**Boeing Plant 2**
**Seattle/Tukwila, Washington**

# Uplands Corrective Measures Study
# Volume VIIa: North Area

## Data Gap Investigation Work Plan

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# List of Abbreviations/Acronyms

| Abbreviation/Acronym | Definition |
|---|---|
| AOC | Area of Concern |
| ARI | Analytical Resources, Inc. |
| ASTM | American Society for Testing and Materials |
| Boeing | The Boeing Company |
| bgs | below ground surface |
| CMS | Corrective Measures Study |
| COC | constituent of concern |
| cPAHs | carcinogenic polycyclic aromatic hydrocarbons |
| DO | dissolved oxygen |
| DOT | Department of Transportation |
| DRPH | diesel-range petroleum hydrocarbons |
| DSOA | Duwamish Sediment Other Area |
| Ecology | Washington State Department of Ecology |
| Emerald | Emerald Services, Inc. |
| EPA | Environmental Protection Agency (U.S.) |
| EPI | Environmental Partners, Inc. |
| Golder | Golder Associates, Inc. |
| gpm | gallons per minute |
| GRPH | gasoline-range petroleum hydrocarbons |
| HSA | hollow-stem auger |
| IM | interim measure |
| LAR | Liquid Argon |
| L/min | Liters per minute |
| mg/kg | milligrams per kilogram |
| MS | matrix spikes |
| MSD | matrix spike duplicates |
| NAPL | Non-aqueous phase liquid |
| NFA | No Further Action |
| NAVD | North American Vertical Datum |
| NGVD | National Geodetic Vertical Datum |

| Abbreviation/Acronym | Definition |
|---|---|
| NTU | nephelometric turbidity unit |
| OA | Other Area |
| Order | Administrative Order on Consent |
| ORP | oxidation-reduction potential |
| ORPH | motor oil-range petroleum hydrocarbons |
| PAH | polycyclic aromatic hydrocarbon |
| PCB | polychlorinated biphenyl |
| ppm | parts per million |
| PTFE | polytetrafluoroethylene |
| PID | photo-ionization detector |
| PQL | practical quantitation limit |
| QC | quality control |
| RCRA | Resource Conservation and Recovery Act |
| RFA | RCRA Facility Assessment |
| RFI | RCRA Facility Investigation |
| RL | reporting limit |
| SVOC | semivolatile organic compound |
| SWMU | Solid Waste Management Unit |
| TOC | total organic carbon |
| TPH | total petroleum hydrocarbon |
| TSCA | Toxic Substances Control Act |
| TSD | treatment, storage, and disposal |
| µg/kg | micrograms per kilogram |
| µg/L | micrograms per liter |
| µs/cm | microseimens per centimeter |
| USCS | Unified Soil Classification System |
| VC | vinyl chloride |
| VOC | volatile organic compounds |
| WAC | Washington Administrative Code |
| Weston | Roy F. Weston, Inc. |

# Foreword

This Work Plan presents the scope and methodology for a data gap investigation in the North Area of Boeing Plant 2. The need for this investigative work was identified by The Boeing Company (Boeing) during the preparation of the Uplands Corrective Measures Study (CMS), well after the completion of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). The RFI used a RCRA unit-by-unit approach to investigate the site. When corrective measures were being evaluated for groundwater, this approach was inadequate for remedy selection due to the more integrated nature of groundwater contaminant distributions. Boeing, with the concurrence of the United States Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology), has embarked on a series of focused investigations to enable the Uplands CMS to proceed. The results of these investigations will be reported in the CMS Report.

As coordinated with the EPA, this data gap investigation Work Plan, which covers the North Area at Boeing Plant 2, is designated Volume VIIa of the CMS. Volume VIIb will present the results of the data gap investigation for the North Area when they are available and Volume VIIc will evaluate and select the remedies for the North Area. Similar processes are being implemented simultaneously for the other areas at Boeing Plant 2. This volume (VIIa) will be preceded in the CMS report by Volume I – Introduction, Volume II – Cleanup Level Evaluation Technical Memorandum, and Volumes IIIa, IIIb, and IIIc – South Yard Area through Volumes VIa, VIb, and VIc – 2-40s Area. Volume I will contain introductory text explaining Plant 2 history, the RCRA CMS process, the Plant 2 physical conceptual site model, a description of the study areas, and a discussion of the site-wide RCRA and non-RCRA unit accounting process. Volume II will contain the Cleanup Level Evaluation Technical Memorandum and Volume's III through VII will contain the South Yard through North Area, respectively. Subsequent volumes will address the 2-31 and 2-10 Areas.

