottom of screen across the dredge fill and silt aquitard contact (5-10 foot screen interval).
    - Deep wells (~25 feet) to be installed with top of screen in the sand unit within two (2) feet of the bottom of the silt aquitard (5-foot screen interval).
    - Deeper wells (~30-35 feet) to be installed with bottom of screen at least 15 feet below the bottom of the silt aquitard (5-foot screen interval).
11) Field screening includes descriptions of soil sample texture, composition, color, consistency, moisture content, recovery, odor and presence of staining using the Unified Soil Classification system. Field screening to also includes organic vapor screening using a photo-ionization detector and water-sheen testing.

Nomenclature:

bgs = below ground surface
CB = Catch Basin
COPC = Constituent of Potential Concern
GP = Direct Push Boring
MW = Monitoring Well
NA = Not Applicable
PQL = Pracitcal Quantitation Limit
RB = River Bank
SMP = Sump
SWD = Stormwater Ditch
SWP = Stormwater Pipe
Tank = Stormwater holding tank

TABLE 2

REMEDIAL INVESTIGATION WORK PLAN
SOIL AND CATCH BASIN SOLIDS ANALYSIS MATRIX

Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW, Seattle, Washington

Location ID	COPC Analytes and Analtical Methods(1)												Field Screening(2)
	SVOCs	Priority Pollutant Metals	Ba	Hexavalent Chromium (Cr VI)	TPH	TBT (pore water)	PCB Aroclors	Dioxins/ Furans	VOCs	Total Organic Carbon	pH	Grain Size	
	USEPA 8270D SIM (Full List)	USEPA 6010B/6020/ 7470A(Hg)	USEPA 6010B/6020	USEPA 3060A/7196A	NWTPH-Dx, Gx/BTEX	Krone/ USEPA 8270D SIM	USEPA 8082A	AXYS Method	USEPA 8260C	USEPA 9080	USEPA 9045	PSEP or equivalent	
Soil Borings(3,4)													
GP-26	X	X		X							X		X
GP-27	X	X			X	X	X				X		X
GP-28	X	X	X		X	X	X				X		X
GP-29	X	X			X			X			X		X
GP-30	X	X						X			X		X
GP-31	X	X		X			X				X		X
GP-32	X	X		X			X				X		X
GP-33	X	X					X				X		X
GP-34	X	X					X	X			X		X
GP-35	X	X			X			X			X		X
GP-36	X	X	X		X			X	X		X		X
GP-37		X					X				X		X
GP-38		X					X				X		X
GP-39	X	X					X		X		X		X
GP-40	X	X									X		X
GP-41	X	X									X		X
GP-42	X	X									X		X
GP-43	X	X	X		X			X			X		X
GP-44	X	X			X			X			X		X
GP-45	X	X			X			X			X		X
GP-46	X	X			X			X			X		X
GP-47	X	X	X	X							X		X
GP-48	X	X									X		X
GP-49	X	X			X						X		X
GP-50	X	X			X		X				X		X
GP-51	X	X									X		X
GP-52	X	X		X	X	X	X				X		X
GP-53	X	X							X		X		X
GP-54	X	X			X	X	X				X		X
GP-55	X	X						X			X		X
GP-56	X	X		X	X	X	X	X			X		X
GP-57		X	X	X							X		X
GP-58	X	X					X		X		X		X
GP-59	X	X	X	X							X		X
GP-60	X	X		X		X			X		X		X
GP-61	X	X			X	X	X		X		X		X
GP-62	X	X					X		X		X		X
GP-63	X			X	X				X		X		X
GP-64	X				X	X			X		X		X
GP-65	X				X				X		X		X
GP-66	X	X		X		X					X		X
GP-67	X	X	X								X		X
GP-68	X	X	X	X					X		X		X
GP-69	X	X	X	X					X		X		X
GP-70	X	X	X								X		X
GP-71	X	X									X		X
GP-72	X	X		X		X			X		X		X
GP-73	X	X		X		X			X		X		X
GP-74	X	X	X	X		X			X		X		X

TABLE 2

REMEDIAL INVESTIGATION WORK PLAN
SOIL AND CATCH BASIN SOLIDS ANALYSIS MATRIX
Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW, Seattle, Washington

Location ID	COPC Analytes and Analtical Methods(1)												Field Screening(2)
	SVOCs	Priority Pollutant Metals	Ba	Hexavalent Chromium (Cr VI)	TPH	TBT (pore water)	PCB Aroclors	Dioxins/ Furans	VOCs	Total Organic Carbon	pH	Grain Size	
	USEPA 8270D SIM (Full List)	USEPA 6010B/6020/ 7470A(Hg)	USEPA 6010B/6020	USEPA 3060A/7196A	NWTPH-Dx, Gx/BTEX	Krone/ USEPA 8270D SIM	USEPA 8082A	AXYS Method	USEPA 8260C	USEPA 9080	USEPA 9045	PSEP or equivalent	
Monitoring Well Borings(3)													
MW-3DD	X	X	X	X				X	X		X		X
MW-14DD	X	X	X								X		X
MW-21D	X	X							X		X		X
MW-36D	X	X									X		X
MW-37S	X	X	X		X	X	X	X	X		X		X
MW-38D	X	X			X			X			X		X
MW-39D	X	X	X	X	X			X			X		X
MW-40S	X	X			X				X		X		X
MW-41S	**See MW-41D**												X
MW-41D	X	X		X			X		X		X		X
MW-42S	**See MW-42D**												X
MW-42D	X	X						X	X		X		X
MW-43S	**See MW-43D**												X
MW-43D	X	X			X			X	X		X		X
MW-44S	X	X			X				X		X		X
River Bank Area(3)													
RB-01	X	X				X	X	X		X	X	X	X
RB-02	X	X		X			X	X		X	X	X	X
RB-03	X	X		X			X	X		X	X	X	X
RB-04	X	X					X	X		X	X	X	X
RB-05	X	X					X	X		X	X	X	X
RB-06	X	X					X	X		X	X	X	X
RB-07	X	X					X	X		X	X	X	X
Catch Basin Solids(3)													
CB-01	X	X			X		X	X		X	X	X	X
CB-02	X	X			X		X	X		X	X	X	X
CB-03	X	X			X		X	X		X	X	X	X
SMP-01	X	X					X	X		X	X	X	X
SMP-02	X	X					X	X		X	X	X	X
SWD-01	X	X					X	X		X	X	X	X
SWD-02	X	X					X	X		X	X	X	X
SWP-01	X	X					X	X		X	X	X	X
Tank-01	X	X					X	X		X	X	X	X
Tank-02	X	X					X	X		X	X	X	X
Tank-03	X	X					X	X		X	X	X	X

Notes:

1) Refer to the text and Table 5 for full descriptions of analytical methods and sampling requirements, and to Table 6 for PQL values.
2) Field screening includes descriptions of soil sample texture, composition, color, consistency, moisture content, recovery, odor and presence of staining using the Unified Soil Classification system. Field screening to also includes organic vapor screening using a photo-ionization detector and water-sheen testing.
3) Refer to the text and Table 1 for a description of required sampling intervals and depths.
4) All samples collected at indciated location are to be analyzed for all indicated analytes unless otherwise noted.

Analytes Key:

SVOCs = Semi-Volatile Organic Compounds [phenols, phthalates, polycyclic aromatic hydrocarbons (PAHs)]
SIM = Select Ion Monitoring (low level)
TPH = Total Petroleum Hydrocarbons
NWTPH = Northwest Method TPH
BTEX = Benzene, toluene, ethylbenzene, and xylenes
PCB = Polychlorinated Biphenyls
AXYS Method = USEPA Method 1613B (i.e., AXYS MLA-017)
VOCs = Volative Organic Compounds
PQL = Practical Quantitation Limit
PSEP = Puget Sound Estuary Protocols

Priority Pollutant Metals:

Ag = Silver
As = Arsenic
Be = Beryllium
Cd = Cadmium
Cr = Cromium (total)
Cu = Copper
Hg = Mercury
Ni = Nickel
Pb = Lead
Sb = Antimony
Se = Selenium
Tl = Thallium
Zn = Zinc

Other Metals:

Ba = Barium
Al = Aluminum
TBT = Tributyl tin
Cr VI = Hexavalent chromium

TABLE 3

REMEDIAL INVESTIGATION WORK PLAN
GROUNDWATER AND STORMWATER SAMPLING MATRIX
Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW, Seattle, Washington

Well / Sample Location ID	Approximate Well Screen Interval (exisiting wells) or Anitipcated Well Screen Interval (new wells) (feet bgs)(2)	New Wells(2)	COPC Analytes and Analytical Methods (1)										Water Quality Parameters/General Chemistry Analytes and Analytical Methods (1)								Field Parameter Measurement(4)
			SVOCs	Priority Pollutant Metals(3)	Ba(3)	Cr VI(3)	TPH	Ammonia	TBT	PCB Aroclors	Dioxins/ Furans	VOCs	Salinity	Metals (Ca, K, Mg, Na, Al(3), Fe(3), Mn(3))	Anions Cl, SO_4, NO_3, PO_4	TOC	TSS	Hardness	pH	Alkalinity	
			USEPA 8270D SIM (full list)	USEPA 6010B/6020/ 7470A(Hg)	USEPA 6020	USEPA 7196A	NWTPH-Dx, Gx/BTEX	USEPA 350.1	Krone/ USEPA 8270D SIM	USEPA 8082A	AXYS Method	USEPA 8260	SM 2520	USEPA 6010	EPA 300.0/SM 4500	USEPA 9060	SM 2450 D	SM 2340D	USEPA 9045	SM 2320B	
Monitoring Wells (5)																					
MW-1S	4.5 - 9.5		X	X	X	X	X			X		X	X						X		X
MW-1D	17.5 - 22.5		X	X						X			X						X		X
MW-2S	5 - 10		X	X									X						X		X
MW-2D	18 - 23		X	X							X		X						X		X
MW-3S	6 - 11		X	X								X	X						X		X
MW-3D	20 - 25		X	X	X						X	X	X	X	X	X	X	X	X	X	X
MW-3DD	30 - 35	X	X	X	X							X	X						X		X
MW-4S	5 - 10		X	X	X		X					X	X						X		X
MW-5S	5 - 10		X	X			X						X						X		X
MW-6S	5 - 10		X	X			X			X	X		X						X		X
MW-7S	5 - 10		X	X	X		X				X	X	X				X		X		X
MW-10	3 - 10		X	X			X				X	X	X				X		X		X
MW-11	3 - 10		X	X									X						X		X
MW-12	4.5 - 11.5		X	X									X						X		X
MW-13	4.5 - 11.5		X	X			X				X	X	X				X		X		X
MW-14	4 - 11		X	X	X							X	X						X		X
MW-14D	18 - 23		X	X	X							X	X						X		X
MW-14DD	30 - 35	X	X	X	X							X	X	X	X	X	X	X	X	X	X
MW-16	3 - 10		X	X			X			X	X	X	X						X		X
MW-17	4.5 - 11.5		X	X								X	X						X		X
MW-18	3 - 13		X	X									X						X		X
MW-19	3 - 13		X	X									X						X		X
MW-20	3 - 13		X	X									X						X		X
MW-21	3 - 13		X	X								X	X						X		X
MW-21D	18 - 23	X	X	X								X	X	X	X	X	X	X	X	X	X
MW-22	5 - 15		X	X									X						X		X
MW-23	5 - 15		X	X									X						X		X
MW-23D	25 - 30		X	X								X	X						X		X
MW-24	5 - 15		X	X									X						X		X
MW-26	5 - 15		X	X									X						X		X
MW-27	5 - 15		X	X									X						X		X
MW-28S	5 - 12		X	X			X	X	X			X	X						X		X
MW-29S	5 - 12		X	X			X	X	X			X	X						X		X
MW-30S	5 - 12		X	X		X	X	X	X			X	X						X		X
MW-31S	5 - 12		X	X		X	X	X	X	X		X	X						X		X
MW-32S	5 - 12		X	X								X	X						X		X
MW-32D	18 - 23		X	X								X	X						X		X
MW-33S	5 - 12		X	X							X	X	X						X		X
MW-34S	5 - 12		X	X		X	X	X		X		X	X						X		X
MW-35S	5 - 12		X	X		X	X	X	X	X		X	X						X		X
MW-36S	5 - 12			X			X					X	X						X		X
MW-36D	18 - 23	X		X			X					X	X	X	X	X	X	X	X	X	X
MW-37S	5 - 12	X	X	X	X	X			X	X		X	X	X	X	X	X	X	X	X	X
MW-38D	18 - 23	X	X	X	X	X	X			X		X	X	X	X	X	X	X	X	X	X
MW-39D	18 - 23	X	X	X	X		X				X	X	X	X	X	X	X	X	X	X	X
MW-40S	5 - 12	X	X	X			X					X	X	X	X	X	X	X	X	X	X
MW-41S	5 - 12	X	X	X		X	X					X	X	X	X	X	X	X	X	X	X
MW-41D	18 - 23	X	X	X		X	X					X	X	X	X	X	X	X	X	X	X
MW-42S	5 - 12	X	X	X			X					X	X	X	X	X	X	X	X	X	X
MW-42D	18 - 23	X	X	X			X					X	X	X	X	X	X	X	X	X	X
MW-43S	5 - 12	X	X	X	X		X					X	X	X	X	X	X	X	X	X	X
MW-43D	18 - 23	X	X	X	X		X					X	X	X	X	X	X	X	X	X	X
MW-44S	5 - 12	X	X	X			X					X	X	X	X	X	X	X	X	X	X

TABLE 3

REMEDIAL INVESTIGATION WORK PLAN
GROUNDWATER AND STORMWATER SAMPLING MATRIX
Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW, Seattle, Washington

Well / Sample Location ID	Approximate Well Screen Interval (exisiting wells) or Anitipcated Well Screen Interval (new wells) (feet bgs) (2)	New Wells (2)	COPC Analytes and Analytical Methods (1)										Water Quality Parameters/General Chemistry Analytes and Analytical Methods (1)								Field Parameter Measurement (4)
			SVOCs	Priority Pollutant Metals (3)	Ba (3)	Cr VI (3)	TPH	Ammonia	TBT	PCB Aroclors	Dioxins/ Furans	VOCs	Salinity	Metals (Ca, K, Mg, Na, Al (3), Fe (3), Mn (3))	Anions Cl, SO$_4$, NO$_3$, PO$_4$	TOC	TSS	Hardness	pH	Alkalinity	
			USEPA 8270D SIM (full list)	USEPA 6010B/6020/ 7470A(Hg)	USEPA 6020	USEPA 7196A	NWTPH-Dx, Gx/BTEX	USEPA 350.1	Krone/ USEPA 8270D SIM	USEPA 8082A	AXYS Method	USEPA 8260	SM 2520	USEPA 6010	EPA 300.0/SM 4500	USEPA 9060	SM 2450 D	SM 2340D	USEPA 9045	SM 2320B	
Stormwater Discharge (6)																					
STW-01	Stormwater Outfall		X	X			X			X	X	X							X		X

Notes:

1) Refer to the text and Table 5 for full descriptions of analytical methods and sampling requirements, and to Table 6 for PQL values.
2) Well depths are approximate. Actual depths to be based on specific lithologic conditionas at well locations:
    -Shallow wells (~12 feet) to be installed with bottom of screen across the dredge fill and silt aquitard contact (5 -10 foot screen interval).
    -Deep wells (~23 feet) to be installed with top of screen in the sand unit within two (2) feet of the bottom of the silt aquitard (5-foot screen interval).
    -Deeper wells (~35 feet) to be installed with bottom of screen at least 15 feet below the bottom of the silt aquitard (5-foot screen interval).
3) Collect and analyze total (unfiltered) and dissolved (filtered) metals samples.
4) Field parameter measurements to include: dissolved oxygen, temperature, pH, oxidation reduction potential, specific conductivity, and turbidity.
5) Groundwater samples to be collected for four (4) quarters from all monitoirng wells following installation of new monitoring wells.
6) Stormwater samples to be collected for seven (7) sampling events to be conducted during periods of measurable precipitaion (refer to text).

Sample Nomenclature:

bgs = below ground surface
COPC = Constituent of Potential Concern
GP = Direct Push Boring
MW = Monitoring Well
NA = Not Applicable
STW = Stormwater Outfall
LDW = Lower Duwamish Waterway
SM = Standard Method
S = Designation following well identification number indicates shallow monitoring well.
D = Designation following well identification number indicates deep monitoring well (screened below aquitard).
DD = Designation following well identification number indicates deeper monitoring well (screened in lower sand unit).

Analytes Key:

SVOCs = Semi-Volatile Organic Compounds [phenols, phthalates, polycyclic aromatic hydrocarbons (PAHs)]
SIM = Select Ion Monitoring (low level)
TPH = Total Petroleum Hydrocarbons
NWTPH = Northwest Method TPH
BTEX = Benzene, toluene, ethylbenzne, and xylenes
PCB = Polychlorinated Biphenyls
AXYS Method = USEPA Method 1613B (i.e., AXYS MLA-017)
VOCs = Volative Organic Compounds
PQL = Practical Quantitation Limit
PSEP = Puget Sound Estuary Protocols
TOC = Total Oragnic Carbon
TSS = Total Suspended Solids

Priority Pollutant Metals:

Ag = Silver
As = Arsenic
Be = Beryllium
Cd = Cadmium
Cr = Cromium (total)
Cu = Copper
Hg = Mercury
Ni = Nickel
Pb = Lead
Sb = Antimony
Se = Selenium
Tl = Thallium
Zn = Zinc

Other Metals:

Al = Aluminum
Ba = Barium
Ca = Calcium
Cr VI = Hexavalent chromium
Fe = Iron
K = Potassium
Mg = Magnesium
Mn = Manganese
Na = Sodium
TBT = Tributyl tin

TABLE 4

REMEDIAL INVESTIGATION WORK PLAN
SUMMARY OF ESTIMATED QA/QC SAMPLES(1)
Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW, Seattle, Washington

Analyte	**SVOCs**	**Priority Pollutant Metals**	**Ba**	**Hexavalent Chromium (Cr VI)**	**TPH**	**Ammonia**	**TBT**	**PCB Aroclors**	**Dioxins/ Furans**	**VOCs**	**TOC**	**Grain Size**	**Anions** **Cl, SO_4, NO_3, PO_4**	**Metals (Ca, K, Mg, Na, Al$^{(6)}$, Fe$^{(6)}$, Mn$^{(6)}$)**	**Salinity**	**TSS**	**Hardness**	**Alkalinity**
Analytical Method	**USEPA 8270D SIM (full list)**	**USEPA 6010B/6020/ 7470A(Hg)**	**USEPA 6010B/6020**	**USEPA 3060A/7196A**	**NWTPH-Dx, Gx/BTEX**	**USEPA 350.1**	**Krone/ USEPA 8270D SIM**	**USEPA 8082A**	**AXYS Method**	**USEPA 8260**	**USEPA 9060**	**PSEP or equivalent**	**EPA 300.0/ SM 4500**	**USEPA 6010**	**SM 2520**	**SM 2450D**	**SM 2340D**	**SM 2320B**
Soil and Solids Samples$^{(2)}$																		
Direct Push Soil Samples																		
Standard Samples$^{(2)}$	203	206	57	70	74		53	68	49	59								
Duplicate Samples	21	21	6	7	8		6	7	5	6								
MS/MSD	11	11	3	4	4		3	4	3	3								
Field Blank	0	0	0	0	4		0	0	0	3								
Rinsate Blank	11	11	3	4	4		3	4	3	3								
Monitoring Well Soil Samples																		
Standard Samples$^{(2)}$	68	68	18	20	31		4	10	36	43								
Duplicate Samples	7	7	2	2	4		1	1	4	5								
MS/MSD	4	4	1	1	2		1	1	2	3								
Field Blank	0	0	0	0	2		0	0	0	3								
Rinsate Blank	4	4	1	1	2		1	1	2	3								
Catch Basin Solids Samples																		
Standard Samples$^{(2)}$	11	11			3			11	11		11	11						
Duplicate Samples	2	2			1			2	2		2	2						
MS/MSD	1	1			1			1	1		1	1						
Field Blank	0	0			1			0	0		0	0						
Rinsate Blank	1	1			1			1	1		1	1						
River Bank Soil Samples																		
Standard Samples$^{(2)}$	14	14		2			1	14	14		14	14						
Duplicate Samples	2	2		1			1	2	2		2	2						
MS/MSD	1	1		1			1	1	1		1	1						
Field Blank	0	0		0			0	0	0		0	0						
Rinsate Blank	1	1		1			1	1	1		1	1						
Water Samples																		
Monitoring Well Samples (per event) $^{(3)}$																		
Standard Samples	51	53 / 53$^{(4)}$	13 / 13$^{(4)}$	9 / 9$^{(4)}$	26	6	6	9	9	38	15		15	15 / 15$^{(6)}$	53	18	15	15
Duplicate Samples	6	6 / 6$^{(4)}$	2 / 2$^{(4)}$	1 / 1$^{(4)}$	3	1	1	1	1	4	0		0	0	0	0	0	0
MS/MSD	3	3 / 3$^{(4)}$	1 / 1$^{(4)}$	1 / 1$^{(4)}$	2	1	1	1	1	2	0		0	0	0	0	0	0
Field Blank	0	0	0	0	2	0	0	0	0	2	0		0	0	0	0	0	0
Rinsate Blank	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0
Storm Water Samples (per event) $^{(5)}$																		
Standard Samples	1	1			1			1	1	1								
Duplicate Samples	1	1			1			1	1	1								
MS/MSD	1	1			1			1	1	1								
Field Blank	0	0			1			0	0	1								
Rinsate Blank	1	1			1			1	1	1								

Notes:

1) Actual number of QA/QC samples may vary and will be based on the number of standard samples collected and the QA/QC sampling frequencies shown in Table 4A.
2) Sample quantities shown are based on the the minimun number of standard samples expected. QA/QC sampling will be based on the the actual number of standard samples (refer to Note 1).
3) Samples shown are per sampling event. Four quarterly sample events are anticipated.
4) Analyses are for both total and dissolved (filtered) metals samples (i.e. #total / #dissolved).
5) Samples shown are per sampling event. Seven surface water sampling events are anticipated.
6) Analyses are for total (all metals) and dissolved (Al, Fe, and Mn only) metals samples (i.e. #total / # dissolved).

Nomenclature:

MS/MSD = Matrix Spike/Matrix Spike Duplicate
Cl = Chloride
PCB = Polychlorinated biphenyls
PSEP = Puget Sound Estuary Protocols
SM = Standard Method
SVOC = Semi-volatile organic compounds
TBT = Tributyltin
TOC = Total Organic Carbon
TPH-DX = Diesel rang
TPH-GX = Gasoline range hydrocarbons
TSS = Total Suspended Solids
USEPA = United States Environmental Protection Agency
VOC = Volatile organic compounds

TABLE 4A. SUMARY OF QA/QC SAMPLE COLLECTION FREQUENCY

QA/QC Sample Type	**QA/QC Sample Collection Frequency**
Field Duplicates	1 per 10 standard samples with a minimum of 1 per sampling event.
MS/MSD	1 per 20 standard samples with a minimum of 1 per sampling event
Field Blanks	1 per 20 standard volatile samples with a minimum of 1 per sampling event
Rinsate Blanks	1 per 20 standard samples with a minimum of 1 per sampling event.
Trip Blanks	1 per cooler containing volatile samples.
Temperature Blanks	1 per cooler

TABLE 5

REMEDIAL INVESTIGATION WORK PLAN
SUMMARY OF SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES(1)
Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW, Seattle, Washington

Analyte	Method	Soil/Sediment			Groundwater/Stormwater		
		Container	Preservative	Holding Time	Container	Preservative	Holding Time
Total/Dissolved Metals	USEPA 6010/6020/7000 and 200 Series	4oz.WMG	Cool≤6°C	6 Months	500mL HDPE	HNO_3, Cool≤6°C	6 Months
Total/Dissolved Mercury	USEPA 7470A/7471A	4oz.WMG	Cool≤6°C	28 Days	500mL HDPE	HNO_3, Cool≤6°C	28 Days
Hexavalent Chromium	USEPA 7196A	4oz.WMG	Cool≤6°C	28 Days	500mL HDPE	Filter, NaOH, Cool≤6°C	24 hours/ 28 Days(2)
Chloride	SM 4500				500mL HDPE	Cool≤6°C	28 Days
Sulfate	USEPA 375.2 / SM 4500				500mL HDPE	Cool≤6°C	28 Days
Nitrate	USEPA 353.2 / SM 4500				500mL HDPE	Cool≤6°C	48 hours
Phosphate	SM 4500				500mL HDPE	Cool≤6°C	48 hours
SVOCs/Phenols/PAHs	USEPA 8270D-SIM	8oz.WMG	Cool≤6°C	14 Days	2-500mL AG	Cool≤6°C	7 Days
Tributyltin - bulk sample	Krone/8270D-SIM	8oz.WMG	Cool≤6°C	14 Days	2-500mL AG	Cool≤6°C	7 Days
Tributyltin - pore water	Krone/8270D-SIM	8oz.WMG	Cool≤6°C	14 Days	2-500mL AG	Cool≤6°C	7 Days
Gas Range TPH / BTEX	NWTPH-Gx	2-40ml vial/ 1-2oz.WMGS	Cool≤6°C, 2xMethanol	14 Days	2-40mL AGV	HCl, Cool≤6°C	2 Days/ 14 Days(3)
Diesel Range TPH	NWTPH-Dx	8oz.WMG	Cool≤6°C	14 Days	2-500mL AG	Cool≤6°C	7 Days
Dioxins/Furans	AXYS Method	250mL AWMG	Frozen	1 year	1 Liter AG	Cool≤4°C[1]	14 Days
PCB Aroclors	USEPA 8082B	8oz.WMG	Cool≤6°C	14 Days	2-500mL AG	Cool≤6°C	7 Days
Total Organic Carbon	USEPA 9060 / Plumb 1981	4oz.WMG	Cool≤4°C	14 Days	250mL AG	NH_2SO_4, Cool≤6°C	28 Days
Grain Size	PSEP or equivalent	16oz. WMG	None	6 Months			
Total Suspended Solids	SM 2450D				1000ml HDPE	Cool≤6°C	7 Days
Hardness	SM 2340B				500mL HDPE	HNO_3, Cool≤6°C	6 Months
Alkalinity	SM 2320B				500mL HDPE	Cool≤6°C	14 Days
Salinity	SM 2520				500mL HDPE	Cool≤6°C	28 Days
Ammonia	USEPA 350.1	4oz.WMG	Cool≤6°C	7 Days	500mL HDPE	NH_2SO_4, Cool≤6°C	48 Hours/ 28 Days(4)
VOCs	USEPA 8260C	4-40mL vial/ 1-2oz WMGS	Cool≤6°C, 2xSodium Bisulfate, 2xMethanol	14 Days	3-40mLvial	HCl, Cool≤6°C	2 Days/ 14 Days(3)

Notes:

1) All sampling requirements and holding times to be verified by consultant/contractor prior to any sample collection activities.
2) Holding time is 24 hours if unpreserved, 28 days otherwise.
3) Holding time is 2 days if unpreserved, 14 days otherwise.
4) Holding time is 48 hours if unpreserved, 28 days otherwise.