The Work Plan and the CMS are being performed under the Administrative Order on Consent (Order) issued by EPA to Boeing under the authority of Section 3008(h) of the RCRA of 1976, as amended (42 USC 6928(h)). This Order (RCRA Docket Number 1092-01-22-3008(h)) became effective on January 18, 1994. The Order specifies activities necessary to correct actual or potential threats to human health and the environment resulting from the release or potential release of hazardous constituents from the Boeing Plant 2 Facility located at 7755 East Marginal Way South, Seattle/Tukwila, Washington.

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# 1.0 North Area Description

## 1.1 DESCRIPTION AND SETTING

The Boeing Plant 2 Facility (Plant 2) is located on the east bank of the Duwamish Waterway in Seattle and Tukwila, Washington (Figure 1-1). Historically, Plant 2 specialized in manufacturing aluminum alloy, steel alloy, and titanium alloy parts for airplanes. Plant 2 was built on farmland in the late 1930s, and became a significant manufacturing facility during World War II. In recent years, Plant 2 has shifted from manufacturing to research, storage and administration.

Plant 2 is bounded on the east by East Marginal Way South, a four-lane arterial, on the south by Jorgensen Forge, an active steel and aluminum forge; on the north by Slip 4 and Emerald Services, Inc., (Emerald); and on the west by the Duwamish Waterway. The Duwamish Waterway is a federally-maintained shipping channel of the Duwamish River; Slip 4 is an off-channel extension of the waterway. Plant 2 is served by both truck and rail, and was historically accessible from the waterway. Plant 2 is divided into northern and southern sections by an arterial, 16th Ave S, which services the 16th Ave S Bridge over the Duwamish Waterway.

Plant 2 occupies approximately 107 acres of developed topographically flat land covered by buildings and paved yards. Most buildings are slab on grade with below grade utilities.

The soils in the upper 100 feet beneath the North Area consist of four major geologic units. The first 3 to 12 feet of soil are comprised of a dark gray to brown fill that is a loose to very dense silt and fine to medium sand. Much of the fill appears to be alluvial in nature and probably reflects dredge spoils from modifications to the Duwamish River channel at the beginning of the 20$^{th}$ Century; some debris exists within the fill. The fill is underlain by a discontinuous layer of dark brownish gray to black silt and a soft organic silt layer that is approximately 2 feet thick.

Beneath the silt is the shallow portion of the upper aquifer that consists of poorly-graded dark brown to dark gray fine to medium sand with varying amounts of silt. Borehole investigations in the North Area did not extend beyond the alluvial unit. In Plant 2 areas southeast of the North Area, the alluvial unit extends from approximately 10 feet below ground surface (bgs) to 40 to 50 feet bgs. Underlying this unit are the older Duwamish River alluvial deposits consisting of thick coarsening-upward sequences of inter-bedded sand and silty sand. These alluvial deposits extend from approximately 40 to 50 feet bgs to approximately 80 feet bgs.

At approximately 80 feet bgs, well logs from areas in the southeast end of Plant 2 describe a distinctive marine silt layer with shell fragments. The contact between the overlying silty sand and the marine silt is sharp and is readily noted in the field. The marine silt layer is underlain by a dense gray glacial till unit. These two low-permeability deposits form an aquitard that isolates the shallow aquifer (upper 80 to 100 feet) from the deeper aquifers beneath Plant 2.

Groundwater occurs in the alluvial aquifer generally starting at 9 to 12 feet bgs. The general groundwater flow direction is southwest towards the Duwamish Waterway but is likely influenced locally in the north area by Slip 4.

The Duwamish Waterway (inclusive of Slip 4) in the vicinity of Plant 2 is a tidally-controlled marine embayment with a freshwater lens of outgoing river water on top of the denser (more saline) marine waters. The sediments, while alluvial in nature, have salinities consistent with the marine waters from Elliott Bay. A saline groundwater wedge extends into the Uplands from the waterway, and deeper deposits (greater than 60 feet) contain groundwater with high salinity due to trapped sea water that was present at the time of sedimentation. The groundwater column ranges from saline at depth to fresh on the top (Boeing, 2003).