Abbreviations:

°C = Degrees Celsius
AG = Amber Glass Boston Round Bottle
AGV = Amber Glass Vial
AWMG = Amber Wide Mouth Glass Jar
AXYS Method = USEPA Method 1613B (i.e., AXYS MLA-017)
BTEX = Benzene, Toluene, Ethylbenzene, Xylenes
Cl = Chloride
H_3PO_4 = Phosphoric acid
H_2SO_4 = Sulfuric acid
HCl = Hydrochloric acid
HDPE = High Density Polypropylene
HNO_3 = Nitric acid
mL = Milliliters
NaOH = Sodium Hydroxide
oz = Ounce
PCB = Polychlorinated Biphenyls
PO_4 = Phosphate
SM = Standard Method
SO_4 = Sulfate
TPH = Total Petroleum Hydrocarbons
USEPA = United States Environmental Protection Agency Method
VOCs = Volatile Organic Compounds
SIM = Select Ion Monitoring
SVOCs = Semi-Volatile Organic Compounds
WMG = Wide Mouth Glass Jar
WMGS = Wide Mouth Glass Jar with Septa

Grayed cells indicate that analyte will not be sampled for that matrix.

TABLE 6

REMEDIAL INVESTIGATION WORK PLAN
SUMMARY OF QAPP PQL AND ARI LOQ VALUES(1,2)
Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW, Seattle, Washington

Analyte	Upland Soil		Storm Water Solids/Sediment		Surface/Ground Water	
	QAPP PQL μg/kg	ARI LOQ μg/kg	QAPP PQL μg/kg	ARI LOQ μg/kg	QAPP PQL μg/L	ARI LOQ μg/L
Metals						
Total Aluminum	--	20000	--	20000	50	20
Total Calcium	--	50000	--	50000	50	50
Total Magnesium	--	20000	--	20000	50	20
Total Potassium	--	20000	--	20000	500	20
Total Sodium	--	100000	--	100000	500	100
Total/Dissolved Antimony	200	200	--	200	50	0.2
Total/Dissolved Arsenic	200	200	200	200	0.2	0.2
Total/Dissolved Beryllium	100	200	--	200	0.2	0.2
Total/Dissolved Barium	300	500	--	500	0.5	0.5
Total/Dissolved Cadmium	100	100	100	100	0.2	0.1
Total/Dissolved Chromium (total)	500	500	500	500	0.5	0.5
Total/Dissolved Chromium (hexavalent)	100	100	--	100	10	10
Total/Dissolved Copper	200	500	200	500	2	0.5
Total/Dissolved Iron	--	20000	--	20000	50	20
Total/Dissolved Lead	100	100	100	100	1	0.1
Total/Dissolved Manganese	--	500	--	500	1.0	0.5
Total/Dissolved Mercury	25	25	25	25	0.1	
Total/Dissolved Nickel	1000	500	--	500	0.5	0.5
Total/Dissolved Selenium	--	500	--	500	0.5	0.5
Total/Dissolved Silver	300	200	300	200	3	0.2
Total/Dissolved Thallium	--	200	--	200	0.2	0.2
Total/Dissolved Zinc	1000	4000	1000	4000	10	4
Tributyltin						
Tributyltin - bulk sample	4	3.86	4	3.86	--	
Tributyltin - pore water	0.0075	--	0.0075	--	0.0075	0.0052
Volatile Organic Compounds						
1,1,1,2-Tetrachloroethane	1.0	1.0	--	1.0	0.2	0.2
1,1,1-Trichloroethane	1.0	1.0	--	1.0	0.2	0.2
1,1,2,2-Tetrachloroethane	1.0	1.0	--	1.0	0.2	0.2
1,1,2-Trichloro-1,2,2-Trifluoroethane	2.0	2.0	--	2.0	0.2	0.2
1,1,2-Trichloroethane	1.0	1.0	--	1.0	0.2	0.2
1,1-Dichloroethane	1.0	1.0	--	1.0	0.2	0.2
1,1-Dichloroethene	1.0	1.0	--	1.0	0.2	0.2
1,1-Dichloropropene	1.0	1.0	--	1.0	0.2	0.2
1,2,3-Trichlorobenzene	5.0	5.0	--	5.0	0.5	0.5
1,2,3-Trichloropropane	2.0	2.0	--	2.0	0.5	0.5
1,2,4-Trichlorobenzene	5.0	5.0	--	5.0	0.5	0.5
1,2,4-Trimethylbenzene	1.0	1.0	--	1.0	0.2	0.2
1,2-Dibromo-3-Chloropropane	5.0	5.0	--	5.0	0.5	0.5
1,2-Dibromoethane	1.0	1.0	--	1.0	0.2	0.2
1,2-Dichlorobenzene	1.0	1.0	--	1.0	0.2	0.2
1,2-Dichloroethane	1.0	1.0	--	1.0	0.2	0.2
1,2-Dichloropropane	1.0	1.0	--	1.0	0.2	0.2
1,3,5-Trimethylbenzene	1.0	1.0	--	1.0	0.2	0.2
1,3-Dichlorobenzene	1.0	1.0	--	1.0	0.2	0.2
1,3-Dichloropropane	1.0	1.0	--	1.0	0.2	0.2
1,4-Dichlorobenzene	1.0	1.0	--	1.0	0.2	0.2
2,2-Dichloropropane	1.0	1.0	--	1.0	0.2	0.2
2-Butanone	5.0	5.0	--	5.0	5	5
2-Chloroethyl Vinyl Ether	5.0	5.0	--	5.0	0.2	1
2-Chlorotoluene	1.0	1.0	--	1.0	1	0.2
2-Hexanone	5.0	5.0	--	5.0	5	5
4-Chlorotoluene	1.0	1.0	--	1.0	0.2	0.2
4-Isopropyl Toluene	1.0	1.0	--	1.0	0.2	0.2
4-Methyl-2-Pentanone	5.0	5.0	--	5.0	5	5
Acetone	5.0	5.0	--	5.0	5	5
Acrolein	50	50	--	50	5	5
Acrylonitrile	5.0	5.0	--	5.0	1	1
Benzene	1.0	1.0	--	1.0	0.2	0.2
Bromobenzene	1.0	1.0	--	1.0	0.2	0.2
Bromochloromethane	1.0	1.0	--	1.0	0.2	0.2
Bromodichloromethane	1.0	1.0	--	1.0	0.2	0.2
Bromoethane	2.0	2.0	--	2.0	0.2	0.2

TABLE 6

REMEDIAL INVESTIGATION WORK PLAN
SUMMARY OF QAPP PQL AND ARI LOQ VALUES$^{(1,2)}$

Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW, Seattle, Washington

Analyte	Upland Soil		Storm Water Solids/Sediment		Surface/Ground Water	
	QAPP PQL µg/kg	ARI LOQ µg/kg	QAPP PQL µg/kg	ARI LOQ µg/kg	QAPP PQL µg/L	ARI LOQ µg/L
Volatile Organic Compounds, Cont'd						
Bromoform	1.0	1.0	--	1.0	0.2	0.2
Bromomethane	1.0	1.0	--	1.0	1	1
Carbon Disulfide	1.0	1.0	--	1.0	0.2	0.2
Carbon Tetrachloride	1.0	1.0	--	1.0	0.2	0.2
Chlorobenzene	1.0	1.0	--	1.0	0.2	0.2
Chlorodibromomethane	1.0	1.0	--	1.0	0.2	0.2
Chloroethane	1.0	1.0	--	1.0	0.2	0.2
Chloroform	1.0	1.0	--	1.0	0.2	0.2
Chloromethane	1.0	1.0	--	1.0	0.5	0.5
cis-1,2-Dichloroethene	1.0	1.0	--	1.0	0.2	0.2
cis-1,3-Dichloropropene	1.0	1.0	--	1.0	0.2	0.2
Dibromomethane	1.0	1.0	--	1.0	0.2	0.2
Ethyl Benzene	1.0	1.0	--	1.0	0.2	0.2
Hexachloro-1,3-Butadiene	5.0	5.0	--	5.0	0.5	0.5
Iodomethane (Methyl Iodide)	1.0	1.0	--	1.0	1	1
Isopropyl Benzene	1.0	1.0	--	1.0	0.2	0.2
m,p-Xylene	1.0	1.0	--	1.0	0.4	0.4
Methylene Chloride	2.0	2.0	--	2.0	0.5	1
Methyl-t-butyl ether (MTBE)	1.0	1.0	--	1.0	0.5	0.5
Naphthalene	5.0	5.0	--	5.0	0.5	0.5
n-Butylbenzene	1.0	1.0	--	1.0	0.2	0.2
n-Propyl Benzene	1.0	1.0	--	1.0	0.2	0.2
o-Xylene	1.0	1.0	--	1.0	0.2	0.2
s-Butylbenzene	1.0	1.0	--	1.0	0.2	0.2
Styrene	1.0	1.0	--	1.0	0.2	0.2
t-Butylbenzene	1.0	1.0	--	1.0	0.2	0.2
Tetrachloroethene	1.0	1.0	--	1.0	0.2	0.2
Toluene	1.0	1.0	--	1.0	0.2	0.2
trans-1,2-Dichloroethene	1.0	1.0	--	1.0	0.2	0.2
trans-1,3-Dichloropropene	1.0	1.0	--	1.0	0.2	0.2
trans-1,4-Dichloro-2-Butene	5.0	5.0	--	5.0	1	1
Trichloroethene	1.0	1.0	--	1.0	0.2	0.2
Trichlorofluoromethane	1.0	1.0	--	1.0	0.2	0.2
Vinyl Acetate	5.0	5.0	--	5.0	1	0.2
Vinyl Chloride	1.0	1.0	--	1.0	0.2	0.2
Semi-Volatile Organic Compounds: Phenol and Chlorinated Phenols						
Phenol	20	20	--	20	1	1
2-Chlorophenol	20	20	--	20	1	1
2,4-Dichlorophenol	200	200	--	200	5	20
2,4,6-Trichlorophenol	100	100	--	100	5	3
2,4,5-Trichlorophenol	100	100	--	100	5	5
2,3,4,6-Tetrachlorophenol	20	20	--	20	1	1.0
Pentachlorophenol	200	200	--	200	5	0.5
Semi-Volatile Organic Compounds: Low Level PAH						
1-Methylnaphthalene	5	5	5	5	0.1	0.1
2-Methylnaphthalene	5	5	5	5	0.1	0.1
Acenaphthene	5	5	5	5	0.1	0.1
Acenaphthylene	5	5	5	5	0.1	0.1
Anthracene	5	5	5	5	0.1	0.1
Benzo(a)anthracene	5	5	5	5	0.1	0.1
Benzo(a)Pyrene	5	5	5	5	0.1	0.1
Benzo(g,h,i)Perylene	5	5	5	5	0.1	0.1
Benzofluoranthene(s) (total)	5	5	5	5	0.1	0.2
Chrysene	5	5	5	5	0.1	0.1
Dibenz(a,h)Anthracene	5	5	5	5	0.1	0.1
Dibenzofuran	5	5	5	5	0.1	0.1
Fluoranthene	5	5	5	5	0.1	0.1
Fluorene	5	5	5	5	0.1	0.1
Indeno(1,2,3-cd)Pyrene	5	5	5	5	0.1	0.1
Naphthalene	5	5	5	5	0.1	0.1
Phenanthrene	5	5	5	5	0.1	0.1
Pyrene	5	5	5	5	0.1	0.1

TABLE 6

REMEDIAL INVESTIGATION WORK PLAN
SUMMARY OF QAPP PQL AND ARI LOQ VALUES(1,2)
Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW, Seattle, Washington

Analyte	Upland Soil		Storm Water Solids/Sediment		Surface/Ground Water	
	QAPP PQL µg/kg	ARI LOQ µg/kg	QAPP PQL µg/kg	ARI LOQ µg/kg	QAPP PQL µg/L	ARI LOQ µg/L
Semi-Volatile Organic Compounds (including Phenols, Phthalates, and Polycyclic Aromatic Hydrocarbons)						
1,2,4-Trichlorobenzene	20	5	5	5	1	1
1,2-Dichlorobenzene	20	5	5	5	1	1
1,3-Dichlorobenzene	20	5	--	5	1	1
1,4-Dichlorobenzene	20	5	5	5	1	1
1-Methylnaphthalene	20	20	--	20	1	1
2,2'-oxybis(1-Chloropropane)	20	20	--	20	1	1
2,3,4,6-Tetrachlorophenol	20	20	--	20	5	1
2,4,5-Trichlorophenol	100	100	--	100	5	5
2,4,6-Trichlorophenol	100	100	--	100	5	3
2,4-Dichlorophenol	100	20	--	20	5	3
2,4-Dimethylphenol	40	40	20	40	1	3
2,4-Dinitrophenol	850	850	--	850	10	20
2,4-Dinitrotoluene	100	100	--	100	5	3
2,6-Dinitrotoluene	100	100	--	100	5	3
2-Chloronaphthalene	20	20	--	20	1	1
2-Chlorophenol	20	20	--	20	1	1
2-Methylnaphthalene	20	20	20	20	1	1
2-Methylphenol	20	5	5	5	1	1
2-Nitroaniline	100	100	--	100	5	3
2-Nitrophenol	100	100	--	100	5	3
3,3'-Dichlorobenzidine	150	150	--	150	5	5
3-Nitroaniline	100	100	--	100	5	3
4,6-Dinitro-2-methylphenol	200	200	--	200	10	10
4-Bromophenyl-phenylether	20	20	--	20	1	1
4-Chloro-3-methylphenol	100	100	--	100	5	3
4-Chloroaniline	270	270	--	270	5	5
4-Chlorophenyl-phenylether	20	20	--	20	1	1
4-Methylphenol	40	10	40	10	1	2
4-Nitroaniline	100	100	--	100	5	3
4-Nitrophenol	100	100	--	100	5	10
Acenaphthene	20	20	20	20	1	1
Acenaphthylene	20	20	20	20	1	1
Anthracene	20	20	20	20	1	1
Benzo(a)anthracene	20	20	20	20	1	1
Benzo(a)pyrene	20	20	20	20	1	1
Benzo(g,h,i)perylene	20	20	20	20	1	1
Benzofluoranthene(s) (Total)	40	40	40	40	1	5
Benzoic acid	400	400	400	400	10	20
Benzyl alcohol	20	20	20	20	5	2
Bis(2-Chloroethoxy)methane	20	20	--	20	1	1
Bis(2-Chloroethyl)ether	20	20	--	20	1	1
bis(2-Ethylhexyl)phthalate	25	25	25	25	1	3
Butylbenzylphthalate	20	5	5	5	1	1
Carbazole	20	20	--	20	1	1
Chrysene	20	20	20	20	1	1
Dibenzo(a,h)anthracene	20	5	5	5	1	1
Dibenzofuran	20	20	20	20	1	1
Diethylphthalate	50	5	5	5	1	1
Dimethylphthalate	20	5	5	5	1	1
Di-n-butylphthalate	20	20	20	20	1	1
Di-n-octylphthalate	20	20	20	20	1	1
Fluoranthene	20	20	20	20	1	1
Fluorene	20	20	20	20	1	1
Hexachlorobenzene	20	5	5	5	1	1
Hexachlorobutadiene	100	5	5	5	1	3
Hexachlorocyclopentadiene	400	400	--	400	5	5
Hexachloroethane	20	20	--	20	1	2
Indeno(1,2,3-cd)pyrene	20	20	20	20	1	1
Isophorone	20	20	--	20	1	1
Naphthalene	20	20	20	20	1	1
Nitrobenzene	20	20	--	20	1	1
N-Nitroso-di-n-propylamine	20	25	--	25	1	1

TABLE 6

REMEDIAL INVESTIGATION WORK PLAN
SUMMARY OF QAPP PQL AND ARI LOQ VALUES(1,2)
Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW, Seattle, Washington

Analyte	Upland Soil		Storm Water Solids/Sediment		Surface/Ground Water	
	QAPP PQL µg/kg	ARI LOQ µg/kg	QAPP PQL µg/kg	ARI LOQ µg/kg	QAPP PQL µg/L	ARI LOQ µg/L
Semi-Volatile Organic Compounds (including Phenols, Phthalates, and Polycyclic Aromatic Hydrocarbons), Cont'd						
N-Nitrosodiphenylamine	20	12	20	12	5	3
Pentachlorophenol	200	50	50	50	5	10
Phenanthrene	20	20	20	20	1	1
Phenol	20	5	20	5	1	1
Pyrene	20	20	20	20	1	1
Polychlorinated Biphenyl Aroclors						
Aroclor 1016	4	4	4	4	0.01	0.01
Aroclor 1221	4	4	4	4	0.01	0.01
Aroclor 1232	4	4	4	4	0.01	0.01
Aroclor 1242	4	4	4	4	0.01	0.01
Aroclor 1248	4	4	4	4	0.01	0.01
Aroclor 1254	4	4	4	4	0.01	0.01
Aroclor 1260	4	4	4	4	0.01	0.01
Dioxins/Furans(3)						
2,3,7,8-TCDD	5.00E-05	--	5.00E-05	--	5.00E-07	--
1,2,3,7,8-PECDD	5.00E-05	--	5.00E-05	--	5.00E-07	--
1,2,3,4,7,8-HXCDD	5.00E-05	--	5.00E-05	--	5.00E-07	--
1,2,3,6,7,8-HXCDD	5.00E-05	--	5.00E-05	--	5.00E-07	--
1,2,3,7,8,9-HXCDD	5.00E-05	--	5.00E-05	--	5.00E-07	--
1,2,3,4,6,7,8-HPCDD	5.00E-05	--	5.00E-05	--	5.00E-07	--
OCDD	5.00E-05	--	5.00E-05	--	5.00E-07	--
2,3,7,8-TCDF	5.00E-05	--	5.00E-05	--	5.00E-07	--
1,2,3,7,8-PECDF	5.00E-05	--	5.00E-05	--	5.00E-07	--
2,3,4,7,8-PECDF	5.00E-05	--	5.00E-05	--	5.00E-07	--
1,2,3,4,7,8-HXCDF	5.00E-05	--	5.00E-05	--	5.00E-07	--
1,2,3,6,7,8-HXCDF	5.00E-05	--	5.00E-05	--	5.00E-07	--
1,2,3,7,8,9-HXCDF	5.00E-05	--	5.00E-05	--	5.00E-07	--
2,3,4,6,7,8-HXCDF	5.00E-05	--	5.00E-05	--	5.00E-07	--
1,2,3,4,6,7,8-HPCDF	5.00E-05	--	5.00E-05	--	5.00E-07	--
1,2,3,4,7,8,9-HPCDF	5.00E-05	--	5.00E-05	--	5.00E-07	--
OCDF	5.00E-05	--	5.00E-05	--	5.00E-07	--
Total Petroleum Hydrocarbons						
Gas Range	5000	5000	--	5000	30	250
Diesel Range	5000	5000	--	5000	100	100
Anions						
Chloride	--	--	--	--	100	100
Nitrate	--	--	--	--	100	100
Sulfate	--	--	--	--	100	100
Phosphate	--	--	--	--	8	100
General Groundwater Chemistry Parameters						
Total Organic Carbon	0.02%	0.01%	0.02%	0.01%	1500	1500
Total Suspended Solids	--	--	--	--	1000	--
Hardness	--	--	--	--	330	--
Alkalinity	--	--	--	--	1000	--
Ammonia	100	100	--	100	10	40

Notes:

1) Values presented in this table are based on PQLs listed in the QAPP prepared by ERM (copy provided in Appendix C) and LOQs provided by ARI.

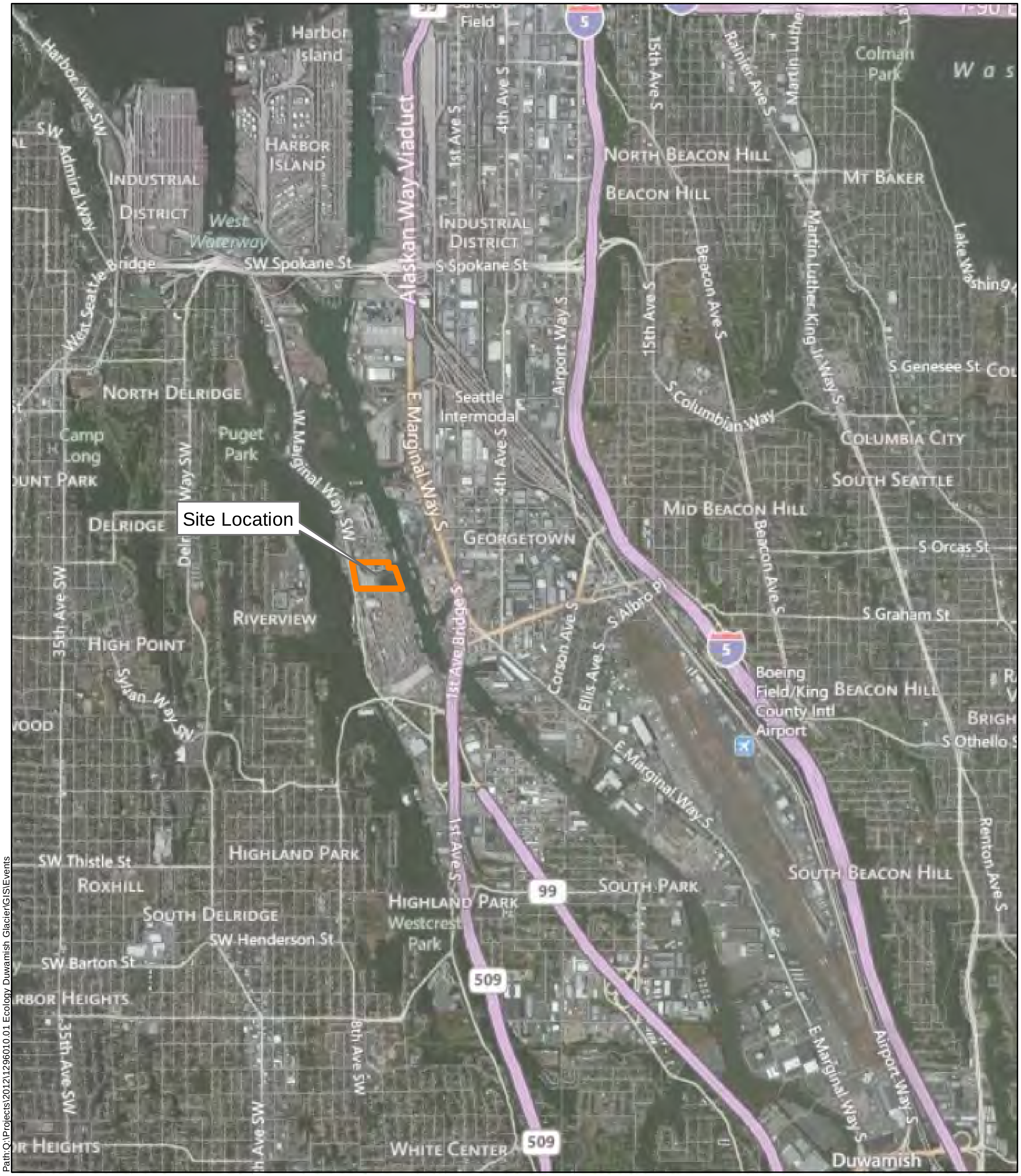
2) All values to be verified by consultant/contractor prior to submitting any samples for analysis.

3) Analysis of dioxins/furans to be performed by AXYS Analytical Services, Ltd. of Sydney, B.C. All other analyses to be performed by ARI.

Abbreviations:

-- = Not applicable/available
µg/kg = Micrograms per kilogram
µg/L = Micrograms per liter
PQL = Practical Quantitation Limit
LOQ = Limit of Quantitation
ARI = Analytical Resources, Inc. (Seattle, WA)
QAPP = Quality Assurance Project Plan

Figures



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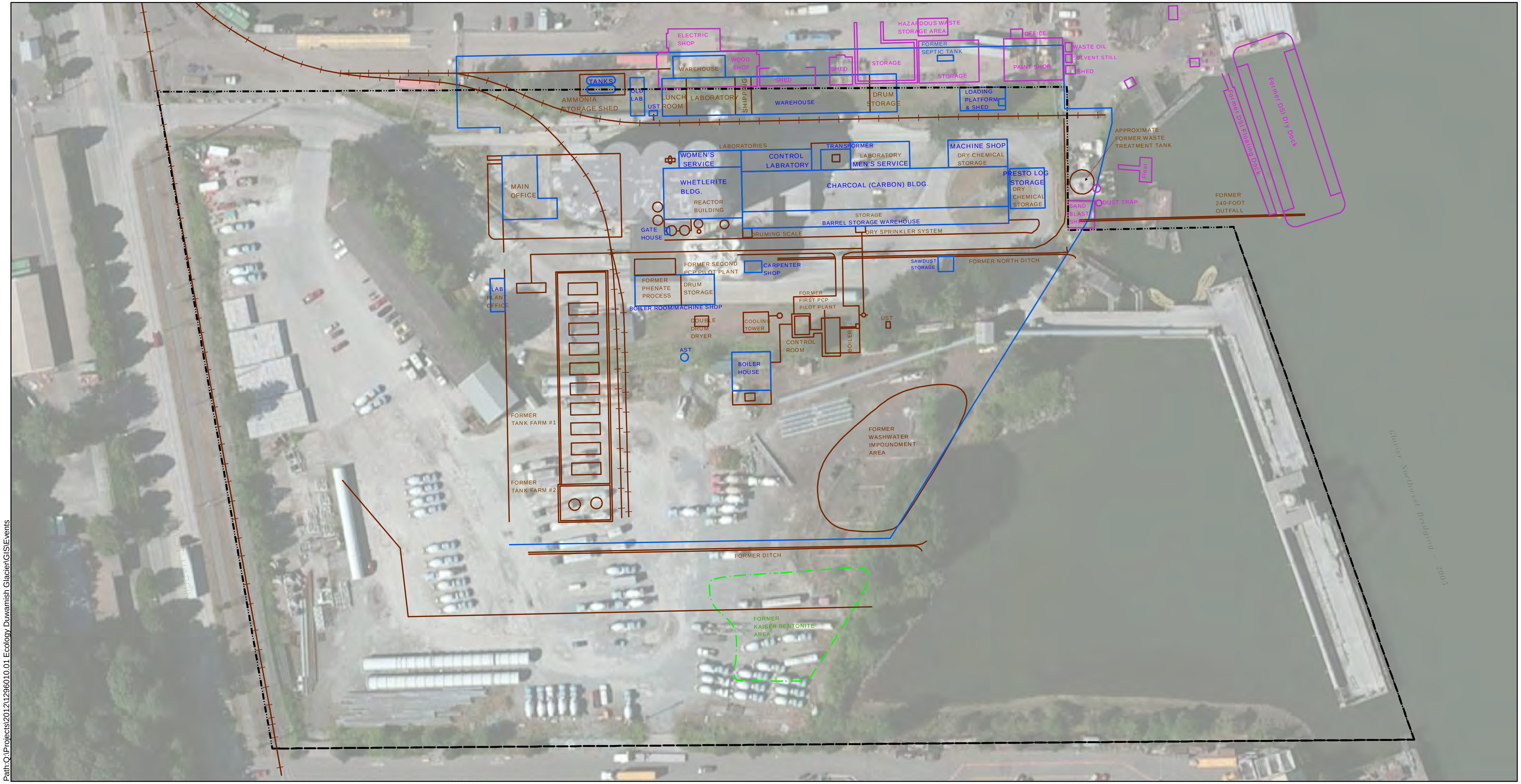
RI/FS Workplan

The Lower Duwamish Waterway (LDW)
Glacier Northwest Inc - Reichhold Inc, Seattle WA

Site Location Map

August 2012

Figure 1



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Basemap and features are from Revised Final RI/FS Workplan (ERM 2012)

Legend

- Site Boundary
- Railroad
- Duwamsih Shipyard Features
- Former Army Buildings and Features
- Former Kaiser Bentonite Area
- Former Reichhold Features

N

0 150 300

Scale: Feet

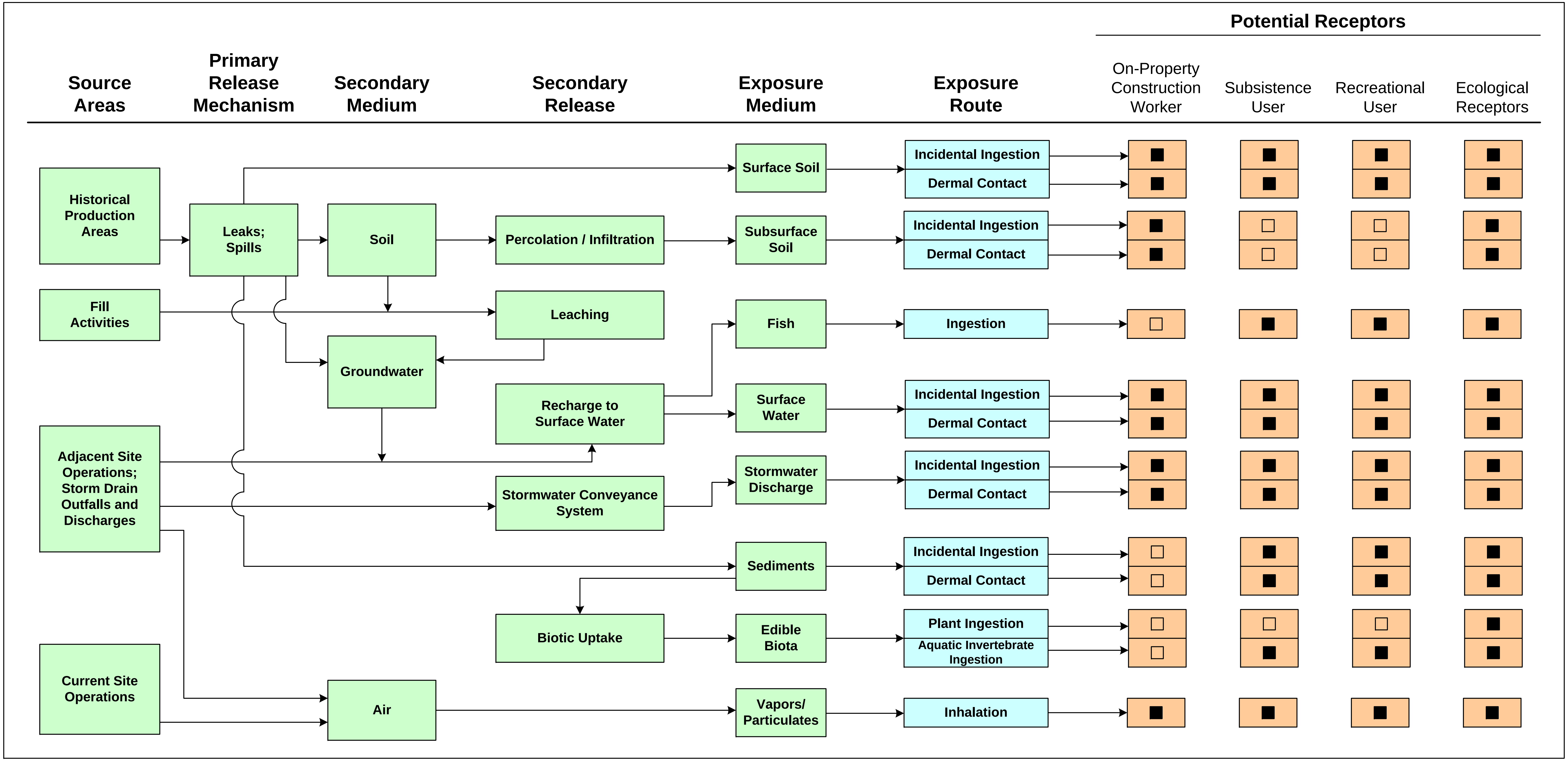
RI/FS Workplan

The Lower Duwamish Waterway (LDW)
Glacier Northwest Inc - Reichhold Inc, Seattle WA

Site Plan and Historical Features

August 2012

Figure 2



Exposure Medium	Exposure Route	On-Property Construction Worker	Subsistence User	Recreational User	Ecological Receptors
Surface Soil	Incidental Ingestion	■	■	■	■
	Dermal Contact	■	■	■	■
Subsurface Soil	Incidental Ingestion	■	☐	☐	■
	Dermal Contact	■	☐	☐	■
Fish	Ingestion	☐	■	■	■
Surface Water	Incidental Ingestion	■	■	■	■
	Dermal Contact	■	■	■	■
Stormwater Discharge	Incidental Ingestion	■	■	■	■
	Dermal Contact	■	■	■	■
Sediments	Incidental Ingestion	☐	■	■	■
	Dermal Contact	☐	■	■	■
Edible Biota	Plant Ingestion	☐	☐	☐	■
	Aquatic Invertebrate Ingestion	☐	■	■	■
Vapors/ Particulates	Inhalation	■	■	■	■

Figure modified from the *Revised Final Remedial Investigation and Feasibility Study Work Plan* prepared by ERM (ERM 2012)

RI/FS Workplan

The Lower Duwamish Waterway (LDW)
Glacier Northwest Inc – Reichhold Inc, Seattle, WA

Preliminary Conceptual Site Exposure Model

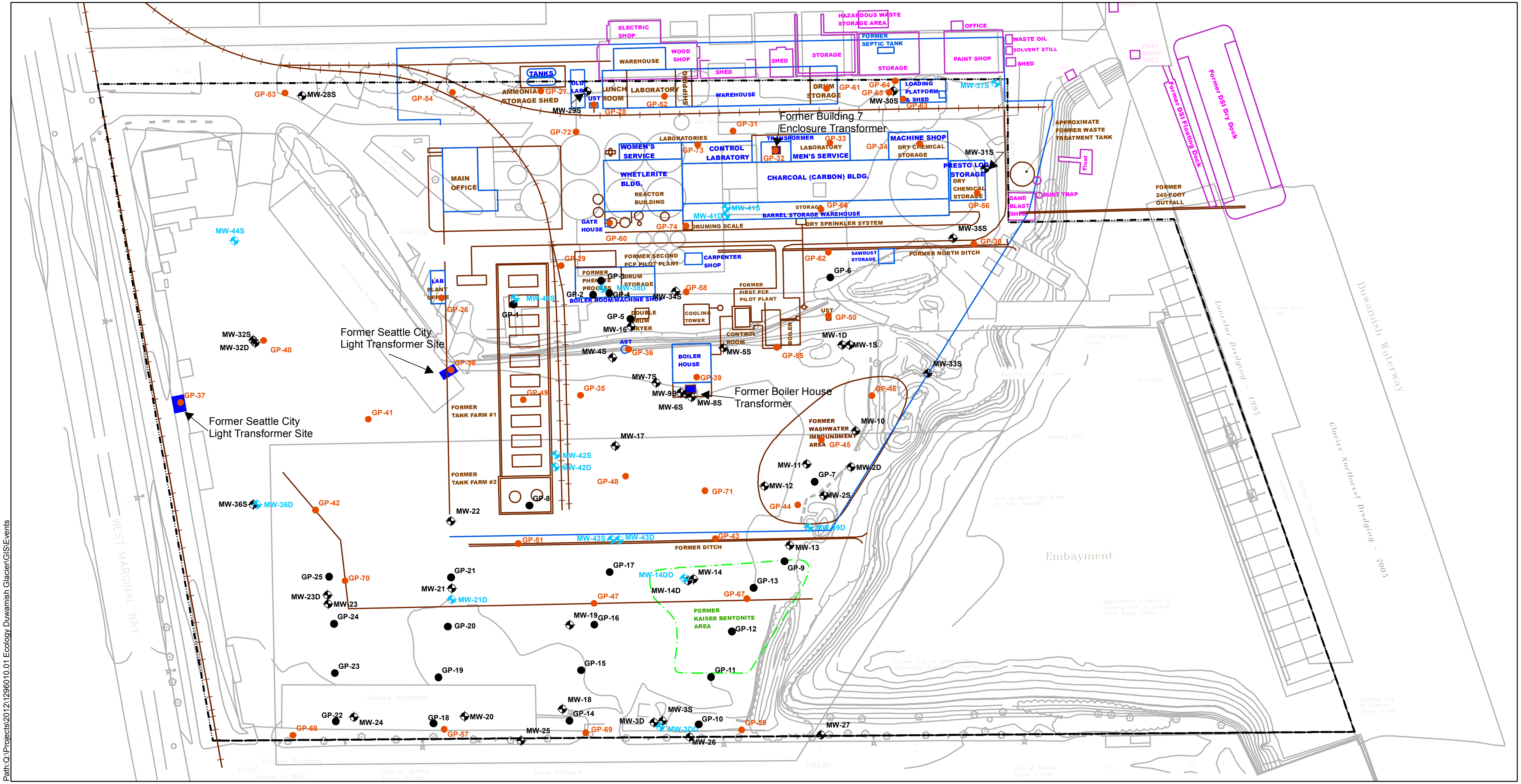
August 2012

Figure 3

■ Complete exposure pathway.

☐ Potentially complete exposure pathway.

NOTE: Figure depicts a preliminary assessment of potential exposure pathways. All potential pathways are to be fully evaluated as part of the RI/FS.



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Basemap and features are from Revised Final RI/FS Workplan (ERM 2012)

Legend

Sample Location

● Existing Soil Boring	Railroad
● Proposed Soil Boring	Duwamsih Shipyard Features
⯐ Existing Monitoring Well	Former Army Buildings and Features
⯐ Proposed Monitoring Well	Former Kaiser Bentonite Area
Site Boundary	Former Reichhold Features

N

0 150 300
Scale: Feet

RI/FS Workplan

The Lower Duwamish Waterway (LDW)
Glacier Northwest Inc - Reichhold Inc, Seattle WA

Proposed Boring and Well Locations and Historical Site Features

August 2012

Figure 4

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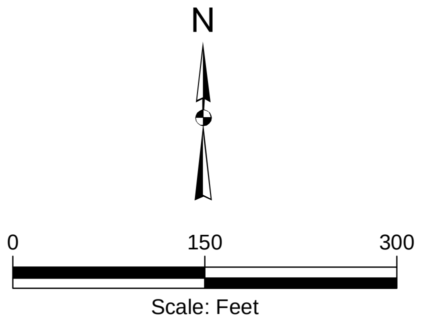
Basemap and features are from Revised Final RI/FS Workplan (ERM 2012)

Legend

▶ Sediment Sample Location
■ Catch Basin Location
☐ Suspected Catch Basin Location
🟥 Stormwater Sample Location
🟩 Solids Sample Location
— Sewer Drainage Mainline
— Stormwater Ditch
— Truck Wash Stormwater Collection
— Water Tanks
-··- Approximate Site Boundary
— Dock Drainage System
— Stormwater Conveyance



RI/FS Workplan

The Lower Duwamish Waterway (LDW)
Glacier Northwest Inc - Reichhold Inc, Seattle WA

Stormwater and Catch Basin Soils Sampling Map

August 2012

Figure 5

Basemap and features are from Revised Final RI/FS Workplan (ERM 2012)

Legend

- ● Approximate River Bank (RB) Sample Location
- Approximate GPR Transects
- Approximate Former Drainage Ditch Locations
- Site Boundary

RI/FS Workplan

The Lower Duwamish Waterway (LDW)
Glacier Northwest Inc - Reichhold Inc, Seattle WA

Drainage Ditch and GPR Tansect Map

August 2012

Figure 6

Path:Q:\Projects\2012\1296010.01 Ecology Duwamish Glacier\GIS\Events

Basemap and features are from Revised Final RI/FS Workplan (ERM 2012)

Legend

Sample Location

- ● Existing Soil Boring
- ● Proposed Soil Boring
- ⯐ Existing Monitoring Well
- ⯐ Proposed Monitoring Well
- -··- Approximate Site Boundary

N

0 150 300

Scale: Feet

RI/FS Workplan

The Lower Duwamish Waterway (LDW)
Glacier Northwest Inc - Reichhold Inc, Seattle WA

Proposed Soil Boring and Well Location Map

August 2012

Figure 7

Appendix A

Ecology Draft Data Gaps Report Comments

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office 3190 160th SE Bellevue, Washington 98008-5452 (425) 649-7000

June 28, 2010

Via electronic email and postal service

Mr. Erik Ipsen
erik.ipsen@erm.com
101 S. W. Main Street, Suite 804
Portland, OR 97204

Dear Mr. Ipsen,

Re: Ecology Review and Comment on *Draft Data Gaps Report, Glacier Northwest, Inc. Reichhold, Inc.*, dated October, 2009 prepared by ERM for Glacier Northwest, Inc., and Reichhold, Inc..

The Department of Ecology (Ecology) has reviewed and prepared comments on the *Draft Data Gaps Report* for the Glacier Northwest, Inc./Reichhold, Inc. Site. Please review these comments and incorporate them into the Draft Work Plan for the Site. As discussed at the February 18th, 2010 meeting at the Department of Ecology, it is the Department's preference that the Data Gaps report is not finalized and future effort is placed on the next deliverable, the Draft Work Plan.

The Department noted several areas of deficit within the *Draft Data Gaps Report*. A thorough history review was not discussed or not demonstrated on the maps or constituent lists, detection limits for most of the sampled parameters were above preliminary screening levels, some data were not considered in the report, and sediment issues within the embayment were not noted as Data Gaps.

The Department has developed a Draft Preliminary LDW Screening Levels spreadsheet which is attached that should assist in applying the most appropriate screening levels. There are two versions, one for potable water bodies and one for non-potable. A non-potability determination must be demonstrated before eliminated from the discussion regarding the perched water table. Potable values should be utilized for that unit.

Ecology would like to schedule a technical meeting to discuss Ecology's comments, the Draft Data Gaps Report, and timeline for the work schedule to be performed under the Agreed Order.

Please contact me within two weeks of receipt of this letter to schedule the next technical meeting. The Schedule under the Agreed Order allows 45 days for preparation of the Draft Work Plan. Ecology understands per review of the Monthly Progress Reports that the Work Plan has been under preparation for some time. That said, I also note that changes to the plan may be significant to incorporate comments from Ecology. I look forward to hearing from you and moving forward on the remediation of this site.

Sincerely,

Donna Ortiz de Anaya
Environmental Engineer, M.S.
Site Manager
Toxics Cleanup Program
425-649-7231

do/kp

cc: Shawn Lilley
Ron Timm, Ecology
Nels Johnson, Assistant Attorney General

Data Gaps Review by Ecology
Glacier Northwest, Inc./Reichhold, Inc.

June 28, 2010

Data Gaps Report Summary

Manufacturing History

U.S. Army: Whetlerite manufacturing

Reichhold Chemicals, Inc.: resin, pentachlorophenol and sodium pentachlorophenate

Ash Grove, Lone Star and Glacier Northwest, Inc.: cement distribution and concrete manufacture

Chemical History

Chemical use, manufacture or by-products included fuels, solvents, metals, chlorophenols, and acids. Specifically:

- Chromium VI, silver, copper, pentachlorophenol, BPA-bisphenol A, phenol, formaldehyde, methanol, triethanolamine, hydrochloric acid, aluminum chloride, sodium pentachlorophenate, phenol formaldehyde, molybdenum, and various chemicals in cement materials

Soil

Soil sampled within the site detected metals, phthalates, and organic volatile, semi-volatile chemicals, and chlorophenols. More specifically:

- Aldrin, alpha-BHC, dieldrin, phthalates, arsenic, barium, chromium, lead, mercury, TPH & PAH, pentachlorophenol, acetone, chlorobenzene, vinyl chloride, bis(2-ethlyhexyl)phthalate, di-n-butyl phthalate, 2,3,5,6-tetrachlorophenol, 2,4,5 trichlorophenol, 2,4,6-trichlorophenol, 2,4-dichlorophenol, 2-chlorophenol, nickel, zinc, fluorine, and thallium

Groundwater

Ground water samples within the site detected metals, volatiles and semi-volatile chemicals. More specifically:

- Silver, pentachlorophenol, and various chlorophenols, arsenic, chromium, lead, copper, aluminum, zinc, acetone, chloroform, formaldehyde, and naphthalene

Stormwater

Stormwater has not been investigated (except NPDES permit constituents).

Sediment

Sediment samples within the site detected arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, silver, vanadium, zinc, dibutlytin, tributyltin, TPH, 1,2-dichlorobenzene, di-n-butyl phthalate, bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, dieldrin, pentachlorophenol, 1-chlorophenol, 2,4,6-trichlorophenol, 2,4-demethylphenol, 2,4,5-trichlorophenol, hexachlorobenzene, chrysene, dibenzofuran, phenanthracene, anthracene, naphthalene, , flouranthene, benzo(a)pyrene, PCB's (Aroclor 1248, Aroclor 1254, Aroclor 1260), dioxins/furans and more (see Attached Table #1 – "Sediment Sample Results at Key Locations for Some Known Parameters").

Seeps

Seeps sampled within the Site detected arsenic above screening levels (see attached screening levels Table).

Air

Air quality and impact to potential receptors has not been investigated.

Remaining Data Gaps

1. The site must be screened for potential contaminants to the lowest method PQL's, and the nature and extent defined for each chemical present. The analytical methods selected in the Work Plan QAPP should generate the lowest technically reliable practical quantitation limits (PQLs), minimizing the possibility that the PQLs will be greater than the future potential site cleanup levels (see Table #2 – Preliminary Screening Levels).

2. Areas where samples were analyzed with PQLs above screening levels must be re-sampled and analyzed at the lowest technically reliable PQLs.

3. It is premature to apply MTCA Method C soil criteria for this site which is currently zoned commercial/industrial. It lies within a few hundred feet of Puget Park, a public green area, residential zoning, and a junior college with an onsite daycare. The sediments, surface water and bank are readily accessible, and it appears public can access the upland property from the waterway.

   Soil concentrations must be protective of other media, so any MTCA soil standards based upon risk from direct contact may be superseded by other standards which protect human health and the environment, including those that protect the surface water, groundwater, air and sediment from upland soil contamination. Following the remedial investigation there should be enough information to make a decision on the cleanup levels relative to location and media.

4. A conceptual site model (CSM) is needed that reviews all historic contaminants and includes locations of known contaminants based on appropriate screening levels. All historic operations have not been completely identified in the Data Gaps Report, and the work plan should include a revised history section. All current and former tanks, transformers, laboratories, process buildings, septic tanks, ditches, impoundments, and outfalls should have clear labels on the CSM drawing that describes the types of contaminants used and potential pathways. This includes, but is not limited to, the US Army whetlerite process, all processes performed by Reichhold at the site including pentachlorophenol pilot plants, formaldehyde, phthalates, resins, potential laboratory spills and wastes, phenate processing, and any fuels, solvents, etc. associated with the Kaiser/Lone Star/Glacier concrete manufacturing and cement distribution.

5. Historic reports with potentially important information, such as lab reports from chemical formulation tests, blueprints for site layout, architectural plans, engineering plans, plats and deeds should included in the Work Plan and original documents sent to Ecology.

6. Given the documented historic references to some pollution problems dating back to the 1950's, a thorough investigation is required to follow known pathways of contaminants and sample appropriately for historic activities; such as phenols and related constituents in ditches, tank areas, kettle and resin areas, control basin and impounding basin, etc., particularly in the sediments related to the 240 foot outfall into the Duwamish, ditches and areas surrounding tanks conveying wastewater and stormwater.

7. Additional groundwater sampling should include the surface water-groundwater interface, its location and the contaminant transformation within and past this zone into the benthic zone.

8. Hydrochloric acid was part of the waste stream for at least 8 years prior to selling it as a product. The Washington State Pollution Control Commission was so concerned in 1956 about phenols and pH they required the removal of hydrochloric acid and required a deep water outfall for the remaining contaminants. The pathways and all outfalls, deep and shallow must be further investigated. Disclosure of all other constituents known to have discharged through that outfall is required.

9. The whetlerite process changed with the ownership between Carlisle and Crown Zellerbach. The Carlisle and original process manufactured type A whetlerite which used mainly copper. From 1943 to 1944, Crown Zellerbach manufactured ASC whetlerite which contained chromium VI, silver and copper. All lab and building areas associated with these chemicals should be tested including soil, groundwater and along drainage lines.

10. Geotech investigations are missing that were conducted by Shannon and Wilson in 1964, 1966, and 1969, and Hart Crowser in 1975. All site logs and reports from these investigations should be incorporated into the Work Plan and copies of the originals sent to Ecology.

    Also missing is a copy of the 1954 plot plan referenced in the 1996 RETEC remedial investigation and the October, 1995 Retec Scoping Document 2-3. Please include this Plot Plan of the Reichhold facility. These documents should be incorporated into the Work Plan and copies of the originals sent to Ecology at your earliest convenience.

11. The Site carries a history of spills and using ditches to intentionally drain spilled potential contaminants to the Lower Duwamish Waterway (LDW). For example, during one period, fish kills were noted in the river adjacent to a drainage ditch where spilled product was allowed to follow the ditch to the river. Additionally, Crown Zellerbach dumped 750 gallons of copper ammoniate into the LDW every month. Historic references point out several open ditches used in the past to convey stormwater and wastewater. Constituents known to have discharged into ditches should be sampled in

soil, groundwater, river bank and adjacent sediment at appropriate intervals necessary to delineate and characterize any contamination.

12. River bank and sediment samples at and near the historic wastewater treatment tank and the septic line are required to rule out contamination. The old river bank is now the embayment bank as the river has been channelized and filled. When sampling the embayment, rationale should note that in the 1940's and 1950's, the river moved up and downstream as tidally influenced, however, there was no embayment at that time. The embayment and related depositional properties were in effect following the construction of Terminal 115 around 1969. Sampling for constituents related to the gas mask and resin and pentachlorophenol production should follow the historic flow at the time. Additionally, past and current barge operations should be investigated.

13. All ditch lines utilized throughout the history of the site should be well represented geographically from origination to end point. Soil samples above the mean high higher water (MHHW) and sediment samples below the MHHW line are required in the river bank. Investigations should include soil to surface water connections given bank and tidal fluctuations.

14. Sediment sampling is required to delineate and characterize contamination within the bay, as well as along the western edge of the property boundary and within the area around the discharge of the previous deep water outfall and relative tidal boundary of the LDW. The PLPs must demonstrate the best possible effort toward defining the nature and extent of historic releases.

15. All potential receptors must be included in pathway analysis including stormwater. Stormwater samples are required to characterize the stormwater and rule out contamination carried to the LDW. These should include all contaminants known to have been historically carried in the ditches or outfalls and include catch basin solids and rain event related stormwater samples. Process water from ongoing operations should be characterized including the full suite of priority pollutants as the NPDES permit does not require full characterization.

16. If natural attenuation is considered as a possible remediation alternative, further investigation and reporting is required. This includes demonstrating compliance with Ecology's MNA guidance (2007) in the Work Plan. This would also include an Ecology approved groundwater work plan.

17. To clarify, no remedial remedies have been approved for this site, so no containment features or institutional controls will be considered as reasons for no further investigation in the work plan. For example, the 1996 RETEC report mentions that

pentachlorophenol in soils is inaccessible because it is 13 to 14 feet down and located under current cement storage and transfer facility. The 1996 RETEC Feasibility study also notes that excavation of soils at the former impoundment area would be hampered by the presence of a 4 to 5 foot deep layer of discontinuous concrete layer present just below ground surface and by a large pile of debris covering the eastern portion of the site bordering on the Duwamish River which includes part of the former impoundment area. Further investigation and discussion on these features is required to define the nature and extent of contamination at the site.

18. The Data Gaps Report (DGR) notes this site entering Ecology's Voluntary Cleanup Program. Ecology has no records of this Site formally entering any Ecology voluntary cleanup program.

19. On page 22 of the DGR a statement notes, "No PCB-containing electrical equipment had been removed or currently exists at the Cement Terminal." The history of transformer use at the rest of the site is not clear. Please include all records noting placement, removal and replacement for all transformers utilized from 1940 until present.

20. The DGR does not prove whether PCP is a source of dioxin at this site. It is commonly known that PCP can be a dioxin source, but chlorinated dioxins/furans have not been adequately investigated at the site to show a correlation. The inferred correlation between PCP and TCDD TEQ concentrations in surface and subsurface sediment samples also neglects to relate the depths of the samples. PCP may degrade faster than dioxins/furans, and in addition, PCP may be more closely correlated to OCDD than TCDD. Further investigation and analysis for chlorinated dioxins/furans is required.

21. Any known contamination on adjacent properties should be considered and definition of the extent of the plume onto this Site must be investigated. Sampling along adjacent property boundaries for contaminants associated with their respective contaminants is required. Samples are needed at the northern boundary for contaminants associated with Duwamish Shipyard's shipbuilding COCs (such as TBT, metals, solvents, PAHs, etc) and the southern boundary for contaminants associated with MRI tin recycling.

22. Air quality is a pathway of concern at the site and has not been investigated. All contaminants which may be in the soil or may become airborne during daily practices, including all dust sources onsite should be sampled and fully characterized. Additionally, consideration should be made for grading or other excavations which may be minor, however, may result in dust emissions containing contamination.

23. Due to the overlapping activities at the site and the inconsistent pattern of constituents found, the site should be sectioned and sampled for contaminants so the extent of contamination can be properly mapped. As an example, arsenic (and other possible constituents not yet identified) appears to be randomly spaced throughout the site and

has not been well delineated. Also, the soil sampling design needs to include investigation of the nature and extent of contaminants that may be associated with episodes of fill. Provide more historic photos, if available, to document the filling.

24. The entire northern area where the former whetlerite activity took place has not been sampled. Sampling of soil and groundwater for metals, solvents and TPH and any other activity-related constituents is required.

25. Only three wells have been sampled in the deeper confined aquifer and three in the silt layer. Chromium, copper and zinc were detected in all three wells with copper and zinc exceeding screening criteria. Chromium VI was not isolated even though it was used during the whetlerite process. Silver was detected in well MW-2D. Cadmium, lead and mercury were not sampled. Given the extent of known contamination throughout the site, further sampling within the silt and deeper aquifer for full priority metal suites with necessary corresponding Chromium VI analyses, is required. More groundwater monitoring wells will need to be installed.