### 1.1.1 Corrective Measures Study Areas at Boeing Plant 2

Plant 2 has been divided into seven "CMS Study Areas" to facilitate the development and screening of RCRA corrective measures. These areas from south to north are:

- South Yard Area
- 2-60s Area
- 2-66 Area
- 2-40s Area
- 2-31 Area
- 2-10 Area
- North Area

These areas are shown in Figure 1-2, Site Plan with CMS Study Areas.

#### *1.1.1.1 The North Area*

The area northwest of the 2-10 Area of Boeing Plant 2 is referred to as the North Area and consists of approximately 19.3 acres. The North Area is bordered on the north by Emerald Services and on the southeast by the 2-10 Area. The southwestern and northwestern edges of the North Area abut the Duwamish Waterway and Slip 4, respectively.

The North Area contains Buildings 2-122, 2-124, and the wastewater containment structure and extensive grounds devoted to public access and stormwater controls. Building 2-122 was constructed in 1992. Building 2-122 houses the Integrated Aircraft Systems Laboratory and is the dominant feature observed in the North Area. The 2-01 and 2-02 Buildings were demolished in 1991 for construction of the 2-122 Building. The wastewater containment structure and the 2-124 building were built in 2006 to support the Integrated Aircraft Systems Laboratory.

There are no active RCRA units within the North Area. Solid Waste Management Unit (SWMU) 2-01.1 "Landing Gear Cleaning Sump" is the only RCRA unit associated with the North Area and it was clean closed under an agreement with Ecology in 1992.

### 1.1.2 Previous Investigations

Numerous investigations of Plant 2 have been carried out by Boeing consultants, including Roy F. Weston, Inc. (Weston) and Landau Associates, Inc. Key site-wide investigations include the following:

- RCRA Facility Investigation Work Plan (Weston, 1994a)
- RCRA Facility Investigation – Phase 1A Completion Report Volumes I to II Soil and Groundwater Presentation (Weston, 1994b)
- RCRA Facility Investigation - Groundwater Investigation Interim Report (Weston, 1996a)
- RCRA Facility Investigation – Soil Investigation Interim Report (Weston, 1997)
- Comprehensive RCRA Facility Investigation Report (Weston, 1998a)
- RCRA Facility Investigation Health Evaluation for Upland Soil (Weston, 1998c)
- RCRA Facility Investigation Groundwater Human Health and Environmental Evaluation (Weston, 1998e)
- Technical Memorandum SWMU/AOC/OA-Specific Data Presentation, RCRA Corrective Measures Study Volumes I, II, III. (Weston, 2000a)

Investigations specific to the North Area in addition to Plant 2 site-wide studies are listed in Table 1-1. These documents include environmental subsurface assessments conducted before building the 2-122 Building and soil investigations conducted to support construction of the 2-124 Building and Wastewater Containment Structure.

#### *1.1.2.1 Scope of Information Available*

The analytical data gathered during previous investigations has been combined into a comprehensive database, which includes groundwater analytical results since 1988 and soil analytical results for existing soil. When an interim measure (IM) or construction activities removed soil from a unit, samples representing the removed material were identified as “removed” in the database and post-removal confirmatory samples were added to the database as applicable.

The North Area has been the subject of to a limited number of investigations. As a result of these investigations, five temporary probes were sampled and four monitoring wells were installed. Three of the monitoring wells were subsequently decommissioned to allow construction of Building 2-122. Groundwater samples were collected at nine locations. Soil was collected at 50 locations, of those locations, seven have had soil that was removed all or in part. Constituent groups of interest in the North Area include volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and inorganics (metals and cyanide), as well as total petroleum hydrocarbons (TPHs). VOCs, SVOCs, PCBs, and inorganics were analyzed using standard EPA Methods and TPHs were analyzed by using

a variety of EPA, American Society for Testing and Materials (ASTM), and Washington State methods.