26. It should be noted and considered that groundwater samples using 5 foot well screens may be influenced by a factor of dilution, especially when considering the perched unit varies from 2 to eleven feet. When investigating the perched zone, well screens should not cross the confining layer. Wells in shallow zones should measure the water table and field parameters during high and low tidal events. Testing should be implemented during high tide events in order to demonstrate an absence of continuity between the perched layer and the confined layer. Elevation of groundwater relative to the silt layer should be tested at high tides.

27. Initial sampling done in 1985/1990 showed exceedences that still have not been fully characterized. The Parametrix Report, done as the Kaiser Property Environmental Audit, detected several pesticides including aldrin, alpha-BHC, dieldrin, phthalates, and arsenic (20-51mg/kg). Since these are composites made up of 3 or 4 different locations, there was dilution and these locations must be sampled discretely. Parallel groundwater sampling is required. Appropriate PQLs meeting the preliminary screening levels are required.

28. Adequate sampling needs to identify hydrogeologic units at the site such as the deep and perched aquifers.

29. The Hart Crowser Report (J-4267) Figure 1 shows a former Lone Star concrete disposal pit in the far southwest corner of the site. This is not shown on the current maps. Please explain the difference.

30. The Department has reviewed figure 3-1 and has attached an edited version which incorporates additional known information including the former deepwater discharge

outfall 240 foot out from the tank, the whetlerite impregnating station which is was stationed outside, a septic field, locations of earlier transformer pads, locations of old railroad tracks, a former septic tank with drain line pipe to ditch, etc. Comparing the U.S. Army Real Estate Map to Figure 3-1, Site Plan of Historical Operations, several notes were made:

- The northern property line drawn for Figure 3-1 has the older US Army whetlerite buildings straddling the boundary. Please explain the difference in the property line boundary.
- See notes attached from EPA (Jonathon Maas) titled *Comment on Draft Summary of Existing Information and Data Gaps Report (DGR*) where EPA has noted specific details from referenced historic documents which conflict with findings in the DGR.
- Ditches from Army presence are not all delineated o*n* Figure 3-1. All ditches should be delineated with corresponding known and found PCOCs.
- The main septic tank (17) appears to serve four buildings (5, 6, 7, 8). Building activities should be listed with corresponding CPOCs.
- There are several former ditches noted in Figure 3-1 (DGR). There appears to be an overlay where the most southern ditch changes from an open ditch to a pipeline with catch basins draining into the City of Seattle storm drain. This should be better defined.
- There is an open ditch which initiates near the R.G. Gate in the north central area of the site. It appears to tie in to a ditch on the northern side of building 9 (identified as the Warehouse) and continues to flow to the LDW. The building straddling the ditch should be indentified and sampling along the ditch line should be done as there are large storage tanks, the barrel warehouse and an unidentified building adjacent to this ditch line. It is also located close to the old septic tank. No testing has been done near this feature.

  The former septic tank north of the loading platform appears to drain the office (10), Women's service and first aid, control laboratory, transformer enclosure and Men's service and first aid buildings. This tank then drains to the waterway. Only one test pit was sampled at the tank location-TP-7 (1995) for soil, phenols, arsenic (detection limit of 19 mg/kg), silver (D.L. 1.1 mg/kg), to a max 4 foot depth. Further soil and groundwater sampling is required.

The Department is requesting a new figure incorporating all of the known information. Additionally, the Department would like to see Figure 4-1 with the updated information added.

31. Page 19 of the DGR notes that the waste treatment tank which was earlier described as located near the river and may have been constructed without a bottom was in error and interviews with staff have determined there were two tanks setback from the shoreline and constructed with bottoms. Affidavits from employees and original historic documents are required to show which construction situation was true.

    The 1996 RETEC report noted several concerns which have not been addressed:

    - The document notes the waste treatment tank located near the river received wastes from the entire facility. The document further notes, "There is evidence that the tank overflowed at times, and it may have been constructed without a bottom."
    - Assumption should be made that any and all contaminants and raw materials used within the source area for the waste treatment tank may have leached into the soil below. The soil and groundwater beneath the former tank and down gradient (or downstream) should be tested for all possible constituents related to the former Reichhold operations.

32. On page 56 the DGR notes concentrations of arsenic are lower in the deep wells and higher in the shallow wells and a conclusion is drawn that, "These observations suggests a lack of vertical connection between the shallow and deeper zones (that is, the arsenic does not appear to be moving from the shallow to the deeper confined aquifer)." The PLPs have not demonstrated a continuous aquitard exists. Further investigation of the continuity of the silt layer and the nature and extent of contamination of all three aquifer layers is needed.

Further Sampling Details

Specific Examples of Data Gaps

Past sampling has resulted in limited information for several areas within the Site. The Work Plan must include a plan that identifies potential or suspected sources of hazardous substances, types and concentration of hazardous substances, potentially contaminated media and actual and potential exposure pathways and receptors. (WAC 173-340-200) When contaminants above screening levels (see LDW Screening Level Table) have been identified, a thorough investigation of nature and extent of contaminants both vertically and horizontally in soil, groundwater and sediment is required.

- Central Western Area

  Past sampling (Parametrix, 1990) in this general area has noted (B-1) with the depth composited sample for chromium at 21 mg/kg and 0.26 mg/kg for mercury. The TCLP performed on the composited soil lists leachate at 40 µg/L for chromium, 180 µg/L barium and 6 µg/L for arsenic, which exceed potential screening levels for groundwater or surface water. Monitoring well (MW-1) tested groundwater with chromium at 90 µg/L, copper at 40 µg/L, lead at 6 µg/L, zinc at 40 µg/L and silver at 270 µg/L. These constituents were found in soil from the silt layer, so further sampling in the silt, 'perched' and deeper aquifer, is required.

- The most western part of this drainage line was minimally tested in the past. This area still needs full characterization of soil and groundwater constituents.

- Tank Farm:
  All of the soil samples were noted to have detectable levels of TPH. Elevated levels of TOX (24 ppm) and TPH (10,000 ppm) were found at TP-3 (located between the tank farm and the former phenate process building). The tank farm contained raw materials, including transitory by –products (HCl) and other products, which could account for the TOX levels.

  TCLPs were performed on the samples taken in the first 1.5 feet below surface from TP-1, TP-2 and TP-3. TP-1, located in the southwest portion of the site, had leaching results from the soil samples noted arsenic at 240 µg/L and barium at 50 µg/L, which exceed potential screening levels for groundwater and surface water. TP-3 results from the TCLP were arsenic at 73 µg/L, barium at 90 µg/L, cadmium at 10 µg/L, and lead at 100 µg/L. Further soil sampling, especially at depth, should be completed to define the nature and extent.

At GP-1, located at the northeastern tip of the tank farm, chlorinated phenols were analyzed above the selected screening criteria. Even then, pentachlorophenol was detected below the 1.2 mg/kg reported limit. Since the pentachlorophenol screening value is 0.0010 mg/kg, further sampling is required to define extent. Arsenic and silver were also analyzed with detection limits higher than screening values. Composite samples 28 and 29 –C yielded high concentrations of metals in soil, measured as mg/kg; arsenic (46), chromium (7.3), copper (24.1), nickel (11.4) and zinc (40.3) and pesticides aldrin (5.4) and alpha-BHC (3.4).

The tank farm is referenced in the Parametrix, 1990 document and explained this is not only an area of possible bottomless storage tanks, but it also appears to be part of a drain field for a septic area that appears to have drained the Former Phenate Process Area and the tank farm. The RETEC document lists several chlorinated phenols tested for in Table 5-3, however, the lowest detection limit on any of the parameters sampled is 70 µg/kg and the highest is 4,200 µg/kg. This bears further investigation and analysis with lower detection limits.

No groundwater wells are located here, however MW-4S and MW7S appear to be down-gradient. No groundwater sampling has been done near this tank farm.

Given the use in this area, sampling should include the full suite of metals, including barium and chromium VI, chlorophenols, volatiles and semi-volatiles for soil and groundwater.

- Former Phenate Process and Second PCP Plant

  The area of the former phenate process and second PCP plant has been sampled and labeled GP-2, GP-3, GP-4, GP-5, TP-4, and TP-5, with MW-16 located to the southeast and MW-4S to the south. GP-2 was sampled at two depths 13-14 feet and 3-4 feet. The deeper sample indicated various concentrations of chlorinated phenols with PCP at 69 mg/kg, 5 mg/kg 2,3,5,6-tretrachlorophenol, 2,4,5-trichlorophenol 0.78 mg/kg. 2,4,6-trichlorophenol was not detected at 0.65 mg/kg detection limit. The shallower sample detected PCP at 2.2 mg/kg. Metals sampled for these locations were only done for arsenic and silver with the lowest detection levels for arsenic at 5 and the highest 6.5

mg/kg and a screening level of 0.0134 mg/kg. Silver was sampled with a detection level (2.2 mg/kg) above potential screening levels. Most detection levels used were above appropriate screening levels for this site.

The closest groundwater wells, MW-16 and MW-4S, are from 50-100 feet away from potential source areas indicating that more groundwater wells are needed. Existing well MW-16 was last sampled in 20099 with a result for PCP of 10 µg/L, which exceeded potential screening levels and indicates further sampling is needed. This well was not sampled for many constituents that were present in the soil, including silver, chromium, copper or zinc. All other chlorophenols were analyzed with detection limits at 5 µg/L or above. MW-4S was also last sampled in 2009 with a value of 2.1 µg/L PCP, above the potential screening levels. Metals in MW-4S were last sampled in 2009 having an arsenic concentration of 30.9 µg/L , chromium estimated at 0.46 µg/L and copper estimated at 1.8 µg/L (Estimated values denote a detection below the reporting limit that exceeds potential screening levels for this site).

Further sampling is needed to fully characterize this area including a full suite of metals, volatiles and semi-volatiles for soil and groundwater.

- <u>First PCP Pilot Plant</u>

  Soil sample points MW-1S, MW-1D, MW-5S, TP-8, TP-9, 5-C-1 were reviewed. The composite soil sample 5-C-1 is part of a sampling which resulted in detections and selected screening criteria exceedences of metals, pesticides and semi-volatiles compounds. Specifically, detections were found for metals including arsenic, chromium, copper, lead, mercury, nickel, zinc and fluorine; for the pesticide Alpha-BHC, and the phthalates Bis(2-ethylhexyl)phthalate and Di-n-butyl phthalate. Test pit samples revealed 28 mg/kg arsenic at TP-9 at the 5-6 foot depth, with detection limits ranging from 19-24 mg/kg. MW-5S was only sampled for pentachlorophenol with a detection of 0.054 mg/kg, exceeding potential screening levels.

  Monitoring wells MW-1S and MW-1D appear not to have been sampled during the 1996 and 2003 sampling events. There was groundwater sampling done for MW-1S in March, 2009 which revealed concentrations of dissolved arsenic at 8.89 µg/L in the perched aquifer and 11.6 µg/L in the lower confined aquifer. Chromium was detected in the deeper aquifer at 8.2 mg/L dissolved, as was copper at 3.5 µg/L. Copper was also detected in the upper aquifer at an estimated 1 µg/L. Zinc was detected at 52.4 µg/L dissolved in the perched zone with an estimated 4.8 dissolved in the lower aquifer.

Pentachlorophenol was not detected at 1 µg/L and the other chlorophenols were non-detect at detection limits of 5.1 µg/L. Formaldehyde was detected at 29 µg/L in the upper aquifer.

Further soil and groundwater sampling with appropriate detection limits is required.

- Wastewater Treatment Tank and Septic Tanks

  Per the 1996 RETEC report, a treatment tank was located near the river and received wastes from the entire facility. The tank no longer exists and there is evidence that the tank overflowed at times and may have been constructed without a bottom. This area has not been investigated and requires testing of soil, groundwater, surface water and sediment for all known constituents. As dioxin has been documented in sediment adjacent to this area, it should be investigated in the soils in the upland and along the banks.

  The northern septic tank was noted in the report as a potential source because it received discharges from the control and resin laboratory, so additional sampling is also needed in this area.

- Area between Tank Farm and Pilot Plant

  Data for wells MW-8S and MW-9S sampled in 1997 by Flour Daniel GTI could not be found in the DGR document. Monitoring wells MW-6S and MW-7S were sampled in 1996 for pentachlorophenol, and was detected in MW-7S at depth 5-6.5 feet with a concentration of 1.8 µg/L and at 7.5-9 foot depth with 0.42 µg/L, exceeding potential screening levels. The most recent groundwater sampling in March, 2009 noted concentrations of arsenic and aluminum in both wells which exceeded potential screening levels. Well 6S was not tested for other metals, while 7S noted detections of dissolved chromium at estimated 0.46 µg/L and pentachlorophenol at 48 µg/L, with other chlorophenols non-detect above 5.1 µg/L.

  Continued groundwater sampling with appropriate detection levels and full chemical suites is required.

- Wastewater Impoundment Area

  The wastewater impoundment received wastewater, storm water, and hydrochloric acid. This area has had some remediation yet no confirmation sampling has been done as soil has not been re-sampled since 1998. Soil samples from B-2 indicate arsenic (79 mg/kg), barium (25 mg/kg), chromium (24 mg/kg), lead (10 mg/kg) and mercury (0.22

mg/kg) detections, which are above potential screening levels. Composite soil sample C-1 noted a concentration of di-butyl phthalate at 0.99 mg/kg, above the potential screening criteria. TP-10 sampled by RETEC in 1996 noted 2 mg/kg silver, which exceeds the potential screening criteria.

TCLPs done from soil samples taken during the borings indicated leaching of arsenic and barium.

Well B-2 is located in the northern area of the former impoundment area, screened at the aquitard or silt layer located below the perched unconfined unit and above the confined aquifer. Well MW-2 noted detections of acetone, chloroform, several semi-volatiles, including 2-chlorophenol (28 µg/L), above potential screening levels. Naphthalene concentration in groundwater was noted at 86 µg/L, above the potential screening levels.

One well in this area is screened deeper, in the confined aquifer (17.8 to 22.8 feet). This well, MW-2D, is on the eastern edge of the shoreline within the impoundment footprint. Groundwater well MW-2D is in communication with surface tidal water and has a noted arsenic concentration of 11.8 µg/L, with a soil concentration of 13 mg/kg arsenic at the 10-11 foot depth in 1995.

Although the DGR notes that MW-2S was sampled in the perched aquifer, the depth documented for MW2S is 5-10 feet, with a total depth of 11.5, while MW-2S was reportedly sampled in the silt aquitard, however, the depth in the protocol for sampling describes a boring to 8 feet with a screen installed. Please explain as the two wells are less than 50 feet apart.

This area has been sampled at three different depths, including the perched or unconfined aquifer, the silt unit, and the confined aquifer which is in communication with tidal waters. More recent 2009 groundwater results indicated PCP is still present in well MW-13 at a concentration of 41 µg/L which is above potential screening levels and located on the southern tip of the former impoundment area. The sampling of MW-13 indicated arsenic is still present at 1130 µg/L, chromium at 3.7 µg/L, copper at 114 µg/L, and zinc at 132 µg/L. Soil samples taken in 1995 and 1996 for chlorophenols had detection limits ranging from 0.23 to 0.35 mg/kg, exceeding potential screening criteria. As dioxins and other parameters were found in sediment adjacent to this area (see Table 1) these parameters should be sampled in the soils and bank in this area.

Groundwater should be sampled throughout the perched, silt and deeper aquifer for constituents with appropriate detection limits. Then comparisons can be made to the appropriate screening level.

- Southeast Area

  This section of the property has documented the presence of pentachlorophenol (PCP), along with potential screening level exceedences of arsenic and other metals, in soil and groundwater.

  Boring B-3 is the sampling point at the most southeastern edge of the site and detected concentrations of arsenic (150 mg/kg), barium (20 mg/kg) and chromium (22 mg/kg). The Kaiser Environmental Audit done in 1985 by Parametrix noted composite soil samples taken at a 5 foot depth. Results indicated concentrations of semi-volatile, metals, and pesticides. Specifically, metals-arsenic, chromium, copper, lead, nickel, zinc and fluorine ; the pesticide alpha-BHC; semi-volatiles biz ethyl hexyl phthalate and di-n-butyl phthalate were detected from the composited sample. Detection limits for PCBs were set at 35 mg/kg, exceeding potential screening levels. No aroclors were reported detections. See screening level table, Table #2.

  The TCLP for B-3 sample noted arsenic at 600 µg/L.

  Well MW-3, in the silt layer, detected pentachlorophenol at 2800 µg/L. Metals sampled indicated detections of arsenic (330 µg/L), lead (5 µg/L) and silver (340 µg/L).

  Lab sheets for GP-11,-12,and -13 are missing although a summary table lists data for GP-11,-12,and -13 as 99, 140, 120 mg/kg arsenic in soil and 100, 760 and 750 µg/L arsenic in groundwater (per Table 5-4) in the RETEC document. Historically, groundwater sampling at MW-3S and MW-3D has not been as extensive as at other wells; however, sampling done on plant pre-treatment discharge samples noted dissolved arsenic concentrations ranging from 22.7 to 2,090 µg/L for MW3s and 36.1 to 114 µg/l for MW-3D. The most recent sampling results (March, 2009) indicate MW-3S with concentrations of dissolved arsenic at 604µg/L, manganese at 320 µg/L, chromium at 0.37 µg/l, total copper at 0.584 (chromium and copper are estimated values as they were detected below the reporting limit), pentachlorophenol detected at 2.1 µg/L, and all other chlorophenols non-detect with detection limits above 5µg/L. Well MW-3D noted detections of dissolved arsenic at 54.2 µg/L, chromium at 3.7 µg/L, estimated dissolved copper at 0.48 and total zinc at 9.4 µg/L. Pentachlorophenol was non-detect at 1 µg/L and all other chlorophenols were non-detect with reporting limits above 5 µg/L. These results show that potential exceedances of screening levels exist at this area. As dioxins and other parameters were found in sediment adjacent to this area (see Table 1) these parameters should be sampled in the soils and bank in this area.

Hart Crowser, 1995 letter to Ecology summarized conditions at the site and noted, “Upward gradients have also been reported in the site vicinity between deeper water-bearing zones and the shallow groundwater flow system.” That has been validated for MW-3S and further sampling should be done in the vicinity of MW-3.

This area requires further sampling at appropriate PQLs. Also, further information is needed to characterize the hydrogeologic regime.

- <u>Central Southern Area</u>

  This area is adjacent to the MRI tin reclamation facility along the property boundary. The geoprobe locations, sampled in 1996, by RETEC, Inc. are numbered GP-14, -15 and -16, -18, -19 and -20. Only geoprobes 15 and 16 are listed in table 5-2 with corresponding sampling results for chlorophenols. GP-16, at depth 7-8 feet, resulted in a 1000 mg/kg concentration for pentachlorophenol, 62 mg/kg for 2,3,5,6-tretrachlorophenol, 0.2 mg/kg estimated for 2,4,6-trichlorophenol, 0.27 mg/kg for 2,4-dichlorophenol, 0.066 mg/kg estimated for 2-chlorophenol. Geoprobe 15, at depth 3-4 feet was sampled with a detection limit of 0.23 mg/kg for all chlorophenols except pentachlorophenol which was sampled at 1.2 mg/kg. MW-16 was sampled in 1998 for pentachlorophenol and at the 5.5-6.5 and 10.5 to 11.5 feet depths the concentration was not detected at 0.05 mg/kg for both. The highest concentration was found at 10.5 to 11 foot depth at 250 mg/kg in soil at well MW-26. At depth 5.5-6.0 feet 180 mg/kg arsenic was noted at the same well.

  Monitoring wells MW-16, -18, -19, -20 and -25 were sampled for arsenic in 2003. All samples detected arsenic with MW-19 revealing concentrations of 1290 mg/kg at depth 5.5-6.5 feet and 2240 mg/kg at 13-13.5 feet.

  Monitoring wells MW-25 and MW-26 are located right on the southern property boundary and were sampled for arsenic in 2003 by Shaw. The groundwater sample was taken July, 2003 at well MW-25 noted 1100 µg/L post treatment. More recent sampling done March, 2009, for well MW-26 revealed dissolved arsenic at 957 µg/L, total aluminum at 111 µg/L. Other metals were not sampled and PCP and other chlorophenols were not detected at the selected detection limits which are above potential screening level criteria.

- More groundwater sampling is needed to fully characterize the soil and groundwater in this area. Additionally, if data is available that has not been included in the report it should be included in the Work Plan and disclosed to Ecology, including originals.

- Southwestern Area

  The southwestern area of the site includes a Lonestar Co. concrete disposal pit with several previously sampled points. One of the composite samples was taken here (C-4, --19), along with test pit TP-1, several geoprobes (GP-22,-23, and -24 and monitoring well MW-24. Composite C-4 detected several metals, the pesticide Dieldrin at 2 mg/kg, and Di-n-butyl phthalate at 0.43 mg/kg. The metals detected included arsenic at 20 mg/kg, chromium at 6.4 mg/kg, copper at 4.4 mg/kg, mercury at 0.15 mg/kg, nickel at 5.3 mg/kg, thallium at 17 mg/kg and fluorine at 98 mg/kg. Arsenic, copper, mercury, nickel, and thallium all exceed the potential screening level criteria. Test pit sample TP-1 was not analyzed for metals in soil.

  A TCLP sample from TP-1 noted a detection of arsenic at 240 µg/L and barium at 50 µg/L, which exceed potential screening levels.

  Further soil and groundwater sampling at appropriate detection limits is required.

- Southern and Central Ditch Line Areas

  The 1996 RETEC report notes that ditches on site carried wastewater from the production and tank storage areas and stormwater to the Duwamish River. The central ditch was noted to be very transmissive and has not been investigated. The RETEC report noted that the central ditch acted as a source of recharge to the perched aquifer.

  The southern ditch line is oriented from west to east and includes sampling points MW-14, MW-21, MW-23, GP-17, GP-21, GP-25, TP-14, TP-13/GP-9 and Seep-61 at the shoreline. The geoprobe points 9, 17, 21 and 25 were sampled for arsenic in 1996 with GP-9 at 1,100 mg/kg, and GP-22 and GP-25 non-detect with a 21 mg/kg detection limit. MW-14 sampled in 1998 by Fluor Daniel noted 103 mg/kg at depth 5.5-6.5 and 166 mg/kg at a depth of 10-11.5 feet bgs.

  Monitoring wells, MW-14, MW-21 and MW-23 were sampled for arsenic and aluminum with groundwater exceedences to screening criteria. This ditch should be sampled for all constituents known on-site as it was used as a main conveyance for waste products.

Both ditches require a thorough investigation of soil, groundwater, streambank and adjacent sediment media.

- Site Stormwater

  Stormwater on site has not been investigated. A 15 inch pipe connection to the 48 inch City of Seattle storm drain has been confirmed, however, no samples of discharges have been taken. Additionally, stormwater coming off the Site may contribute contaminants such as TPH, solvents, and metals known to occur in cement including arsenic, barium, cadmium chromium, chromium VI, cobalt, copper, lead, mercury, manganese, nickel, selenium, silver, thallium, tin, vanadium and zinc. Since a large part of the Site is unpaved any contaminants in the soil may be transported via stormwater. All sources of stormwater discharging offsite should be investigated. In addition, catch basin solids from the storm drain pipes should be analyzed for all known contaminants onsite.

- Seeps

  The RETEC report notes that the perched unit discharges to the Duwamish River though intertidal seeps. Seeps were sampled along the eastern border to the LDW with seep one (SW-01, located farthest southeast, seep 2 (SW-02) farthest north at the edge of the former drainage ditch, and seep 3 (SW-03) east of the former impounding basin. Samples were only analyzed for the metals arsenic and silver, Method 8270 semi-volatile organics and TPH (seeps 1 and 2 only). Arsenic in the seeps was measured at 85, 82 and 30 µg/L for seeps 1, 2, and 3, showing that arsenic exceeds potential screening criteria. Silver and PCP both had a detection limit of 1 µg/L and were not detected with detection levels above screening criteria. Surface water quality criteria for marine water bodies for chronic discharges is 36 µg/L arsenic.

  Seeps within the site along the LDW were also sampled by the Lower Duwamish Waterway Group. Two seeps were sampled for specific metals. LDW Seep 61 was noted as a broad seep flow from base of riprap entering large channel draining about 150 feet of shoreline and LDW seep 62 was noted as a single small seep emerging from riprap. Seep 61, located adjacent to the lower ditch and the impoundment basin, noted dissolved arsenic at 72.4 µg/L and non-detect copper at reporting limit 4.72 µg/L. Seep 62, located south of the existing stormwater outfall noted arsenic at 6.84 µg/L and copper was non-detect at reporting limit 7.77 µg/L.

  Given the history of the wastewater tank and the various historic outfalls along the shoreline, and spills, further testing is required to identify and test for pollutants in the seeps originating from the Glacier property. Samples should be analyzed with the lowest possible PQLs to determine nature and extent. All seeps originating from the upland landform should be sampled for a comprehensive suite of metals, dioxins, volatiles and semi-volatiles and any other constituents found or suspected in upland and in sediments at the Site.

- <u>Sediment and Bay Area</u>

  The history of outfalls, wastewater tanks, erosion, spills, ditches used as conveyors for wastewater and stormwater, the pipeline conveying site wastewater 240 feet out into the bay and the LDW, need to be included in the sampling plan. The plan should include a thorough investigation on known contaminants in and around the areas of outfalls. Additionally, in areas known to erode or slough into the bay, testing should be done on the adjacent sediments.

  The preliminary screening criteria for dioxins/furans in sediment is 0.000000141 mg/kg. Sampling done within the embayment adjacent to the Glacier shoreline and within the property boundary have been noted at 2,100, 463, and 565 TEQ (ng/kg dw). While the Draft DGR lists the sediment data results for arsenic and pentachlorophenol, PCBs, dioxin/furans other parameters are not listed and need to be added. Additionally, Table 7-1 does not include sediment in the recommendations for further sampling, and needs to be added. To date, limited sediment sampling has been done within the site, and additional sampling needs to be conducted. Known and recent dioxin sampling of sediment need to be considered.

  See Sediment Sample Results for Key Locations attached. Sediment sample SS58 is located adjacent to the lower ditch outfall. Sample SSB4a is located adjacent to the old wastewater treatment tank. SS59 is located at the southeastern edge of the Bay, just north of T 115.

  Many constituents sampled and detected in the upland area are also found in the sediments sampled. Some sampling has occurred within the sediments of the bay and river adjacent to the Glacier property boundary and further sampling is required in order to characterize the full horizontal and vertical extent of contaminants before cleanup.

Appendix B

Ecology-Approved Sediment Work Plan Documents

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office 3190 160th SE Bellevue, Washington 98008-5452 (425) 649-7000

May 21, 2012

Via electronic email and postal service

Mr. Erik Ipsen
erik.ipsen@erm.com
1001 SW 5th Ave, Suite 1010
Portland, OR 97204

Dear Mr. Ipsen,

Re: Ecology Review and Approval of *Sediment Sampling at 5900 West Marginal Way SW-REVISED,* outlined in the May 16, 2012 letter with attached Figure 1 and Table 1, and portions of Appendix B (REVISED FINAL Remedial Investigation Sampling and Analysis Plan), for the Glacier Northwest, Inc./Reichhold, Inc. Site - Agreed Order DE6000.

Ecology reviewed the May 16, 2012 Letter, *Sediment Sampling at 5900 West Marginal Way SW-REVISED*. Ecology approves the proposed sediment sampling plan described in the letter, including Figure 1, Table 1 and specific sections in Appendix B. The specific approved sections within Attachment B, REVISED FINAL Remedial Investigation Sampling and Analysis Plan are the following:

1. Section B-2.2 Sediments Sampling Design.
2. Section B-3.2 Sediments Field Sampling Methods.
3. Standard Operating Procedure (SOP) J within Attachment A of Appendix B, REVISED FINAL Remedial Investigation Sampling and Analysis Plan.

The original request for authorization to sample sediments was received on May 3, 2012, with the proposed start date of May 21, 2012. Ecology is only able to respond quickly to this request due to its limited nature and your comprehensive response to our previous comments. No further approval is given at this time for sampling of other media or other sediment sampling not outlined in the May 16, 2012 letter.

This partial plan approval is contingent on Glacier, Inc. and Reichhold, Inc. meeting all substantive requirements for relevant and appropriate requirements, including, but not limited to, the Washington Department of Fish and Wildlife Hydraulic Permit. Please keep me informed regarding the access agreement with the Port of Seattle, as my understanding is that several samples may be postponed pending finalization of an access agreement.

Ecology is expecting to observe both surface and subsurface sediment sampling. Currently, I am planning to observe sediment surface sampling on May 24, 2012, so please keep me apprised of any schedule changes. Ecology must be granted access to be present at and to observe the onboard and dock sampling processes prior to and during sampling.

Upon completing the review of the remainder of the Site Draft RI/FS Work Plan, Ecology will be providing additional comments. It should be noted that further sediments sampling may be required, particularly based on review of the most recent 104(e) response from the companies (forwarded to Ecology from EPA on March 26, 2012).

Ecology appreciates Glacier, Inc. and Reichhold, Inc. for their commitment to ongoing investigation and cleanup of the Site. If you have any questions, feel free to contact me.

Sincerely,

Donna Ortiz de Anaya
Environmental Engineer, M.S.
Site Manager
Toxics Cleanup Program
425-649-7231

cc: Scott Isaacson, Glacier, Inc.
John Oldham, Reichhold, Inc.
Ron Timm, Ecology
Nels Johnson, Assistant Attorney General

Environmental
Resources
Management

1218 3rd Avenue.
Suite 1412
Seattle, WA 98101
(425) 462-8591
(425) 455-3573 (fax)

ERM

16 May 2012

Via Electronic Mail

Ms. Donna Ortiz De Anaya
Washington State Department of Ecology
3190 160th Avenue SE
Bellevue, Washington 98008

Subject: Sediment Sampling at 5900 West Marginal Way SW -REVISED

Dear Ms. Ortiz De Anaya:

ERM-West, Inc. (ERM) has prepared this letter on behalf of Glacier Northwest, Inc. (Glacier Northwest) and Reichhold, Inc. (Reichhold) (together "the Companies") to request authorization from the Washington State Department of Ecology (Ecology) to conduct sediment sampling at the site located at 5900 West Marginal Way SW, Seattle, Washington (the site) in May 2012.

As you are aware, the Companies and Ecology are in the process of finalizing the Remedial Investigation/Feasibility Study Work Plan (Work Plan) for the site. The Companies are currently revising the Work Plan to incorporate many of the additional samples and analytes requested by Ecology in the letter dated 11 April 2012. As you know, Ecology only made one additional request related to sediment sampling in that April 11 letter: to collect sediment samples down to core refusal. The Companies agree to this request. To the Companies' knowledge, they have agreed with all of Ecology's requests for the sediment characterization portion of the proposed work plan and propose to initiate that portion of the work. In order to progress the project schedule, the Companies are proposing to perform the proposed sediment investigation in May 2012. This sediment sampling is being conducted to comply with Agreed Order DE 6000 between Ecology and the Companies (Agreed Order). Details are provided below.

The Companies tentatively plan to begin conducting sediment sampling on 22 May 2012 and work is expected to be completed by 1 June 2012. Surface sediment samples are expected to be collected from May 22 to approximately May 25. Subsurface cores are expected to be collected from May 29 to approximately June 1. Surface and subsurface sediment samples will be collected from the embayment and the maintained berthing area including the portion that was dredged and capped in 2005 shown on Figure 1. (Note: The Glacier Northwest property line follows along the dock face. Samples collected at location east of the property line including those proposed locations within the previously dredged and capped area will be conducted pending Port of Seattle approval to access the property for that purpose. The Port is currently reviewing a draft access agreement. If access is not received prior to the dates above, samples will be collected in accordance with this letter as part of a separate mobilization.)

Sediment sample intervals and analyses are summarized in Table 1. Sediment sampling will be performed in accordance with the sampling methods described in the attached Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP). Details regarding laboratory analytical methods, detection limits, and practical quantitation limits are presented in Table D-1 in the QAPP. The sediment sampling activities are summarized below.

Surface Sediment Sample Locations and Analyses

Surface sediment samples will be collected from 20 sampling locations. Samples within the embayment are identified as SS-01 through SS-09, SS-13 through SS-19, and SS-22. Samples within the 1995/2005 dredged and capped area are identified as SS-10, SS-11, and SS-12 (Figure 1). Samples will be collected from the top 10 centimeters below mud line and analyzed for arsenic, chromium, copper, silver, zinc, cadmium, lead, mercury, tributyltin (pore water), dioxins/furans, PCB aroclors, SVOCs, total organic carbon and grain size (Table 1). All Washington Sediment Management Standards (SMS) parameters are included in this list.

Subsurface Sediment Sample Locations and Analyses

Subsurface sediment samples will be collected from 17 locations. Samples within the embayment are identified as SC-01 through SC-09 and SC-13 through SC-18 (Figure 1). Samples within the 1995/2005 dredged and capped area are identified as SC-20 and SC-21 (Figure 1). Subsurface sediment samples will be analyzed for arsenic, chromium, copper, silver, zinc, cadmium, lead, mercury, tributyltin (bulk), dioxins/furans, PCB aroclors, SVOCs, total organic carbon and grain size. All SMS parameters are included in this list. Subsurface sediment sampling intervals and sediment sample archiving are presented below.

- Embayment subsurface sediment cores will be co-located with surface sediment samples and will be collected from mud line to refusal. Subsurface sediment cores will be sampled from the following depth intervals:
    - 0 to 1 foot below the mud line;
    - 1 to 2 feet below the mud line; and
    - 2-foot intervals from 2 feet below mud line until refusal.
- Previous dredge area subsurface sediment cores will be collected beginning at the interval below the sand cap layer and will be completed to refusal (expected to be <15 feet). Sediment sampling intervals will be performed as noted above.

Minor adjustments in sampling interval and/or additional samples may be collected based on observation of extruded cores. Samples collected from three intervals (0 to 1 foot, 2 to 4 feet, and 6 to 8 feet below mud line) will be analyzed primarily and the remainder will be archived by the laboratory. Additional intervals will be analyzed for various constituents if field screening indicates that anthropogenic materials may be present (i.e., sheen, sand blast grit, paint chips, color, odor, etc.) or if results of the initial three samples indicate that additional vertical characterization is needed.

The Standard Operating Procedure for Sediment Core Sampling attached to this letter (Attachment SOP J) incorporates revisions requested by Ecology in correspondence dated 8 August 2011 and 15 May 2012. SOP J has been modified based on Ecology direction to require an initial core acceptance criterion of 90 percent. Recovery of at least 80 percent will be accepted after two unsuccessful attempts to achieve 90 percent recovery. The suspected reason(s) for recovery less than 90 percent will be recorded in the field log. In reviewing the Duwamish Shipyard, Inc. (DSI) sediment logs, it is noted that approximately 40 percent of the cores accepted during DSI's subsurface sediment investigation completed on adjacent property recently had recoveries less than 90 percent[1]. While all accepted cores from the DSI investigation met the 80 percent recovery acceptance criterion, the Companies are concerned that the physical properties of the sediment are different at each station location. This is especially true when comparing stations near the channel and in the bay. Therefore, the Companies request that the Ecology sediment experts be prepared to consult with the

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[1] *Phase 1 Remedial Investigation, Duwamish Shipyard, Inc. Site*, Anchor QEA, LLC, September 2011

Companies' Project Manager if difficulty is encountered achieving the 80 percent recovery criterion.

In accordance with the Agreed Order, the Companies provided 14-day advance written notification to Ecology in the letter from the Companies dated 3 May 2012.

It is the Companies expectation and understanding that Ecology and the United States Environmental Protection Agency (USEPA) will continue to coordinate regarding sediment sampling requirements for the site in order to prevent duplicative future sampling efforts.

The Companies look forward to continuing to work collaboratively with Ecology at the site. If you have any questions, please don't hesitate to contact me at (503) 488-5014.

Sincerely,

Erik C. Ipsen, P.E.
Project Manager

MFM/ECI/155129.01

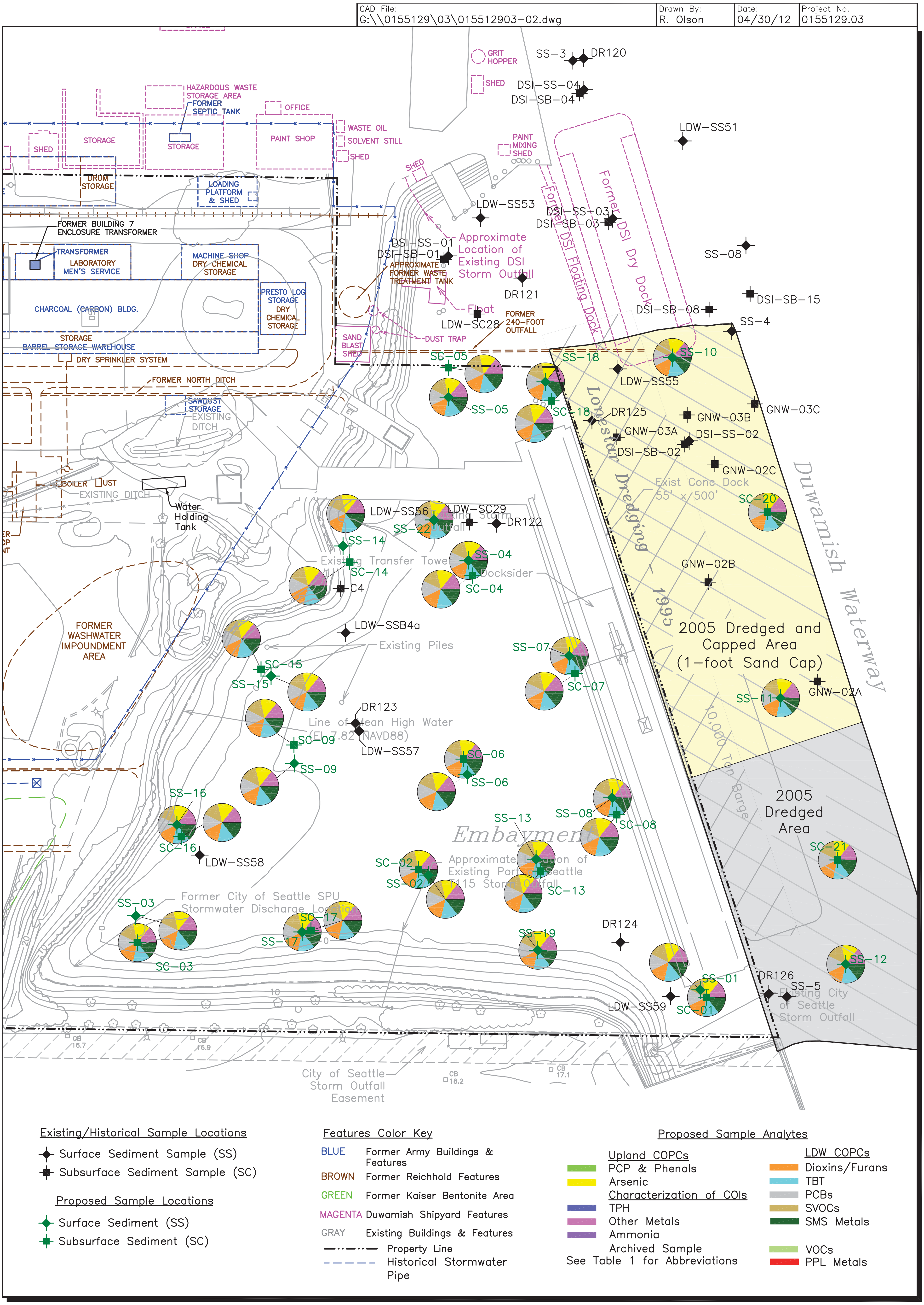
Attachments

cc: Mr. Ron Timm – Ecology
Ms. Louise Bardy – Ecology
Ms. Erika Hoffman - USEPA
Mr. Pete Stoltz – Glacier Northwest, Inc.
Mr. Scott Isaacson – Glacier Northwest, Inc.
Mr. John J. Oldham – Reichhold, Inc.
Mr. John Bjorkman – K&L Gates
Mr. Doug MacCourt– Ater Wynne
Ms. Carolyn Kossik – CH2M HILL

Attachments

Figure 1

CAD File:	Drawn By:	Date:	Project No.
G:\\0155129\03\015512903-02.dwg	R. Olson	04/30/12	0155129.03



Existing/Historical Sample Locations
- ✦ Surface Sediment Sample (SS)
- ■ Subsurface Sediment Sample (SC)

Proposed Sample Locations
- ✦ Surface Sediment (SS)
- ■ Subsurface Sediment (SC)

Features Color Key

BLUE	Former Army Buildings & Features
BROWN	Former Reichhold Features
GREEN	Former Kaiser Bentonite Area
MAGENTA	Duwamish Shipyard Features
GRAY	Existing Buildings & Features
—·—·—	Property Line
– – – –	Historical Stormwater Pipe

Proposed Sample Analytes

Upland COPCs
- 🟩 PCP & Phenols
- 🟨 Arsenic

Characterization of COIs
- 🟦 TPH
- 🟪 Other Metals
- 🟪 Ammonia
- Archived Sample

See Table 1 for Abbreviations

LDW COPCs
- 🟧 Dioxins/Furans
- 🟦 TBT
- ⬜ PCBs
- 🟫 SVOCs
- 🟩 SMS Metals
- 🟩 VOCs
- 🟥 PPL Metals

Figure 1

Sediment Sample Locations
Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW
Seattle, Washington

ERM *04/12*

Table 1

Table 1
Remedial Investigation Sediments Sampling Matrix
Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW
Seattle, Washington

Location ID	Sample Location Coordinates		Sample Frequency				Upland COPCs	Characterization of COIs				Sediment COPCs								Conventional Parameters		
Analyte							As	Cr	Cu	Ag	Zn	Cd	Pb	Hg	TBT (pore water)	TBT (bulk)	Dioxins/ Furans	PCB Aroclors	SVOCs	TOC	Grain Size	Field Screening
USEPA Method	Latitude	Longitude	Minimum Number of Samples	Maximum Number of Samples	Sample Interval	Archived Samples	USEPA 6010B/6020							USEPA 7471A	Krone/ 8270-SIM	Krone/ 8270-SIM	AXYS Method	USEPA 8082B	USEPA 8270D/ 8270-SIM	USEPA 9060	PSEP or equivalent	Various
SED-SS-01	47.5484	122.3404	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-01	47.5484	122.3404	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-02	47.5486	122.3413	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-02	47.5486	122.3414	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-03	47.5485	122.3423	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-03	47.5485	122.3423	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-04	47.5493	122.3412	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-04	47.5493	122.3412	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-05	47.5497	122.3413	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-05	47.5497	122.3413	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-06	47.5488	122.3412	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-06	47.5489	122.3412	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-07	47.5491	122.3409	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-07	47.5491	122.3409	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X

Table 1
Remedial Investigation Sediments Sampling Matrix
Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW
Seattle, Washington

Location ID	**Sample Location Coordinates**		**Sample Frequency**				**Upland COPCs**	**Characterization of COIs**					**Sediment COPCs**									**Conventional Parameters**		**Field Screening**
Analyte			**Minimum Number of Samples**	**Maximum Number of Samples**	**Sample Interval**	**Archived Samples**	**As**	**Cr**	**Cu**	**Ag**	**Zn**	**Cd**	**Pb**	**Hg**	**TBT (pore water)**	**TBT (bulk)**	**Dioxins/ Furans**	**PCB Aroclors**	**SVOCs**	**TOC**	**Grain Size**	
USEPA Method	**Latitude**	**Longitude**					**USEPA 6010B/6020**							**USEPA 7471A**	**Krone/ 8270-SIM**	**Krone/ 8270-SIM**	**AXYS Method**	**USEPA 8082B**	**USEPA 8270D/ 8270-SIM**	**USEPA 9060**	**PSEP or equivalent**	**Various**
SED-SS-08	47.5488	122.3407	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-08	47.5488	122.3407	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-09	47.5489	122.3418	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-09	47.5489	122.3418	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-10	47.5498	122.3406	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SS-11	47.5490	122.3402	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SS-12	47.5484	122.3399	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SS-13	47.5487	122.3410	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-13	47.5486	122.3410	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-14	47.5493	122.3416	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-14	47.5493	122.3416	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-15	47.5491	122.3419	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-15	47.5491	122.3419	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-16	47.5487	122.3422	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-16	47.5487	122.3421	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X

Table 1
Remedial Investigation Sediments Sampling Matrix
Glacier Northwest, Inc. - Reichhold, Inc. Site
5900 West Marginal Way SW
Seattle, Washington

Location ID	Sample Location Coordinates		Sample Frequency				Upland COPCs	Characterization of COIs				Sediment COPCs								Conventional Parameters		
Analyte			Minimum Number of Samples	Maximum Number of Samples	Sample Interval	Archived Samples	As	Cr	Cu	Ag	Zn	Cd	Pb	Hg	TBT (pore water)	TBT (bulk)	Dioxins/ Furans	PCB Aroclors	SVOCs	TOC	Grain Size	Field Screening
USEPA Method	Latitude	Longitude					USEPA 6010B/6020							USEPA 7471A	Krone/ 8270-SIM	Krone/ 8270-SIM	AXYS Method	USEPA 8082B	USEPA 8270D/ 8270-SIM	USEPA 9060	PSEP or equivalent	Various
SED-SS-17	47.5485	122.3417	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-17	47.5485	122.3417	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-18	47.5497	122.3410	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-18	47.5497	122.3409	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-19	47.5485	122.3410	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
SED-SC-20	47.5494	122.3402	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SC-21	47.5487	122.3400	3	5	0-1 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					1-2 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					2-4 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					4-6 ft	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					6-8 ft		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
					8 ft to refusal (2 ft increments)	Archive	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
SED-SS-22	47.5494	122.3413	1	1	0-10 cm		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
			71	**105**			**122**	**122**	**122**	**122**	**122**	**122**	**122**	**122**	**20**	**102**	**122**	**122**	**122**	**122**	**122**	**122**

Notes:

Samples to be analyzed for Sediment Management Standards analytes listed on Table 1 of WAC 173-204-320.
Archived samples will be frozen.
COI = Constituent of Interest
COPC = Constituent of Potential Concern
USEPA = United States Environmental Protection Agency
PSEP = Puget Sound Estuary Protocols
TOC = Total Organic Carbon
SVOC = Semivolatile Organic Compounds
SVOCs include phenols, phthalates, and polycyclic aromatic hydrocarbons
VOC = Volatile Organic Compounds

Notes (continued):

PCB = Polychlorinated biphenyls
# - Cd, Pb and Hg metals also grouped in Priority Pollutant Metals (adjacent site COIs) constituent list.
AXYS Method = USEPA Method 1613B (i.e., AXYS MLA-017)
SIM = Selective Ion Method for polycyclic aromatic hydrocarbons

Field Screening = Organic vapors will be quantified using a photoionization detector. Descriptions of soil sample texture, composition, color, consistency, moisture content, recovery, odor and presence of staining will be documented using the Unified Soil Classification system.

Analytes Key

As	Arsenic
Cd	Cadmium
Cr	Chromium
Cu	Copper
Pb	Lead
Hg	Mercury
Ag	Silver
TBT	Tributyltin
Zn	Zinc

reduction potential will be recorded during the purge of each well. Groundwater sampling methods are presented in Section 3.1.7.

B-2.2 SEDIMENTS SAMPLING DESIGN

Sediment sampling will be conducted in the Embayment (adjacent to the upland property) and in the 1995 and 2005 maintenance dredge/cap area adjacent to the Embayment (east of the dock).

As presented in the DGR (ERM 2009), the Embayment adjacent to the site was created by the Port of Seattle during a major LDW and tidelands filling activity in approximately the late 1960s/early 1970s to create land surface for the construction of the T115 site. During that time period, the existing meander of the LDW was filled to form what is now the Port of Seattle's T115 site. That fill project altered the natural course of water flow in front of the site, creating what is now the Embayment.

The Embayment is bounded by:

- The Duwamish Shipyard wharf to the north;
- The Glacier Northwest dock to the east;
- The Glacier Northwest Cement Terminal property to the west; and
- The Port of Seattle T115 site to the south.

The shoreline of the Embayment is mostly vegetative with some riprap material. It is relatively steep and rocky, with some tall grasses and vegetation from the current site elevation down to the water surface. In the mid to late 1960s, the shoreline was straightened and extended by the Port of Seattle (the site owner at the time) to its current configuration. During the same time period, the Kaiser Cement Terminal was being constructed on the site.

The four stormwater outfalls that currently discharge into, or immediately adjacent to, the Embayment are:

- The Duwamish Shipyard outfall on the northernmost shoreline of the Embayment;
- The Glacier Northwest outfall south of the dock on the western side of the Embayment;
- The Port of Seattle T115 outfall on the southern side of the Embayment; and

- The city of Seattle Public Utility 48-inch stormwater outfall located at the southern end of the Embayment on the LDW.

The approximate locations of the stormwater outfalls are shown on Figure 5.

The proposed sediment sampling is based on the information presented above; the sediment data evaluation completed in the DGR; Ecology's comments on the DGR dated 28 June 2010; a series of meetings held between Ecology, the companies, and the United States Environmental Protection Agency (USEPA) in November 2011 to discuss the RI/FS Work Plan scope of work; and, correspondence exchanged between Ecology and the companies from December 2011 to April 2012 regarding the RI/FS scope of work. Sediment sampling activities include collection of surface and subsurface sediment samples for Site COPCs, COIs, LDW sediment COPCs, and physical parameters, as described in Table 3. Sampling locations are identified on Figure 5.

Surface sediment samples will be collected from 20 locations (SS-01 through SS-19 and SS-22. Only surface sediment samples will be collected at locations SS-10, SS-11, SS-12, SS-19, and SS-22), within the Embayment and previous maintenance dredged areas. Subsurface sediment samples will be collected from 17 locations (SC-01 through SC-09, SC-13 through 18, SC-20, and SC-21) in the Embayment.

B-2.2.1 Embayment Surface Sediment Sampling

This section describes considerations for surface sediment sampling locations to assess data gaps, and specifically:

- Provide additional spatial coverage of surface sediment sample locations in the Embayment;
- Evaluate impacts of historical and existing outfall discharges to the Embayment;
- Evaluate the impacts of historical activities during previous ownership of properties adjacent to the Embayment; and
- Evaluate previously elevated LDW COPCs in surface sediment relative to SMS (WAC 173-204) and other applicable or relevant and appropriate requirements (ARARs) to better understand the nature and extent of contamination.

Surface sediment samples will be collected from 20 sampling locations, which will be identified as SS-01 through SS-19 and SS-22as shown on Figure 5. Surface sediment sampling procedures are described in Section 3.2.4. The surface sediment samples will be analyzed for Site COPCs, LDW COPCs, and physical parameters as described in Table 3 and consistent with the SMS list of parameters. The Surface Sediment Sampling SOP is included in Section B-3.2.4.1 below.

B-2.2.2 Embayment Subsurface Sediment Sampling

This section describes considerations for designing the subsurface sediment sampling locations based on identified data gaps, and specifically:

- Provide additional spatial coverage and characterization of the nature and extent of subsurface sediments in selected areas where subsurface data are not available;
- Evaluate impacts of historical and existing outfall discharges to the Embayment;
- Evaluate the impacts of historical activities during previous ownerships of properties adjacent to the Embayment, and observed historical discharges to the Embayment;
- Investigate subsurface constituent concentrations in areas that may be adjacent to potential sources; and
- Characterize the nature and extent of sediment COPCs for subsurface sediment.

The subsurface sampling locations may be modified based on results and/or field observations from surface sediment sampling and the sediment transport evaluation to be completed as presented in the Revised Final RI/FS Work Plan. For example, locations may be moved to avoid large debris or other obstructions. Subsurface sediment samples will be collected from 17 sediment sampling locations and will be identified as SC-01 through SC-09, SC-13 through SC-18, SC-20, and SC-21as shown on Figure 5. Subsurface sediment sampling procedures are described in Section 3.2.4. The subsurface sediment samples will be analyzed for site COPCs, COIs, LDW COPCs, and physical parameters as described in Table 3 and consistent with the SMS list of parameters.

B-2.2.3 Sediment Sampling in Previously Dredge and Cap Area

Three surface and two subsurface sediment samples will be collected in the 1995 and 2005 dredge/cap area. Surface sediment samples will be collected from above the sediment cap to characterize sediment that has been deposited in this area since the cap placement in 2005. Surface sediment samples will be collected from three sampling locations, which will be identified as SS-10 through SS-12 as shown on Figure 5. Surface sediment sampling procedures are described in Section 3.2.4. The surface sediment samples will be analyzed for Site COPCs, LDW COPCs, and physical parameters as described in Table 3. This analytical list is consistent with the SMS list of parameters. The Surface Sediment Sampling SOP is included in Section 3.2.4.1 below.

Subsurface sediment samples will be collected from below the sediment cap to characterize sediment that was deposited in this area prior to the cap placement in 2005. Subsurface sediment samples will be collected from two sampling locations, which will be identified as SC-20 and SC-21, as shown on Figure 5. Subsurface sediment sampling procedures are described in Section 3.2.4. The subsurface sediment samples will be analyzed for site COPCs, LDW COPCs, and physical parameters as described in Table 3. This analytical list is consistent with the SMS list of parameters. The Sediment Core Sampling SOP is included in Section 3.2.4.2 below.

- Ammonia;
- TBT;
- Total metals; and
- Dissolved metals.

Filtered metals samples will be field-filtered using an in-line, disposable, 0.45-micron filter. Field-analysis of ferrous iron and sulfide will be performed at the five new wells. Samples for these analyses will be collected at the same time the sample bottles are being filled for laboratory analyses. SOP I provides instructions for performing field analysis of ferrous iron and sulfide using a Hach® Portable Colorimeter.

The sampling procedure differs slightly for the three wells to be sampled for dioxins and furans. Because these constituents have low solubility, are highly hydrophobic, and are consequently extremely sensitive to bias from even very low levels of artificially-suspended solids in sample water, samples to be analyzed for dioxins and furans will be collected prior to purging the well in an attempt to minimize potential bias from sampling-induced turbidity. After measuring water levels, the tubing from a peristaltic pump will be lowered gently to the water surface and then lowered until the bottom of the tube is within the upper part of the screened interval, but at no time deeper than the midpoint of the screened interval. Using a low pumping rate (0.025 to 0.05 liters per minute or less), samples will be withdrawn and the sample container for dioxins/furans analysis filled from the end of the pump discharge tubing. After a sufficient quantity of sample water has been obtained, the pump will be stopped, the low-flow cell added to the discharge line, and then the well will be purged and sampled as described above.

Groundwater samples will be placed in laboratory-supplied sample jars, labeled, and stored on ice in a cooler. QA/QC samples will be collected as described in Table 5. The samples will be transported to a Washington state-certified laboratory under standard COC protocol for analysis of the parameters shown in Table 2.

B-3.2 SEDIMENTS FIELD SAMPLING METHODS

Sediment sampling will occur within the Embayment and the previously dredged (1995 and 2005) areas as part of the RI field activities Sediment samples will be collected by boat or equivalent floating platform captained by a state of Washington-licensed operator. All personnel conducting sediment-sampling activities will be required to read, and follow the safety procedure defined in the Health and Safety Plan (Appendix C of the Revised Final RI/FS Work Plan).

B-3.2.1 Sample Location Positioning

Sediment samples will be collected as close as possible to the locations indicated on Figure 5, and to the coordinates presented in Table 3. Water currents and wind drift are not anticipated to cause significant errors in the positioning, as the investigation location is located within the Embayment.

The exact sampling location will be recorded using a differential global positioning system (DGPS) and will also be used to navigate to, occupy, and document all over-water sample locations. A Trimble 4000 RS DGPS utilizing the United States Coast Guard differential signal from the closest station to the site will be interfaced to a computer running software enabling real-time plan view navigation to the required sampling stations. Sample coordinates will be digitally recorded and documented in the field logs at the time of collection of each sample in North American Datum 1983 (NAD 83) Washington State North Zone horizontal datum. All position coordinates will be submitted for inclusion in the Ecology Environmental Information Management (EIM) database. The vertical datum will be the National Oceanic and Atmospheric Administration's National Ocean Service mean lower low water datum.

Prior to the start of field collections during each day of survey operations, a known horizontal control point will be occupied to ensure the accuracy of the positioning and navigation systems. All daily navigation checks are expected to be within 2 meters.

Sediment sampling analytical requirements are described in Table 3 and locations are shown on Figure 5.

B-3.2.2 Water Depth

For each sample location, the corresponding water depths (depth to mud line) will be recorded using both an onboard fathometer, and confirmed with a direct lead-line reading. Tide gage measures will be recorded at a minimum of one time during each sample. All measurements will be converted to depth relative to mean lower low water.

B-3.2.3 Depth Interval in the Sediments to be Sampled

The following sections provide the sediment sampling intervals to be evaluated during the RI investigation.

Sediment within the Embayment and within the Previous Dredge Cap Area will be divided into depth intervals described below:

- <u>Surface Sediment</u>: Sediment collected from 0 to 10 cm below mud line (bml). This depth interval represents the bioactive layer of sediment.
- <u>Subsurface Sediment</u>: Sediment collected from 10 cm bml until refusal (approximately 15 feet bml or shallower; Windward 2010). Subsurface sediment will be divided into the following depth intervals:
    - 0 to 1 foot bml;
    - 1 to 2 feet bml;
    - 2-foot intervals from 2 feet bml until refusal.

B-3.2.4 Sampling Equipment and Methods

The following items will be utilized in the field for sediment sample collection:

- Field notebook and/or field forms;
- Revised Final RI/FS Work Plan and project plans;
- Mobile phone;
- Digital camera;
- Health and safety supplies (personal flotation device, first aid kit, hardhat, safety glasses, etc.);
- Hand held GPS;
- Stainless steel mixing bowls and spoons;
- Peristaltic pump and/or baster to decant water from power grab sampler;
- Alconox;
- Spray bottles with distilled water;
- Sample jars and coolers;
- Powder-free nitrile gloves and rubber work gloves;

- Boots and/or waders;
- Zip-lock bags and bubble wrap;
- Aluminum foil;
- Paper towels;
- Inclement weather gear (rain jacket/pants);
- Sample labels;
- Clear packing tape; and
- COC forms and custody seals.

B-3.2.4.1 Surface Sediment

Surface sediment sample collection and processing will closely follow the standardized procedures developed by the Puget Sound Estuary Program (PSEP 1997). Surface sediment samples will be collected from the top 10 cm within the Embayment at the locations noted on Figure 5. Table 3 provides a detailed sample schedule for collection of surface sediment samples. To minimize disturbance of bottom sediment prior to sampling, sample stations will be approached at slow boat speeds with minimal wake.

Surface sediment samples will be collected using an Ekman grab sampler or a 0.25 square meter hydraulically-driven power grab sampler installed on a vessel, or similar method. The surface sediment grab sampler will be lowered over the side of the boat from a cable wire at slow speeds with minimal wake to minimize disturbance of the sediment surface. Sediment samples will be handled carefully to minimize disturbance during collection and transportation.

The following procedures will guide the surface sediment sample acquisition.

- With the GPS receiver, position the vessel on the approximate sampling location identified in Table 3.
- Prepare the power grab sampler for deployment.
- Prior to sampling, wash the power grab with a phosphate-free detergent (e.g., Alconox®).

- Using GPS, position the sampling vessel such that the GPS antenna, mounted on the winch arm directly over the grab sampler, is within ± 3 feet of the intended sampling location.
- Lower the sampler through the water column to the bottom at a slow speed (approximately 0.3 feet per second).
- When the sampler reaches the mud line, the cable will be drawn taut and the GPS location will be recorded.
- Record the water depth and time.
- Retrieve the sampler and raise it at slow speed.
- Bring the power grab sampler aboard the vessel and place it in the work area using care to minimize disturbance of the sample.
- Evaluate the retrieved sample using the following criteria for sample acceptance:
    - Sediment is not extruded from the upper face of the sampler (or in direct contact with the sampler doors);
    - Overlying water is present (indicating minimal leakage from the sample);
    - The sediment surface is relatively flat (indicating minimal disturbance or winnowing);
    - A penetration depth of at least 11 cm is achieved; and
    - No signs of leaking from the sampling device.

If the criteria presented above are not met, the sample will be rejected and unused sediment will be returned to the sampling location. If additional sediment volume is needed, then multiple grab samples will be collected immediately adjacent to (but not below) the initial sample. If an acceptable grab sample cannot be obtained in three attempts, the target sampling location will be moved as close as possible to the original location, but no further than 15 to 20 feet away. If it is not possible to obtain a sample near the desired location, an alternate sample location will be selected.

Once the grab has been accepted, overlying water will be siphoned off and a decontaminated stainless steel trowel, spoon or equivalent will be used to collect only the upper 10 cm of sediment from inside the sampler without touching the sidewalls. The sampler will be decontaminated between stations and rinsed with site water between grabs.

After a sample has been collected and accepted, detailed records of sediment sampling activities will be recorded in the field notebook. The information included in the sampling records will include:

- Sample location;
- Date and time of sampling;
- Weather conditions;
- Color photographs
- Name of sampler and note taker;
- GPS coordinates at sample location;
- Depth of water to mud line and surface elevation;
- River stage;
- Depth of penetration (in centimeters);
- Characteristics of the sample including odor (e.g., petroleum, chemical, sewage, other), texture (e.g., grain size), color, biological indicators, visual characteristics (e.g., sheen, debris, etc), indication of a redox layer (if visible), wood chips, sand blast grit (if visible), paint chips (if visible), or other anthropogenic debris (if visible), color (Munsell scale), stratification, other changes in sediment characteristics;
- Comments regarding sample quality (leakage, disturbance, any other pertinent observations);
- USCS classification;
- Maximum penetration depth of sample to nearest 0.5 cm;
- Collection method; and
- Field parameter measurements.

A minimum of 4 liters (112 ounces) of sediment will be collected at each location unless QA/QC samples are required for the sampling location, in which case additional volume will be necessary. The sediment from the first grab and subsequent grabs at each sample location will be transferred directly from the power grab sampler into a pre-cleaned stainless-steel bowl and stirred with a clean, stainless-steel spoon until texture and color homogeneity are achieved (PSEP 1997). Sample compositing is discussed in Section 3.2.5.

At the completion of sampling activities at each location, excess sediment will be returned to the sampling location and all sampling equipment will be cleaned following the procedures described in Section 3.3.

The samples will be transported to a Washington state-certified laboratory under standard COC protocol (see Section 4.3.3) for analysis of the parameters described in Table 3.

B-3.2.4.2 Subsurface Sediment

Subsurface sediment samples will be collected as close as possible to the paired surface sediment sample. The subsurface sediment includes all sediment from 10 cm bml until refusal. Based on available core logs from the area, depth to refusal is expected to be less than 15 feet bml. The sediment samples will be collected by gravity corer, vibracore, or equivalent mounted on a boat or other floating platform. The specific methods to be used for collecting and processing the sediment cores are provided in SOP J.

Each core will first be logged using USCS methods and stratigraphic layers will be identified. The cores will then divided into intervals for laboratory analyses based on depth. The first interval will include all sediment between 10 cm and 1 foot bml and the second interval will include sediment between 1 and 2 feet bml. All subsequent sediment will be divided into 2-foot intervals to refusal. Three intervals (0 to 1 feet bml, 2 to 4 feet bml, and 6 to 8 feet bml) will be analyzed immediately upon receipt and the remainder will be archived by the laboratory. The decision to analyze the archived samples will be based on results from the initial chemical analyses and identified data needs or if field screening indicates that anthropogenic materials may be present (i.e., sheen, sand blast grit, paint chips, color, odor, etc.). Each sample will consist of a representative volume of all included depths.

After cores are collected, they will be cut length-wise with an electric saw, being careful to minimize contact of the saw blade with the sediment. Each core section will be logged throughout the full penetration depth using USCS methods. Each sample core will then be split into sample intervals described Table 3. Field notes will indicate the following subsurface lithologic intervals (Recent Deposits, Upper Alluvium, Lower Alluvium, and/or anthropogenic as appropriate). Each interval will be processed separately for laboratory analysis, as appropriate.

Any large (e.g., greater than 1-inch diameter) non-sediment items such as rocks, shells, wood chips, or organisms (e.g., clams) will be noted prior to removal before homogenization. Homogenized sediment will then be split into the appropriate sample containers. At the completion of sampling activities at each location, excess sediment will be containerized and characterized prior to disposal at a solid waste facility and all sampling equipment will be cleaned following the procedures described in Section 3.3.

The samples will be transported to a Washington state-certified laboratory under standard COC protocol (see Section 4.3.3) for analysis of the parameters described in Table 3.

B-3.2.5 Sample Compositing

As the goal of this sampling is remedial investigation, samples will include collecting an adequate amount of material that is homogeneous. If a sample of a specific lithology or different segment (grain size, contamination noted, etc.) does not result in adequate material for the sample analysis, then a new core will be drilled as close as possible so that more material from the unique section may be obtained. Samples will be homogenized to obtain a representative sample of the subject area (i.e., surface sediment, sediment core or catch basin) and to obtain a large enough volume of solids to run all of the required analyses. Subsamples will be combined in a stainless steel container and mixed until homogenous in color and texture using a stainless steel mixing spoon. Debris and materials more than 0.5 inch in diameter will be removed from the sample prior to mixing. The sample mixture will then be placed in pre-labeled sampling containers and stored on ice in a cooler. The samples will be transported to a Washington state-certified laboratory under standard COC protocol for analysis of the parameters shown in Table 3. All mixing materials will be decontaminated prior to and following use, using methods provided in Section 3.3.

B-3.3 EQUIPMENT DECONTAMINATION PROCEDURES

Equipment to be decontaminated will include rods and augers for drilling, hand tools for solids collection, homogenizing/compositing containers, and other mixing equipment. After completing the decontamination process, the equipment will be positioned to preclude inadvertent contamination prior to reuse.

SOP J: SEDIMENT CORE SAMPLE COLLECTION

Core Collection Methods

Subsurface sediment samples will be collected from within the Embayment. The subsurface sediment samples will be collected by gravity corer, vibracorer, or equivalent. The sampling equipment will be mounted on a boat or other floating platform. Gravity's RIC 3500 vibracore operates at 1800 vibrations per minute with an impact force of 2000 ft/lbs of force. The frequency of the unit can be adjusted in the field to minimize disturbance of the sediment substrates for optimum collection of representative layers. The vibracorer will use polycarbonate tubes that are 4 inches in diameter. The tubes have an internal custom lexan finger system to retain substrate. The vibracorer will be lowered to the bottom, where the unit will then be energized and allowed to penetrate the sediment.

Core Collection Procedures

The following steps should be used to collect sediment core samples:

The sediment core procedure includes the following:

1. All data from sediment core collection is recorded real-time onto field logs.
    a. Elevation of each station sampled as measured from MLLW
    b. Location of each station as determined by DGPS
    c. Date and time of collection of each sediment core sample
    d. Names of field supervisor and person(s) collecting and handling the sample
    e. Observations made during sample collection including: weather conditions, complications, ship traffic, and other details associated with the sampling effort
    f. The sample station identification
    g. Length and depth intervals of each core and estimated recovery for each sediment sample as measured from MLLW
    h. Qualitative notation of apparent resistance of sediment column to coring
    i. Any deviation from the approved SAP

2. The sampling vessel is maneuvered to the designated target coordinates for sample locations using the DGPS and an onboard navigation system.

3. Prior to occupying a sampling location a pre-cleaned aluminum core barrel fit with a core-catcher is set into the vibracore apparatus.

4. The core tube caps will be removed immediately prior to placement into the coring device. Care will be taken during sampling to avoid contact of the sample tube with potentially contaminated surfaces. Extra sample tubes will be available during sampling operations for uninterrupted sampling in the event of a potential core tube breakage or contamination. Core tubes suspected to have been accidentally contaminated will not be used.
5. Once the boat is in the general proximity of the planned sampling point, the coring apparatus is lowered vertically through the water column till just above the sediment surface. The boat is positioned to within ± 3 ft of the designated target coordinates, and the core unit is set on the sediment surface.
6. The vibracore unit is switched on, and the progress of the cores descent through the mud is monitored for achievement of the target push depth or refusal.
7. For each core attempt, the sample name, latitude/longitude, time of collection, depth to mudline, depth of drive, and total drive time are noted in the field log.
8. The core will be driven to its maximum to refusal. Initial acceptance criteria for a sediment core sample are as follows:
    a. The core penetrated to, and retained material to, project depth or refusal;
    b. Recovery was at least 90 percent of the length of core penetration;
    c. Cored material did not extend out the top of the core tube or contact any part of the sampling apparatus at the top of the core tube;
    d. There are no obstructions in the cored material that might have blocked the subsequent entry of sediment into the core tube and resulted in incomplete core collection.

9. The core apparatus is retrieved and brought back on board. The field crew will note the condition (texture, color, presence of debris) of the material in the bottom of the core, and then fix a plastic cap over the tube to retain material prior to removing the tube for cutting.
10. The amount of material retained in the core tube is measured and recorded in the field log. The recovery depth is the total length of tube penetration minus the measured depth from the top of the tube to the height of the mud in the tube.
11. If the core is discarded, make an additional attempt at least 1′ from the previous location.
    - If the second attempt fails, determine if there is a physical reason (e.g., sediment type) that is preventing adequate recovery.
    - A maximum of three attempts will be made. Recovery of at least 80 percent will be accepted after two unsuccessful attempts to achieve 90 percent recovery. The suspected reason(s) for recovery less than 90 percent will be recorded in the field log.

- If the third attempt fails the recovery criteria of 80 percent, the cores are retained, and the field manager will contact the project manager who will consult with the project team and Ecology, to determine how to proceed.

12. The retained core tube is placed into an on-board cutting jig, measured and marked (scoring the metal) in 4-foot intervals. Each interval is marked with the station name, the core interval (i.e., A, B or C), and the direction to the top of the core. Once cut, the scored labels may be written over with a permanent marker.
13. The tubes are cut and capped, with the cap being secured with duct tape. The station, date, time, interval, and a direction arrow to the top of the tube are made with a permanent marker on the duct-taped cap.
14. The cut and marked core intervals are stored vertically in a core rack, on ice, and in the dark (e.g., under a tarp) until processing.

Core Processing Procedures:

Core processing will occur either aboard the sampling vessel or on-site after completion of sampling. Cores will be stored upright on ice until processed. Samples will be sent to the lab as soon as possible and analyzed within the required time and temperature. Processing and sub-sampling of the cores will include the following procedures.

1. All sampling equipment — including spoons, bowls, and other re-usable gear — will be stainless steel, and will be decontaminated (see Section 3.3) prior to processing as follows:
    a. Rinse and pre-clean with potable water;
    b. Wash and scrub the tubes in a solution of laboratory grade, non-phosphate-based soap and potable water;
    c. Rinse with potable water;
    d. Seal both ends of each core tube with aluminum foil.

2. All field logs must accompany the cores to the processing facility. Field logs will be used to maintain chain-of-custody (COC) of core tubes. Laboratory COC forms will be used to document sediment sample custody and transfer after core processing.
3. Extrude sample material from sample core tube onto a stainless steel tray using a vibrating core-extruder. Alternatively, the cores will be split longitudinally by scoring the sides of the aluminum tube with a circular saw. Once scored the cores are opened, and placed onto a foil-covered processing table.
4. The total length of sediment within the core is measured and record on the core data sheet as the total core length upon receipt. Sampling intervals will be completed as specified in Section B-3.2.

5. The entire length of the core is photographed noting the sample id, the segment, and the date and time of the sample is included in the frame. In addition, a tape measure that is extended the entire length of the tube is included in the picture to note the length within the tube.
6. Record the description of the core sample on the core log form for the following parameters as appropriate and present
    a. The core's color, structure, grain size, and any other significant details will be described in detail. This will include, but is not limited to: general soil type based upon the Unified Soil Classification System (USCS), approximate grain size, presence or evidence of biota (e.g., worm tubes or bivalve shells), odor, and color. Grain size will be a qualitative observation denoting the following types: silt, fine sand, coarse sand, clay, organic matter and gravel. This information should be recorded for, at a minimum, every 1-foot of core depth, but is also necessary wherever observable layers occur. This information will be recorded in the field log. The narrative shall include description of organism activities, debris, etc. in the sediment, if there are any.

7. Based upon the core lengths and sample depths, mark on the core tubes the sections to homogenize for analysis. Collect the requisite number of decontaminated stainless steel bowls and spoons for homogenization.
8. Remove the sections of sediment for analysis using a stainless steel spoon and place into a stainless steel mixing bowl. Mix the sediment using a circular motion from top to bottom until there is no observable change in sediment color.
9. Fill container with sample as full as possible to eliminate air space in sample jar (it may be necessary to slightly overfill jar to reach a convex meniscus and slide the the cap liner, with PTFE side down, expelling the additional sample).
10. Screw cap on the container and tighten.
11. Once collected, all sample containers will be appropriately labeled and cooled. Laboratory COC forms will be filled out as the samples are collected. Sample collection information will be recorded in the field log (e.g., marking the sample intervals and sample identification number for each interval).
12. Filled sample containers will be stored in coolers containing ice to maintain the samples at 4°± 2°C until delivery or shipping to the analytical laboratories.
13. Extra (residual) sediment not processed for analysis will be containerized and characterized for appropriate disposal method.

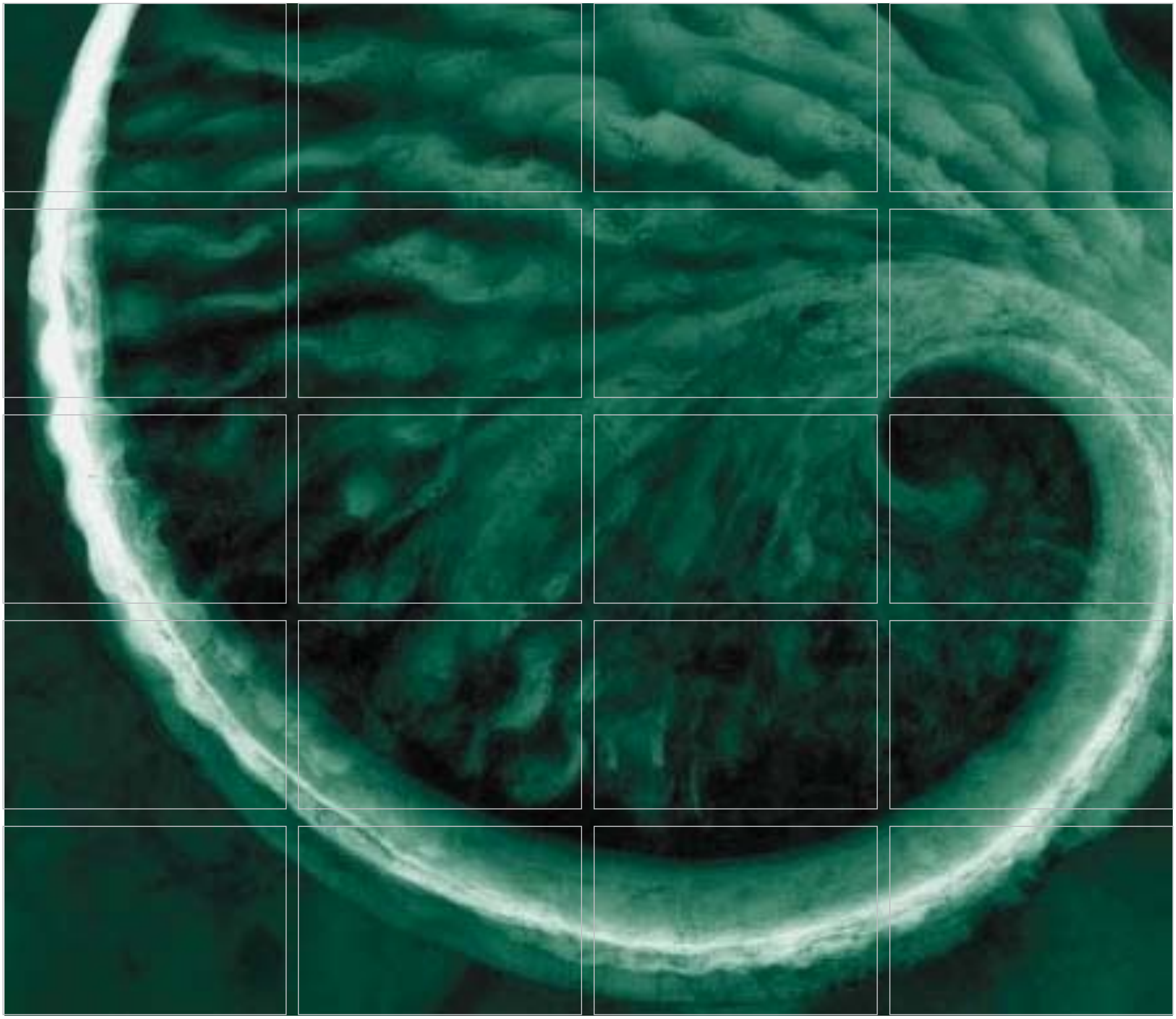
The sample(s) must be sent to the lab as soon as possible and be analyzed within the required reserved duration. Analyses required for core-collected samples are given in Table 3. Sediment volumes for analyses are shown in Table 6.

Station Positioning

Horizontal positioning will be determined by the onboard differential global positioning system (DGPS) based on target coordinates. Measured station positions will be converted to latitude and longitude (North American Datum [NAD] 83) to the nearest 0.1 second. The accuracy of measured and recorded horizontal coordinates will be within 2 meters. Vertical elevation of each boring station will be measured using a fathometer or lead line and converted to the applicable local elevation datum.

Appendix C

Revised Final QAPP



APPENDIX D – REVISED FINAL
Quality Assurance Project Plan Information

Glacier Northwest, Inc. – Reichhold, Inc. Site
Seattle, Washington

May 2012

Prepared for:
Glacier Northwest, Inc.
and Reichhold, Inc.

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LIST OF ACRONYMS

COC	Chain-of-Custody
EDD	Electronic data deliverable
FS	Feasibility Study
GC	Gas chromatography
ID	Identification
LCD	Laboratory control duplicate
LCS	Laboratory control samples
MDL	Method detection limit
MS	Matrix Spike
MSA	Method of Standard Addition
MSD	Matrix spike duplicates
PQL	Practical quantitation limits
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RI	Remedial Investigation
RPD	Relative percent difference
SAP	Sampling and Analysis Plan
SD	Sample Duplicate
SDG	Sample delivery group
SOP	Standard Operating Procedures
USEPA	United States Environmental Protection Agency

D-1.0 INTRODUCTION

The purpose of this Quality Assurance Project Plan (QAPP) appendix to the Glacier Northwest-Reichhold revised final Remedial Investigation and Feasibility Study Work Plan (RI/FS Work Plan) is to provide the specifications for laboratory analyses of groundwater, soil, riverbank soil, storm water solids, storm water and surface and subsurface sediment samples collected from the property located at 5900 West Marginal Way in Seattle, Washington (the "Site"). Data from this sampling will be used in combination with existing data to evaluate data gaps and will be presented in detail in the Remedial Investigation (RI) report and incorporated into the Feasibility Study report.

This QAPP document was developed following guidelines provided by the Washington State Department of Ecology's 2001 *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies*. The required data quality objectives, background, study specifics, organization, schedule, quality assurance (QA) requirements and quality control (QC) procedures and sampling procedures are incorporated in the accompanying Sampling and Analysis Plan (SAP) presented in Appendix B of the revised final RI/FS Work Plan. This QAPP presents the laboratory activities associated with this study.

Samples collected during RI activities will be submitted to two laboratories for analyses:

- Analytical Resources, Inc. in Tukwila, Washington; and
- AXYS Analytical Services, Ltd. in Sidney, BC, Canada.

Analytical Resources, Inc. will perform all analyses except dioxins/furans, which will be performed by AXYS Analytical Services, Ltd. Laboratory expectations are provided in the following sections of this QAPP.

This appendix is organized into the following sections:

- **Section D-2.0** – Laboratory Quality Control Program
- **Section D- 3.0** - Laboratory Quality Assurance
- **Section D- 4.0** – Laboratory Corrective Action
- **Section D-5.0** – Data Management

D-2.0 LABORATORY QUALITY CONTROL PROGRAM

This section describes QC procedures, including laboratory qualifications and a QA program; and QC procedures associated with analytical methods. The laboratory QA program will be compliant with the applicable United States Environmental Protection Agency (USEPA) Methods and laboratory Standard Operating Procedures (SOPs).

D-2.1 LABORATORY QUALITY CONTROL CHECKS

The recovery of known additions is a part of laboratory analytical protocols. The use of additives at known concentrations allows detecting the matrix interferences and estimating the impact of these interferences when present. It also allows evaluating the efficiency of extraction procedures and overall accuracy of analysis. Laboratory internal QC checks will be performed in accordance with analytical procedures that conform to USEPA guidelines published in *Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846,* Third Edition (1986, update package, December 1997) and may include:

- Laboratory control samples (LCSs);
- Laboratory control duplicates (LCDs);
- Matrix spikes (MSs);
- Matrix spike duplicates (MSDs);
- Laboratory duplicates;
- Surrogate standards;
- Internal standards;
- Method and instrument blanks; and
- Post-digestion spikes.

D-2.1.1 Laboratory Control Samples

LCSs are matrix equivalent QC check samples (analyte-free water, laboratory sand, or sodium sulfate) spiked with a known quantity of specific analytes that are carried through the entire sample preparation and analysis process. The spiking solution used for LCS/LCSD preparation is of a source different from the stock used to prepare calibration standards.

D-2.1.2 Laboratory Duplicates

For laboratory sample duplicate (SD) analyses, a sample is prepared and analyzed twice. Laboratory duplicates are prepared and analyzed with each batch of samples for most inorganic analyses.

D-2.1.3 Matrix Spikes

MSs are QC check samples that measure matrix-specific method performance. A MS sample is prepared by adding a known quantity of target analytes to a sample prior to sample digestion or extraction. In general, for organic compound and metal analyses, an MS/MSD pair is prepared and analyzed with each preparation batch or for every 20 field samples. Project-specific MS/MSDs will be requested for primary constituents of potential concern, as listed in Table 5 of the SAP included as Appendix B of the revised final RI/FS Work Plan. The frequency of MS/MSD analysis depends on the project data quality objectives. For inorganic compound analysis, a single MS and a laboratory duplicate are often prepared and analyzed with each batch. The LCS results, together with MS results, allow verifying the presence of matrix effects.

D-2.1.4 Surrogate Standards

Organic compound analyses include the addition, quantitation, and recovery calculation of surrogate standards. Compounds selected to serve as surrogate standards must meet all of the following requirements:

- Are not the target analytes;
- Do not interfere with the determination of target analytes;
- Are not naturally occurring, yet are chemically similar to the target analytes; and
- Are compounds exhibiting a similar response to target analytes.

Surrogate standards are added to every analytical and QC check sample at the beginning of the sample preparation. The surrogate standard recovery is used to monitor matrix effects and losses during sample preparation. Surrogate standard control criteria are applied to all analytical and QC check samples, and if surrogate criteria are not met, re-extraction and reanalysis may be performed.

D-2.1.5 Internal Standards

Some organic compound analyses include the addition, quantitation, and recovery calculation of internal standards. Internal standards are usually synthetic compounds, which are similar in chemical behavior to the target analytes. They are added to sample extracts at the time of instrument analysis, and are used to quantitate results through internal standards calibration procedures. Internal standard recoveries are used to correct for injection and detector variability. Gas chromatography (GC)/mass spectrometry must use internal standards and have acceptability limits for internal standard areas. Use of internal standard quantitation for GC methods is optional.

D-2.1.6 Method Blanks

A method blank is used to monitor the laboratory preparation and analysis systems for interferences and contamination from glassware, reagents, sample manipulations, and the general laboratory environment. A method blank is carried through the entire sample preparation process, and is included with each batch of samples. Some methods of inorganic analysis do not have a distinctive preparation step. For these tests, the instrument blank, which contains all reagents used with samples, is considered to be the method blank.

D-2.1.7 Instrument Blanks

An instrument blank is used to monitor the cleanliness of the instrument portion of a sample analysis process. Instrument blanks are usually just the solvent or acid solution of the standard used to calibrate the instrument. During metals analyses, one instrument blank is usually analyzed for every ten samples. For GC and GC/mass spectrometry analysis, instrument blanks are analyzed on an as-needed basis for troubleshooting and chromatography column carryover determination purposes.

D-2.1.8 Post-Digestion Spikes and the Method of Standard Addition

A post-digestion spike is used during metal analysis to assess analytical interferences that may be caused by general matrix effects or high concentrations of analytes present in the sample. A digested sample is spiked with the analyte of interest at a known concentration, and the spike recovery is used to estimate the presence and magnitude of interferences.

If a post-digestion spike recovery fails to meet acceptance criteria, the Method of Standard Addition (MSA) will be used to quantitate the sample result. The MSA technique compensates for a sample constituent that enhances or depresses the analyte signal. To perform the MSA, known amounts of a standard at different concentrations are added to two to three aliquots of digested sample, and each spiked sample and the original unspiked sample are analyzed. The absorbance is then plotted against the concentration, and the resulting line is extrapolated to zero absorbance. The point of interception with the concentration axis is the indigenous concentration of the analyte in the sample.

D-2.2 DATA QUALITY INDICATORS

This section defines the data quality indicators and their use for assessment of data quality.

D-2.2.1 Precision

Precision measures the reproducibility of measurements under a given set of conditions. The following equation illustrates the method for calculating relative percent difference (RPD) to assess a method's precision:

$$\text{Precision as RPD} = \frac{2\text{x}\left|\text{Result} - \text{Duplicate Result}\right|}{\text{Result} + \text{Duplicate Result}} x100\%$$

The laboratory uses MS/MSD pairs to assess the precision of analytical procedures, with one MS/MSD pair analyzed for every batch of up to 20 samples. This allows determining whether matrix interferences may be present.

The laboratory uses LCS/LCD pairs when MSs are not practical due to the nature of a sample or analytical method used, and they are prepared and analyzed with each batch of samples instead of MS/MSD. An LCS/LCD may also be prepared in place of an MS/MSD in the case that a sufficient sample volume was not obtained in the field to perform the MS/MSD analysis. For inorganic analyses, analytical precision is usually calculated based on the sample and SD results.

The analytical laboratory will have statistically-based acceptability limits for RPDs established for each method of analysis and sample matrix. The advisory control limit of 30 percent may be used until statistical limits are determined. The laboratory will review the QC samples to ensure that internal QC data lie within the limits of acceptability. Any suspect trends will be investigated and corrective actions taken.

Field precision is evaluated by collecting and analyzing "blind" field duplicate samples (field QC samples) at a rate of one for every 10 samples. Field duplicates will not be collected for soil samples. Sampling precision will be evaluated based on the RPD for field duplicate samples. The field precision acceptability limits will be 30 percent for all groundwater analyses.

Field precision will be monitored for evaluation of the sampling techniques and sample handling procedures. Analytical data will not qualify during the data validation process, based on the field precision values.

D-2.2.2 Accuracy

Accuracy measures the bias of an analytical system by comparing the difference of a measurement with a reference value. The percent recovery of an analyte, which has been added to the environmental samples at a known concentration before extraction and analysis, provides a quantitation tool for analytical accuracy. The spiking solutions used for accuracy determinations are not used for instrument calibrations. The following equation illustrates how accuracy is evaluated:

$$\text{Accuracy as percent recovery} = \frac{\text{Spiked Sample Result - Sample Result}}{\text{Spike True Value}} x100\%$$

Percent recoveries for MS, MSD, and LCS that are analyzed for every batch of up to 20 samples serve as a measure of analytical accuracy. Surrogate standards are added to all samples, blanks, MS, MSD, and LCS analyzed for organic contaminants to evaluate accuracy of the method and help to determine matrix interferences.

Laboratories may use the Department of Defense Quality Systems Manual for environmental laboratories default LCS control limits until in-house statistically based control limits are developed for each method of analysis and sample matrix.

Control limits are defined as the mean recovery, plus or minus three standard deviations, of the 20 data points, with the warning limits set as the mean, plus or minus two standard deviations. The laboratory will review the QC samples and surrogate standard recoveries for each analysis to ensure that internal QC data lie within the limits of acceptability. The laboratory will investigate any suspect trends and take appropriate corrective actions.

D-2.2.3 Representativeness

Unlike precision and accuracy, which can be expressed in quantitative terms, representativeness is a qualitative parameter. Representativeness is the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. It is a qualitative parameter that depends on proper design of the sampling program.

Field personnel will be responsible for ensuring that samples are representative of field conditions by collecting and handling samples according to approved SAP and field SOPs. Errors in sample collection, packaging, preservation, or chain-of-custody (COC) procedures may result in samples being judged as non-representative and may form a basis for rejecting the data.

Data generated by the laboratory must be representative of the laboratory database of accuracy and precision measurements for analytes in different matrices. Laboratory procedures for sample preparation will ensure that aliquots used for analysis are representative of the whole sample. Aliquots to be analyzed for volatile parameters will be removed before the laboratory composites/homogenizes the samples, to avoid losing volatile compounds during mixing.

D-2.2.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another, whether it was generated by a single laboratory or during interlaboratory studies. The use of standardized field and analytical procedures ensures comparability of analytical data.

Sample collection and handling procedures will adhere to USEPA-approved protocols. Laboratory procedures will follow standard analytical protocols, use standard units, and standardized report formats, follow the calculations as referenced in approved analytical methods, and use a standard statistical approach for QC measurements.

D-2.2.5 Completeness

Completeness is a measure of whether all the data necessary to meet the project have been collected. For the data to be considered complete, they must meet all acceptance criteria including accuracy and precision and other criteria specified for an analytical method. The data will be reviewed and /or validated to keep invalid data from being processed through data collection. Completeness is evaluated using the following equation:

$$\text{Completeness} = \frac{\text{Acceptable Results}}{\text{Total Results}} x100\%$$

The goal for completeness for all QC parameters, except holding times, will be 90 percent. The goal for holding times will be 100 percent. If these goals are not achieved, the sources of nonconformance will be evaluated to determine whether resampling and reanalysis is necessary.

D-2.3 PROJECT-REQUIRED REPORTING LIMITS (SENSITIVITY)

The laboratory will determine the method detection limits (MDLs) for each method, instrument, analyte, and matrix by using the procedure described in Title 40 Code of Federal Regulations Part 136B. The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99percent confidence that the analyte concentration is greater than zero.

An MDL study involves preparation/digestion and analysis of seven replicates of a given MS with target analytes at concentrations two to five times greater than the estimated MDL. The MDLs for metals in soil will be derived from the MDLs for metals in water. At a minimum, the laboratory will conduct annual MDL studies. The laboratory will select the practical quantitation limits (PQLs) for all analytes at concentration levels that exceed the calculated MDLs by a factor of two to ten. Reporting limits for the project are presented in **Table D-1.**

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D-3.0 LABORATORY QUALITY ASSURANCE

D-3.1 LABORATORY QUALIFICATIONS

The analytical laboratories selected to analyze samples for this project are certified by the Washington State Department of Ecology and/or the National Environmental Laboratory Accreditation Program for all the analytical methods required for the project.

Laboratories selected for the project are committed to providing the required turnaround times, project QC, and data deliverables required by the SAP.

D-3.2 LABORATORY QUALITY ASSURANCE AND QUALITY CONTROL PROGRAM

QA is a set of operating principles that, if strictly followed during sample collection and analysis, will produce defensible data of known quality. Included in QA are QC and quality assessments. QC is a set of measures within a sample analysis methodology to ensure that the process is in control. Quality assessment consists of procedures for determining the quality of laboratory measurements by use of data from internal and external QC measures.

A properly designed and executed QC program will result in a measurement system operating in a state of statistical control, which means that errors have been reduced to acceptable levels. An effective QA program includes the following elements:

- Certification of operator competence;
- Internal QC checks, such as recovery of known additions through use of surrogate standards, MSs, and LCSs;
- Analysis of externally supplied standards;
- Analysis of reagent blanks;
- Calibration with standards using internal or external standard procedures;
- Calibration verification with second source standard;

- Analysis of duplicates; and
- Maintenance of control charts.

Strict adherence to Good Laboratory Practices and consistent use of SOPs are also essential for a successful QC program. The laboratory will have the current revisions of the SOPs readily available for all staff. At a minimum, SOPs will be written for the following procedures and methods: sample receipt/control/disposal, sample preparation/extraction, sample analysis, results calculation, database management, health and safety, and corrective action.

The analytical laboratory will have written SOPs defining the instrument operation and maintenance, tuning, calibration, MDL determination, QC acceptance criteria, blank requirements, and stepwise procedures for each analytical method. The SOPs will be available to the analysts in the laboratory. Any method that is subcontracted by the laboratory to another laboratory or sent to another facility of the same network of laboratories will have prior approval from the ERM Project Chemist.

D-3.3 CALIBRATION

All instruments will be calibrated and the calibration acceptance criteria met before samples are analyzed. Calibration standards will be prepared with National Institute for Standards and Testing-traceable standards and analyzed per methods requirements. Initial calibration acceptance criteria documented in the laboratory SOPs will meet those of applicable guidance documents. The initial calibration will meet one of the following requirements:

- The lowest concentration of the calibration standard is less than or equal to the PQL based on the final volume of extract or sample; or
- For each target analyte, at least one of the calibration standards will be at or below the regulatory limit (action level) as defined by the data quality objectives.

Before samples are analyzed, initial calibration will be verified with a second source standard prepared at the mid-point of the calibration curve. Initial calibration verification will meet the acceptance criteria, which are expressed in the laboratory SOPs.

Daily calibration verification will be conducted at the method-prescribed frequencies, and will meet the acceptance criteria of applicable guidance documents. Daily calibration verification will not be used for quantitation of target analytes.

Calibration data (calibration tables, chromatograms, instrument printouts, and laboratory logbooks) will be clearly labeled to identify the source and preparation of the calibration standard and therefore will be traceable to the standard preparation records.

D-3.4 PREVENTITIVE MAINTENANCE

The primary objective of a preventive maintenance program is to help ensure the timely and effective completion of a measurement effort by minimizing the down time of crucial analytical equipment due to expected or unexpected component failure. In implementing this program, efforts are focused in three primary areas: maintenance responsibilities, maintenance schedules, and adequate inventory of critical spare parts and equipment.

Maintenance responsibilities for laboratory equipment are assigned to the respective laboratory managers. The laboratory managers then establish maintenance procedures and schedules for each major equipment item. These are contained in the maintenance logbooks assigned to each instrument.

The effectiveness of any maintenance program depends, to a large extent, on adherence to specific routine maintenance for each major equipment item. Other maintenance activities may also be identified as requiring attention on an as-needed basis. Manufacturers' recommendations and/or sample throughput provide the basis for the established maintenance schedules, and manufacturers' service contracts provide primary maintenance for many major instruments (e.g., GC/MS instruments, atomic absorption spectrometers, analytical balances, etc.). Maintenance activities for each instrument are documented in a Maintenance Log.

Along with a schedule for maintenance activities, an adequate inventory of spare parts is required to minimize equipment down time. This inventory emphasizes those parts (and supplies), which are subject to frequent failure, have limited useful lifetimes or cannot be obtained in a timely manner should failure occur.

The respective laboratory managers are responsible for maintaining an adequate inventory of necessary spare parts. Sufficient equipment is on hand to continue analyses in the event that an instrument encounters problems. In addition to backup instrumentation, a supply of spare parts such as GC columns, fittings, septa, and other ancillary equipment is maintained.

D-3.5 TRAINING

The laboratory will have an established policy and procedure on training and documenting of the analyst's competency. Each staff member that performs sample preparation and analysis will demonstrate their proficiency through preparation and analysis of four LCSs as described in the USEPA SW-846 (*Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* [USEPA 1996]). An analyst will be considered proficient if the acceptance criteria for method accuracy and precision are met. The laboratory will maintain all training records on file.

D-3.6 SUPPLIES AND CONSUMABLES

The laboratory will inspect supplies and consumables prior to their use in analysis. The materials specifications in the analytical methods will be used as a guideline for establishing the acceptance criteria for these materials. Purity of reagents will be monitored by analysis of method blanks. An inventory and storage system for materials and supplies will ensure use before manufacturers' expiration dates and storage under safe and chemically compatible conditions.

D-3.7 SOFTWARE QUALITY ASSURANCE

The generation, compilation, and reporting of electronic data are critical components of laboratory operations. To produce defensible data of known quality, the laboratory will develop an SOP, which describes activities related to data generation, reduction, and transfer with modern tools of data acquisition, and the policies and procedures for procurement, modification, and use of computer software.

D-4.0 LABORATORY CORRECTIVE ACTION

Corrective action takes place when a circumstance arises that has a negative impact on the quality of the analytical data generated during sample analysis. For corrective action to be initiated, awareness of a problem must exist. In most instances, the individuals performing laboratory analyses are in the best position to recognize problems that will affect data quality. Keen awareness on their part can frequently detect minor instrument changes, drifts, or malfunctions that can then be corrected, thus preventing a major breakdown of the QC system in place. If major problems arise, they are in the best position to recommend the proper corrective action and initiate it immediately, thus minimizing data loss. Therefore, the laboratory personnel will have a prime responsibility for recognizing a nonconformance and the need for implementing and documenting the corrective action. If a situation arises requiring corrective action, the following closed-loop corrective action process will be used:

1. Define the problem.
2. Assign responsibility for investigating the problem.
3. Investigate and determine the cause of the problem.
4. Determine corrective action course to eliminate the problem.
5. Assign responsibility for implementing the corrective action.
6. Determine the effectiveness of the corrective action and implement the correction.
7. Verify that the corrective action has eliminated the problem.
8. If not completely successful, return to Step 1.

The personnel identifying or originating a nonconformance will document it and include the following items:

- Identification of the individual(s) identifying or originating the nonconformance;
- Description of the nonconformance;
- Any required approval signatures;
- Method(s) for corrective action or description of the variance granted; and
- Schedule for completing corrective action.

All affected project samples will be listed on the Nonconformance/ Corrective Action Report. The laboratory Project Manager will notify the ERM Project Chemist of any laboratory nonconformance affecting the samples. Nonconformance/Corrective Action Reports will be submitted to ERM as part of data packages.

D-4.1 BATCH CORRECTIVE ACTION

Analytical laboratory processes are batch processes, and the batch is a basic unit for the frequency of some QC elements. A "batch" is a group of samples of similar matrix that behave similarly with respect to the procedures being employed. The following three types of batches can be identified at the analytical laboratory:

- Preparation batch,
- Instrument batch, and
- Sample delivery group (SDG).

A preparation batch is a group of up to 20 field samples that are prepared (e.g., extracted or digested) simultaneously or sequentially without interruption. Samples in each batch are of similar matrix (e.g., soil, sludge, liquid waste, and water), are treated in a similar manner, and are processed with the same lots of reagents. For organic compound analyses, each batch will contain a method blank, LCS, and MS/MSD pair. For inorganic compound analyses, each batch will contain a method blank, LCS, MS, and SD. These QC check samples are not counted into the maximum batch size of 20 samples.

An instrument batch is a group of samples that are analyzed within the same analytical run sequence. If the continuous operation of an instrument is interrupted (shut down for maintenance, etc.), a new instrument batch must be started. The instrument batch includes an instrument blank, calibration check standards, extracts/digestates of the field samples and QC check samples. The number of samples in the analytical batch is not limited, but the frequency of the calibration check standard and instrument blank analysis is mandated in each particular method.

For volatile organic compound analyses by GC or GC/MS, the preparation and instrument batch are the same, since the sample preparation (purge and trap) is performed as part of the instrument analysis. For these analyses, a batch is defined as a group of up to 20 field samples that are sequentially loaded on the instrument and analyzed as a single analytical run sequence. Laboratory QC check samples (method blank, an LCS, an MS/MSD pair) will be analyzed as part of the batch in addition to 20 field samples, as well as the calibration standard per method requirements.

For Contract Laboratory Program analyses, an SDG is defined as a group of 20 or fewer samples within a project that are received over a period of 14 days or less. An SDG is primarily a reporting format and is not limited to sample receipt groups, preparation batches, or analytical batches.

Method QC control acceptance criteria determine whether a method is performing within acceptable limits of precision and accuracy. There is a method component and a "matrix" component to this determination. The method component measures the performance of the laboratory analytical processes during the sample analyses. The matrix component measures the method performance on a specific matrix. Some QC elements uniquely measure the laboratory component of method performance, but all QC elements measuring the matrix component contain the method component.

Method blanks and LCSs uniquely measure the method performance. MSs, MSDs, laboratory blanks, surrogate standards, and post-digestion spikes measure the matrix component of method performance.

D-4.2 METHOD BLANK

The method blank measures laboratory-introduced contamination for the sample batch and batch corrective action is initiated when contamination is found. It may include reanalysis of the blank, reanalysis of the samples, repreparation and reanalysis of the blank, QC, and samples, and assessment of the impact of the contamination on batch sample data. Although it is a goal to have no detected target analytes in the method blanks, analytes may be periodically detected in blanks due to the nature of the analysis or the reporting limit for the analyte. For example, methylene chloride, acetone, and 2-butanone may sometimes be found in blanks for volatile organic compound analysis and the phthalate esters may sometimes be found in the blanks for semi-volatile organic compound analyses.

A method blank will be considered acceptable if the following conditions are met:

- Target analytes are present at concentrations less than ½ of the PQLs.

- Target analytes are present at concentrations less than five percent of the regulatory limits for these analytes.
- Target analytes are present at concentrations less than five percent of the sample results for these analytes.

If the method blank results do not meet these acceptance criteria, the laboratory will initiate corrective action.

The first step of corrective action is to assess the effect on the samples. For example, if an analyte is found only in the blank but not in any of the associated samples or if the target analyte in the blank is less than one-twentieth the value in the sample, no corrective action is necessary.

If corrective action is required, the method blank and any samples containing the same contaminant will be reanalyzed. If the contamination remains, the contaminated samples of the batch would be re-extracted and reanalyzed with a new method blank and QC check samples.

D-4.3 LABORATORY CONTROL SAMPLE

An LCS must meet the accuracy acceptance criteria for target analytes for the batch to be considered acceptable. If the target analytes are outside of the acceptance limits, corrective action will be initiated. Corrective action will include re-extraction and reanalysis of the whole batch, including method blank, samples, and QC check samples.

If MSs are not analyzed, an LCS/LCD pair will be analyzed with each batch of samples. If the LCS/LCD are outside method acceptance criteria for accuracy and precision, the whole batch will be re-extracted and reanalyzed, including method blank, samples, and QC check samples.

D-4.4 MATRIX SPIKE AND MATRIX SPIKE DUPLICATE

An MS/MSD pair is included with each batch of samples for organic compound analyses and MS and laboratory SD are included with each batch of samples for inorganic compound analysis. These QC check samples allow laboratory personnel to evaluate the accuracy and precision of analysis and the influence of matrix effects.

MS data evaluation is more complex than blank or LCS data evaluation since MSs measure matrix effects in addition to sample preparation and analysis effects. Sample heterogeneity, lithological composition of soil, and presence of interfering chemical compounds often negatively affect accuracy and precision of analysis. If the native concentration of target analytes in the sample chosen for spiking is high relative to the spiking concentration, the differences in the native concentration between the unspiked sample and the spiked samples may contribute a significant error in the precision and accuracy. The accuracy and precision in this case are not representative of the true method and matrix performance.

If the accuracy of MS/MSD analysis is outside the acceptability limits, for any target analyte, the LCS will be evaluated. If the LCS accuracy limits are met, the MS/MSD recovery problem will be identified as matrix effect and no further action will be required. If the LCS accuracy limits are not met, corrective action will be implemented, and the affected samples and associated QC samples will be reprepared and reanalyzed.

If the MS/MSD or sample/SD pair fail in precision due to observed matrix interferences, sample heterogeneity, or the nature of the contaminant, corrective action will not be required, and the laboratory will make an appropriate notation in the case narrative.

D-4.5 INDIVIDUAL SAMPLE CORRECTIVE ACTION

In addition to batch corrective action, individual samples within a batch may also require corrective action. Re-extraction and reanalysis of individual samples will take place in the following situations:

- Surrogate standard recoveries are outside acceptability limits.
- Internal standard areas for GC/MS analyses are outside acceptability limits.

Errors have been made during sample preparation, and results of analysis are not conclusive.

D-5.0 DATA MANAGEMENT

This section describes the data management procedures for data review, verification, reporting, and validation. All analytical data generated by the laboratory will be reviewed by the laboratory prior to reporting to ensure the validity of reported data. This internal laboratory data review process will consist of data reduction, three levels of documented review, and reporting. Review processes will be documented using appropriate checklist forms, or logbooks, that will be signed and dated by the reviewer.

D-5.1 DATA REDUCTION

Data reduction involves the mathematical or statistical calculations used by the laboratory to convert raw data to the reported data. Reduction of analytical data will be performed by the laboratory as specified in each of the appropriate analytical methods and laboratory SOPs. For each method, all raw data results will be recorded using method-specific forms or a standardized output from each of the various instruments.

All data calculations will be verified and initialed by personnel both generating and approving them. All raw and electronic data, notebook references, supporting documentation and correspondence will be assembled, packaged, and stored for a minimum of 7 years for future use. All reports will be held client confidential. If the laboratory is unable to store project-related data for 7 years, then it is the responsibility of the laboratory to contact ERM to make alternative arrangements.

D-5.2 LABORATORY DATA VERIFICATION AND REVIEW

The laboratory analyst who generates the analytical data will have the primary responsibility for the correctness and completeness of data. Each step of this verification and review process will involve the evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the review. This application of technical knowledge and experience evaluating data are essential in ensuring that data of known quality are generated consistently. All data generated and reduced will follow well-documented in-house protocols.

Level 1: Technical (Peer) Data Review—Analysts will review the quality of their work based on an established set of guidelines, including the QC criteria established in each method, in the SAP, and as stated within the laboratory QA Manual. This review will, at a minimum, ensure that the following conditions have been met:

- Sample preparation information is correct and complete.
- Analysis information is correct and complete.
- Appropriate SOPs have been followed.
- Calculations are verified.
- There are no data transposition errors.
- Analytical results are correct and complete.
- QC samples are within established control limits.
- Blanks and LCSs samples are within appropriate QC limits.
- Special sample preparation and analytical requirements have been met.

Documentation is complete, for example, any anomalies and holding times have been documented, and forms have been completed.

Level 2: Technical Data Review—This review will be performed by a supervisor or data review specialist whose function is to provide an independent review of data packages. This review will also be conducted according to an established set of guidelines and will be structured to verify the following finding of Level 1 data review:

- All appropriate laboratory SOPs have been followed.
- Calibration data are scientifically sound, appropriate to the method, and completely documented.
- QC samples are within established guidelines.
- Qualitative identification of constituents is correct.
- Manual integrations are justified and properly documented.
- Quantitative results and calculations are correct.
- Data are qualified correctly.
- Documentation is complete, for example, any anomalies and holding times have been documented, and appropriate forms have been completed.

- Data are ready for incorporation into the final report.
- The data package is complete and is in compliance with contract requirements.

The Level 2 review will be structured so that all calibration data and QC sample results are reviewed and all of the analytical results from at least 10 percent of the samples are checked back to the sample preparation and analytical bench sheets. If no problems are found with the data package, the review will be considered complete.

If any problems are found with the data package, an additional 10 percent of the sample results will be checked back to the sample preparatory and analytical bench sheets. This cycle will then be repeated either until no errors are found in the data set checked or until all data have been checked. All errors and corrections noted will be documented.

Level 3: Administrative Quality Assurance Data Review**—**The Laboratory QA Manager will review 10 percent of all data packages. This review should be similar to the review provided in Level 2 except that it will provide a total overview of the data package to ensure its consistency and compliance with project requirements. All errors noted will be corrected and documented.

D-5.3 DATA REPORTING

This section details the requirements for data reporting and data package formats that will be provided by the laboratory.

D-5.3.1 Hard copy deliverables

All relevant raw data and documentation, including (but not limited to) logbooks, data sheets, electronic files, final reports, etc., will be maintained by the laboratory for at least 7 years. The laboratory will notify ERM 30 days before disposal of any relevant laboratory records.

ERM will maintain copies of all COC forms until receipt of the laboratory report. Laboratory reports will be logged in upon receipt and filed in chronological order.

The laboratory hardcopy report will include the following information at a minimum:

- Case narrative including sample identification (ID) and Lab ID cross reference;

- Sample cooler receipt check list (including temperature and sample condition);
- Sample results for all parameters collected, including preparation and analysis date;
- Surrogate recovery for organic analyses;
- Summary results of LCS/LCSD recovery;
- Summary results of MS/MSD recovery;
- Method blank;
- Calibration blank (metals);
- SD results; and
- Serial dilution results (metals).

If deemed necessary, summary reports for initial calibration and continuing calibration data may be requested.

In addition, the laboratory will provide a full, Contract Laboratory Program-like data package that includes all raw data.

D-5.3.2 Electronic Deliverables

The laboratory will provide the electronic data deliverable (EDD) in two formats, a format compatible with the Washington State Department of Ecology's Environmental Information Management System, and a format compatible with EQuIS 4 database program. The laboratory will certify that the EDD and the hard copy reports are identical. The EDD for each SDG will be due at the same time as the hard copy: 14 days after the last sample of the SDG has been delivered to the laboratory.

Field information (date and time collected, sample ID, etc.) will be entered directly into the Sample Tracking Log from the COC forms and Field Sample Logbooks.

D-5.3.3 Manual Integration

Manual integration is sometimes necessary for proper compound quantitation in cases when there are overlapping or tailing peaks, and sloping baselines. When justified, manual integration can be conducted for standards, samples, and QC check samples.

Manual integration may include valley-to-valley baselines, vertical peak separation or slope integration. The type of manual integration is a judgment call of an analyst experienced in GC.

If a need for manual integration arises, the analysts performing analysis will select a proper approach based on their professional judgment. Manual integration will then be conducted and documented in the data file. Once an approach has been selected, it will be consistently used for the similarly affected peaks.

Manual integration documentation will include a copy of a computer-integrated chromatogram, a copy of a manually-integrated chromatogram, a brief justification description, and the name of the person who performed the manual integration. The Laboratory Manager will review and approve all manual integrations performed by analysts.

Table

Table D-1

Laboratory Detection Limits and Practical Quantitation Limits
5900 West Marginal Way SW
Seattle, Washington

Analyte	Method	Upland Soil		Storm Water Solids/Sediment		Surface/Ground Water	
		Method Detection Limit µg/kg	Practical Quantitation Limit µg/kg	Method Detection Limit µg/kg	Practical Quantitation Limit µg/kg	Method Detection Limit µg/L	Practical Quantitation Limit µg/L
Metals							
Total Aluminum	USEPA 6010B/6020	--	--	--	--	14.8	50
Total Calcium	USEPA 6010B/6020	--	--	--	--	5.88	50
Total Magnesium	USEPA 6010B/6020	--	--	--	--	10.81	50
Total Potassium	USEPA 6010B/6020	--	--	--	--	69.07	500
Total Sodium	USEPA 6010B/6020	--	--	--	--	159.27	500
Total/Dissolved Antimony	USEPA 6010B/6020	10	200	--	--	6.28	50
Total/Dissolved Arsenic	USEPA 6010B/6020	81	200	81	200	0.066	0.2
Total/Dissolved Beryllium	USEPA 6010B/6020	16	100	--	--	0.022	0.2
Total/Dissolved Barium	USEPA 6010B/6020	133	300	--	--	0.02	0.5
Total/Dissolved Cadmium	USEPA 6010B/6020	12	100	12	100	0.012	0.2
Total/Dissolved Chromium	USEPA 6010B/6020	260	500	260	500	0.053	0.5
Dissolved Chromium, hexavalent	USEPA 3060A/7196A	30	100	--	--	3	10
Total/Dissolved Copper	USEPA 6010B/6020	40	200	40	200	1.13	2
Total/Dissolved Iron	USEPA 6010B/6020	--	--	--	--	7.15	50
Total/Dissolved Lead	USEPA 6010B/6020	46	100	46	100	0.205	1
Total/Dissolved Manganese	USEPA 6010B/6020	--	--	--	--	0.85	1.0
Total/Dissolved Mercury	USEPA 7470A/7471A	1.3	25	1.3	25	0.0089	0.1
Total/Dissolved Nickel	USEPA 6010B/6020	386	1000	--	--	0.081	0.5
Total/Dissolved Selenium	USEPA 6010B/6020	--	--	--	--	0.125	0.5
Total/Dissolved Silver	USEPA 6010B/6020	40	300	40	300	0.55	3
Total/Dissolved Thallium	USEPA 6010B/6020	--	--	--	--	0.003	0.2
Total/Dissolved Zinc	USEPA 6010B/6020	370	1000	370	1000	3.94	10
Tributyltin							
Tributyltin - bulk sample	Krone/8270-SIM	0.562	4	0.562	4	--	--
Tributyltin - pore water	Krone/8270-SIM	0.0027	0.0075	0.0027	0.0075	0.0027	0.0075
Volatile Organic Compounds							
1,1,1,2-Tetrachloroethane	USEPA 8260C	0.233	1.0	--	--	0.068	0.2
1,1,1-Trichloroethane	USEPA 8260C	0.226	1.0	--	--	0.089	0.2
1,1,2,2-Tetrachloroethane	USEPA 8260C	0.253	1.0	--	--	0.067	0.2
1,1,2-Trichloro-1,2,2-Trifluoroethane	USEPA 8260C	0.287	2.0	--	--	0.107	0.2
1,1,2-Trichloroethane	USEPA 8260C	0.286	1.0	--	--	0.035	0.2
1,1-Dichloroethane	USEPA 8260C	0.203	1.0	--	--	0.053	0.2
1,1-Dichloroethene	USEPA 8260C	0.336	1.0	--	--	0.091	0.2
1,1-Dichloropropene	USEPA 8260C	0.312	1.0	--	--	0.092	0.2
1,2,3-Trichlorobenzene	USEPA 8260C	0.305	5.0	--	--	0.087	0.5
1,2,3-Trichloropropane	USEPA 8260C	0.517	2.0	--	--	0.226	0.5
1,2,4-Trichlorobenzene	USEPA 8260C	0.332	5.0	--	--	0.1	0.5
1,2,4-Trimethylbenzene	USEPA 8260C	0.230	1.0	--	--	0.058	0.2
1,2-Dibromo-3-Chloropropane	USEPA 8260C	0.586	5.0	--	--	0.212	0.5
1,2-Dibromoethane	USEPA 8260C	0.176	1.0	--	--	0.075	0.2
1,2-Dichlorobenzene	USEPA 8260C	0.293	1.0	--	--	0.055	0.2
1,2-Dichloroethane	USEPA 8260C	0.191	1.0	--	--	0.075	0.2
1,2-Dichloropropane	USEPA 8260C	0.162	1.0	--	--	0.093	0.2
1,3,5-Trimethylbenzene	USEPA 8260C	0.254	1.0	--	--	0.063	0.2
1,3-Dichlorobenzene	USEPA 8260C	0.227	1.0	--	--	0.04	0.2
1,3-Dichloropropane	USEPA 8260C	0.209	1.0	--	--	0.02	0.2
1,4-Dichlorobenzene	USEPA 8260C	0.232	1.0	--	--	0.057	0.2
2,2-Dichloropropane	USEPA 8260C	0.292	1.0	--	--	0.083	0.2
2-Butanone	USEPA 8260C	0.513	5.0	--	--	0.808	5

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Analyte	Method	Upland Soil		Storm Water Solids/Sediment		Surface/Ground Water	
		Method Detection Limit µg/kg	Practical Quantitation Limit µg/kg	Method Detection Limit µg/kg	Practical Quantitation Limit µg/kg	Method Detection Limit µg/L	Practical Quantitation Limit µg/L
2-Chloroethyl Vinyl Ether	USEPA 8260C	0.276	5.0	--	--	0.042	0.2
2-Chlorotoluene	USEPA 8260C	0.300	1.0	--	--	0.086	1
2-Hexanone	USEPA 8260C	0.439	5.0	--	--	0.31	5
4-Chlorotoluene	USEPA 8260C	0.277	1.0	--	--	0.073	0.2
4-Isopropyl Toluene	USEPA 8260C	0.236	1.0	--	--	0.075	0.2
4-Methyl-2-Pentanone	USEPA 8260C	0.420	5.0	--	--	0.384	5
Acetone	USEPA 8260C	0.482	5.0	--	--	0.72	5
Acrolein	USEPA 8260C	3.809	50	--	--	0.292	5
Acrylonitrile	USEPA 8260C	1.026	5.0	--	--	0.185	1
Benzene	USEPA 8260C	0.296	1.0	--	--	0.056	0.2
Bromobenzene	USEPA 8260C	0.153	1.0	--	--	0.051	0.2
Bromochloromethane	USEPA 8260C	0.323	1.0	--	--	0.067	0.2
Bromodichloromethane	USEPA 8260C	0.254	1.0	--	--	0.053	0.2
Bromoethane	USEPA 8260C	0.440	2.0	--	--	0.09	0.2
Bromoform	USEPA 8260C	0.297	1.0	--	--	0.07	0.2
Bromomethane	USEPA 8260C	0.187	1.0	--	--	0.043	1
Carbon Disulfide	USEPA 8260C	0.559	1.0	--	--	0.087	0.2
Carbon Tetrachloride	USEPA 8260C	0.213	1.0	--	--	0.075	0.2
Chlorobenzene	USEPA 8260C	0.219	1.0	--	--	0.042	0.2
Chlorodibromomethane	USEPA 8260C	0.266	1.0	--	--	0.09	0.2
Chloroethane	USEPA 8260C	0.462	1.0	--	--	0.152	0.2
Chloroform	USEPA 8260C	0.234	1.0	--	--	0.081	0.2
Chloromethane	USEPA 8260C	0.263	1.0	--	--	0.098	0.5
cis-1,2-Dichloroethene	USEPA 8260C	0.240	1.0	--	--	0.058	0.2
cis-1,3-Dichloropropene	USEPA 8260C	0.226	1.0	--	--	0.1	0.2
Dibromomethane	USEPA 8260C	0.147	1.0	--	--	0.081	0.2
Ethyl Benzene	USEPA 8260C	0.202	1.0	--	--	0.094	0.2
Hexachloro-1,3-Butadiene	USEPA 8260C	0.410	5.0	--	--	0.112	0.5
Iodomethane (Methyl Iodide)	USEPA 8260C	0.215	1.0	--	--	0.04	1
Isopropyl Benzene	USEPA 8260C	0.233	1.0	--	--	0.062	0.2
m,p-Xylene	USEPA 8260C	0.392	1.0	--	--	0.144	0.4
Methylene Chloride	USEPA 8260C	0.635	2.0	--	--	0.391	0.5
Methyl-t-butyl ether (MTBE)	USEPA 8260C	0.231	1.0	--	--	0.046	0.5
Naphthalene	USEPA 8260C	0.429	5.0	--	--	0.07	0.5
n-Butylbenzene	USEPA 8260C	0.262	1.0	--	--	0.108	0.2
n-Propyl Benzene	USEPA 8260C	0.272	1.0	--	--	0.081	0.2
o-Xylene	USEPA 8260C	0.224	1.0	--	--	0.057	0.2
s-Butylbenzene	USEPA 8260C	0.240	1.0	--	--	0.077	0.2
Styrene	USEPA 8260C	0.138	1.0	--	--	0.066	0.2
t-Butylbenzene	USEPA 8260C	0.306	1.0	--	--	0.061	0.2
Tetrachloroethene	USEPA 8260C	0.257	1.0	--	--	0.088	0.2
Toluene	USEPA 8260C	0.151	1.0	--	--	0.056	0.2
trans-1,2-Dichloroethene	USEPA 8260C	0.266	1.0	--	--	0.059	0.2
trans-1,3-Dichloropropene	USEPA 8260C	0.216	1.0	--	--	0.085	0.2
trans-1,4-Dichloro-2-Butene	USEPA 8260C	0.437	5.0	--	--	0.243	1
Trichloroethene	USEPA 8260C	0.212	1.0	--	--	0.076	0.2
Trichlorofluoromethane	USEPA 8260C	0.266	1.0	--	--	0.092	0.2
Vinyl Acetate	USEPA 8260C	0.381	5.0	--	--	0.068	1
Vinyl Chloride	USEPA 8260C	0.235	1.0	--	--	0.075	0.2

Table D-1

Laboratory Detection Limits and Practical Quantitation Limits
5900 West Marginal Way SW
Seattle, Washington

Analyte	Method	Upland Soil		Storm Water Solids/Sediment		Surface/Ground Water	
		Method Detection Limit µg/kg	Practical Quantitation Limit µg/kg	Method Detection Limit µg/kg	Practical Quantitation Limit µg/kg	Method Detection Limit µg/L	Practical Quantitation Limit µg/L
Semi-Volatile Organic Compounds: Phenol and Chlorinated Phenols							
Phenol	USEPA 8270D	8.65	20	--	--	0.163	1
2-Chlorophenol	USEPA 8270D	2.39	20	--	--	0.254	1
2,4-Dichlorophenol	USEPA 8270D	21.5	200	--	--	0.965	5
2,4,6-Trichlorophenol	USEPA 8270D	22.4	100	--	--	0.845	5
2,4,5-Trichlorophenol	USEPA 8270D	21.4	100	--	--	0.665	5
2,3,4,6-Tetrachlorophenol	USEPA 8270D	4.85	20	--	--	0.153	1
Pentachlorophenol	USEPA 8270D	48.5	200	--	--	0.647	5
Semi-Volatile Organic Compounds: Low Level PAH							
1-Methylnaphthalene	USEPA 8270-SIM	1.7	5	1.7	5	0.0193	0.1
2-Methylnaphthalene	USEPA 8270-SIM	1.36	5	1.36	5	0.0163	0.1
Acenaphthene	USEPA 8270-SIM	2.08	5	2.08	5	0.0087	0.1
Acenaphthylene	USEPA 8270-SIM	1.1	5	1.1	5	0.0202	0.1
Anthracene	USEPA 8270-SIM	0.86	5	0.86	5	0.0402	0.1
Benzo(a)anthracene	USEPA 8270-SIM	1.37	5	1.37	5	0.0349	0.1
Benzo(a)Pyrene	USEPA 8270-SIM	0.94	5	0.94	5	0.0347	0.1
Benzo(g,h,i)Perylene	USEPA 8270-SIM	0.91	5	0.91	5	0.0315	0.1
Benzofluoranthene(s) (total)	USEPA 8270-SIM	1.85	5	1.85	5	0.0579	0.1
Chrysene	USEPA 8270-SIM	1.69	5	1.69	5	0.0352	0.1
Dibenz(a,h)Anthracene	USEPA 8270-SIM	1.33	5	1.33	5	0.0316	0.1
Dibenzofuran	USEPA 8270-SIM	1.36	5	1.36	5	0.0225	0.1
Fluoranthene	USEPA 8270-SIM	1.8	5	1.8	5	0.0347	0.1
Fluorene	USEPA 8270-SIM	1.26	5	1.26	5	0.0254	0.1
Indeno(1,2,3-cd)Pyrene	USEPA 8270-SIM	2.04	5	2.04	5	0.021	0.1
Naphthalene	USEPA 8270-SIM	1.68	5	1.68	5	0.0258	0.1
Phenanthrene	USEPA 8270-SIM	1.63	5	1.63	5	0.0231	0.1
Pyrene	USEPA 8270-SIM	1.06	5	1.06	5	0.036	0.1
Semi-Volatile Organic Compounds (including Phenols, Phthalates, and Polycyclic Aromatic Hydrocarbons)							
1,2,4-Trichlorobenzene	USEPA 8270D/SIM	3.48	20	1.86	5	0.479	1
1,2-Dichlorobenzene	USEPA 8270D/SIM	2.50	20	1.10	5	0.4	1
1,3-Dichlorobenzene	USEPA 8270D	2.63	20	--	--	0.406	1
1,4-Dichlorobenzene	USEPA 8270D/SIM	2.86	20	1.19	5	0.418	1
1-Methylnaphthalene	USEPA 8270D	2.68	20	--	--	0.541	1
2,2'-oxybis(1-Chloropropane)	USEPA 8270D	3.76	20	--	--	0.541	1
2,3,4,6-Tetrachlorophenol	USEPA 8270D	4.85	20	--	--	0.153	5
2,4,5-Trichlorophenol	USEPA 8270D	21.4	100	--	--	0.665	5
2,4,6-Trichlorophenol	USEPA 8270D	22.4	100	--	--	0.845	5
2,4-Dichlorophenol	USEPA 8270D	21.5	100	--	--	0.965	5
2,4-Dimethylphenol	USEPA 8270D/SIM	3.46	40	2.89	20	0.176	1
2,4-Dinitrophenol	USEPA 8270D	111	850	--	--	1.147	10
2,4-Dinitrotoluene	USEPA 8270D	19.5	100	--	--	1.025	5
2,6-Dinitrotoluene	USEPA 8270D	30.6	100	--	--	0.922	5
2-Chloronaphthalene	USEPA 8270D	2.64	20	--	--	0.507	1
2-Chlorophenol	USEPA 8270D	2.39	20	--	--	0.254	1
2-Methylnaphthalene	USEPA 8270D	3.06	20	2.99	20	0.185	1
2-Methylphenol	USEPA 8270D/SIM	5.25	20	1.81	5	0.227	1
2-Nitroaniline	USEPA 8270D	18.4	100	--	--	0.68	5
2-Nitrophenol	USEPA 8270D	38.7	100	--	--	1.059	5
3,3'-Dichlorobenzidine	USEPA 8270D	17.8	150	--	--	0.946	5
3-Nitroaniline	USEPA 8270D	22.5	100	--	--	0.851	5

Table D-1

Laboratory Detection Limits and Practical Quantitation Limits
5900 West Marginal Way SW
Seattle, Washington

Analyte	Method	Upland Soil		Storm Water Solids/Sediment		Surface/Ground Water	
		Method Detection Limit µg/kg	Practical Quantitation Limit µg/kg	Method Detection Limit µg/kg	Practical Quantitation Limit µg/kg	Method Detection Limit µg/L	Practical Quantitation Limit µg/L
4,6-Dinitro-2-methylphenol	USEPA 8270D	21.2	200	--	--	1.04	10
4-Bromophenyl-phenylether	USEPA 8270D	5.03	20	--	--	0.397	1
4-Chloro-3-methylphenol	USEPA 8270D	15.1	100	--	--	0.962	5
4-Chloroaniline	USEPA 8270D	22.3	270	--	--	0.85	5
4-Chlorophenyl-phenylether	USEPA 8270D	5.29	20	--	--	0.176	1
4-Methylphenol	USEPA 8270D	6.63	40	6.63	40	0.185	1
4-Nitroaniline	USEPA 8270D	37.9	100	--	--	1.041	5
4-Nitrophenol	USEPA 8270D	34.7	100	--	--	0.568	5
Acenaphthene	USEPA 8270D	3.28	20	3.28	20	0.202	1
Acenaphthylene	USEPA 8270D	5.71	20	5.71	20	0.21	1
Anthracene	USEPA 8270D	4.50	20	4.50	20	0.217	1
Benzo(a)anthracene	USEPA 8270D	3.29	20	3.29	20	0.219	1
Benzo(a)pyrene	USEPA 8270D	5.45	20	5.45	20	0.205	1
Benzo(g,h,i)perylene	USEPA 8270D	4.40	20	4.40	20	0.15	1
Benzofluoranthene(s) (Total)	USEPA 8270D	6.67	40	6.67	40	0.577	1
Benzoic acid	USEPA 8270D	101	400	101	400	0.819	10
Benzyl alcohol	USEPA 8270D	6.09	20	6.09	20	0.652	5
Bis(2-Chloroethoxy)methane	USEPA 8270D	2.00	20	--	--	0.42	1
Bis(2-Chloroethyl)ether	USEPA 8270D	3.35	20	--	--	0.456	1
bis(2-Ethylhexyl)phthalate	USEPA 8270D	14.6	25	14.6	25	0.152	1
Butylbenzylphthalate	USEPA 8270D/SIM	6.14	20	2.89	5	0.153	1
Carbazole	USEPA 8270D	2.69	20	--	--	0.103	1
Chrysene	USEPA 8270D	3.75	20	3.75	20	0.181	1
Dibenzo(a,h)anthracene	USEPA 8270D/SIM	4.31	20	2.02	5	0.163	1
Dibenzofuran	USEPA 8270D	4.1	20	4.1	20	0.157	1
Diethylphthalate	USEPA 8270D/SIM	36.6	50	3.26	5	0.417	1
Dimethylphthalate	USEPA 8270D/SIM	2.90	20	1.34	5	0.408	1
Di-n-butylphthalate	USEPA 8270D	8.16	20	8.16	20	0.189	1
Di-n-octylphthalate	USEPA 8270D	5.84	20	5.84	20	0.194	1
Fluoranthene	USEPA 8270D	2.91	20	2.91	20	0.22	1
Fluorene	USEPA 8270D	4.35	20	4.35	20	0.189	1
Hexachlorobenzene	USEPA 8270D/SIM	4.29	20	1.26	5	0.194	1
Hexachlorobutadiene	USEPA 8270D/SIM	4.57	100	0.96	5	0.348	1
Hexachlorocyclopentadiene	USEPA 8270D	66.4	400	--	--	0.854	5
Hexachloroethane	USEPA 8270D	2.94	20	--	--	0.392	1
Indeno(1,2,3-cd)pyrene	USEPA 8270D	4.68	20	4.68	20	0.214	1
Isophorone	USEPA 8270D	2.86	20	--	--	0.215	1
Naphthalene	USEPA 8270D	2.76	20	2.76	20	0.553	1
Nitrobenzene	USEPA 8270D	4.06	20	--	--	0.551	1
N-Nitroso-di-n-propylamine	USEPA 8270D	3.36	20	--	--	0.449	1
N-Nitrosodiphenylamine	USEPA 8270D/SIM	5.39	20	1.38	20	1.183	5
Pentachlorophenol	USEPA 8270D/SIM	48.5	200	14.3	50	0.647	5
Phenanthrene	USEPA 8270D	3.64	20	3.64	20	0.18	1
Phenol	USEPA 8270D	8.65	20	8.65	20	0.163	1
Pyrene	USEPA 8270D	1.94	20	1.94	20	0.2	1

Table D-1

Laboratory Detection Limits and Practical Quantitation Limits
5900 West Marginal Way SW
Seattle, Washington

Analyte	Method	Upland Soil		Storm Water Solids/Sediment		Surface/Ground Water	
		Method Detection Limit µg/kg	Practical Quantitation Limit µg/kg	Method Detection Limit µg/kg	Practical Quantitation Limit µg/kg	Method Detection Limit µg/L	Practical Quantitation Limit µg/L
Polychlorinated Biphenyl Aroclors							
Aroclor 1016	USEPA 8082B	1.02	4	1.02	4	0.0026	0.01
Aroclor 1221	USEPA 8082B	1.02	4	1.02	4	0.0026	0.01
Aroclor 1232	USEPA 8082B	1.02	4	1.02	4	0.0026	0.01
Aroclor 1242	USEPA 8082B	1.02	4	1.02	4	0.0026	0.01
Aroclor 1248	USEPA 8082B	1.36	4	1.36	4	0.0032	0.01
Aroclor 1254	USEPA 8082B	1.36	4	1.36	4	0.0032	0.01
Aroclor 1260	USEPA 8082B	1.36	4	1.36	4	0.0032	0.01
Dioxins/Furans							
2,3,7,8-TCDD	AXYS Method	3.06E-05	5.00E-05	3.06E-05	5.00E-05	4.41E-07	5.00E-07
1,2,3,7,8-PECDD	AXYS Method	1.32E-04	5.00E-05	1.32E-04	5.00E-05	1.61E-06	5.00E-07
1,2,3,4,7,8-HXCDD	AXYS Method	1.89E-04	5.00E-05	1.89E-04	5.00E-05	1.28E-06	5.00E-07
1,2,3,6,7,8-HXCDD	AXYS Method	1.79E-04	5.00E-05	1.79E-04	5.00E-05	1.84E-06	5.00E-07
1,2,3,7,8,9-HXCDD	AXYS Method	1.68E-04	5.00E-05	1.68E-04	5.00E-05	1.22E-06	5.00E-07
1,2,3,4,6,7,8-HPCDD	AXYS Method	1.68E-04	5.00E-05	1.68E-04	5.00E-05	1.41E-06	5.00E-07
OCDD	AXYS Method	8.27E-04	5.00E-05	8.27E-04	5.00E-05	4.08E-06	5.00E-07
2,3,7,8-TCDF	AXYS Method	2.80E-05	5.00E-05	2.80E-05	5.00E-05	4.48E-07	5.00E-07
1,2,3,7,8-PECDF	AXYS Method	9.52E-05	5.00E-05	9.52E-05	5.00E-05	1.97E-06	5.00E-07
2,3,4,7,8-PECDF	AXYS Method	9.64E-05	5.00E-05	9.64E-05	5.00E-05	1.77E-06	5.00E-07
1,2,3,4,7,8-HXCDF	AXYS Method	9.08E-05	5.00E-05	9.08E-05	5.00E-05	9.19E-07	5.00E-07
1,2,3,6,7,8-HXCDF	AXYS Method	1.20E-04	5.00E-05	1.20E-04	5.00E-05	8.22E-07	5.00E-07
1,2,3,7,8,9-HXCDF	AXYS Method	9.26E-05	5.00E-05	9.26E-05	5.00E-05	2.17E-06	5.00E-07
2,3,4,6,7,8-HXCDF	AXYS Method	1.20E-04	5.00E-05	1.20E-04	5.00E-05	1.44E-06	5.00E-07
1,2,3,4,6,7,8-HPCDF	AXYS Method	9.91E-05	5.00E-05	9.91E-05	5.00E-05	1.23E-06	5.00E-07
1,2,3,4,7,8,9-HPCDF	AXYS Method	8.81E-05	5.00E-05	8.81E-05	5.00E-05	9.71E-07	5.00E-07
OCDF	AXYS Method	2.84E-04	5.00E-05	2.84E-04	5.00E-05	2.84E-06	5.00E-07
Total Petroleum Hydrocarbons							
Gas Range	NWTPH-Gx	2390	5000	--	--	15	30
Diesel Range	NWTPH-Dx	742	5000	--	--	16	100
Anions							
Chloride	USEPA 300.0	--	--	--	--	19	100
Nitrate	USEPA 300.0	--	--	--	--	7	100
Sulfate	USEPA 300.0	--	--	--	--	59	100
Phosphate	SM 4500	--	--	--	--	4	8
General Groundwater Chemistry Parameters							
Total Organic Halides	USEPA 9020	--	--	--	--	640	1000
Total Organic Carbon	USEPA 9060	0.00029%	0.02%	0.00029%	0.02%	150	1500
Total Suspended Solids	SM 2450D	--	--	--	--	--	1000
Hardness	SM 2340B	--	--	--	--	--	330
Alkalinity	SM 2320B	--	--	--	--	370	1000
Ammonia	USEPA 350.1	7.2	100	--	--	7.2	10

Notes:

-- = Not applicable
µg/kg = Micrograms per kilogram
µg/L = Micrograms per liter

SM = Standard Method
AXYS Method = USEPA Method 1613B (i.e., AXYS MLA-017)
USEPA = United States Environmental Protection Agency Method