Attachment A contains maps and tables displaying the analytical data for groundwater constituents of concern (COCs) in the North Area; Attachment B contains maps and tables for soil COCs in the North Area. The introductory section of each attachment provides an explanation of how the information is displayed. The maps in Attachment A and B show current and historical groundwater and soil sampling locations.

## 1.2 RCRA UNITS

During the RCRA Facility Assessment (RFA) and early stages of the CMS process, Plant 2 was evaluated following RCRA guidance and the RCRA Order for Plant 2, which generally uses a unit-by-unit approach. This has been modified to an area-by-area approach for consideration of groundwater remedies; however, many of the soil remedies in the CMS will continue to be considered on a unit-by-unit basis. Therefore, it is critical that the original RCRA units continue to be tracked through the process.

Within the North Area there has been only one RCRA unit identified (see Figure 1-3) under the RCRA process. The unit SWMU 2-01.1, Landing Gear Cleaning Sump, was identified as a solid SWMU under the RFA. The Order defines a SWMU as “any discernable unit at which solid wastes have been placed at any time.” The following section provides a description of the SWMU, including its location, historical use and status, and potential COCs.

### 1.2.1 RCRA Units: Closed Units

The only RCRA unit (SWMU 2-01.1 [Landing Gear Cleaning Sump]) identified in the North Area under the RCRA process was formally closed under Ecology in 1992 (EPA 1992). Further discussion of this unit is presented in Section 1.2.2.

### 1.2.2 RCRA Units: No Further Action (NFA) Determination

EPA (1992) determined that “no further action” (NFA) was needed for vadose zone soils associated with SWMU 2-01.1 (Landing Gear Cleaning Sump).

Having been granted “NFA status for soils”, this unit will not be evaluated further in the CMS with respect to soil remedies. However, as discussed below, groundwater associated with this area will be evaluated further in the CMS.

#### *1.2.2.1 SWMU 2-01.1 (Landing Gear Cleaning Sump)*

SWMU 2-01.1 was a 1,000-gallon capacity landing gear cleaning sump located in the north central section of Building 2-01. From 1980 until its decommissioning in 1990, the reinforced concrete sump was used to contain waste generated during repair and cleaning of aircraft landing gear. Wastes generally consisted of mixtures of water, oils, and nonhalogenated solvents. There were no drainage connections from the sump. Wastes were removed by a

licensed hazardous waste handler one to three times per year. Potential COCs associated with this unit were VOCs, SVOCs, TPHs, and metals (PRC, 1992).

No releases to the environment from the sump were identified during review of HAZMAT spill incident files. However, the results of a subsurface environmental assessment conducted in 1990 by Roy F. Weston, Inc. (Weston, 1990) indicated that the sump had leaked, releasing waste to soil and groundwater (PRC, 1992). As part of the investigation, four borings were advanced at the north end of the building near the sump. Soil samples were collected from all four borings; groundwater samples were collected from three. VOCs (trichloroethene, 1,1,1-trichloroethane, chrysene, 2-butanone, acetone), SVOCs (pyrene and di-n-octylphthalate), metals (arsenic, chromium, copper, lead, and zinc), and total petroleum hydrocarbons were detected in the soil samples. Concentrations of all detected constituents in these samples were below the closure performance standards established for soil (PRC, 1992). Chromium was detected in groundwater at concentrations that exceeded the performance standards in the vicinity of SWMU 2-1.01. The RFI indicated that additional groundwater sampling should be conducted for chromium in association with this unit.

Closure of the sump consisting of decontamination, sump removal and soil excavation was initiated in March, 1991 and completed in September, 1991. Building 2-01 was demolished in 1991 for the construction of Building 2-122, which houses the Integrated Aircraft Systems Laboratory. Ecology granted final approval of closure of SWMU 2-01.1 on July 21, 1992 (PRC, 1992). EPA granted this unit “NFA status for soils” under the 1992 RFA. Groundwater associated with this unit will be evaluated further in the CMS.

### 1.2.3 RCRA Units: Interim Measures

No IMs have been conducted in the North Area.

### 1.2.4 RCRA Units: Ongoing Interim Measures

There are no ongoing IMs for RCRA units in the North Area.

### 1.2.5 RCRA Units: Planned Interim Measures

No IMs are planned for the North Area at this time.

### 1.2.6 RCRA Units: Remaining for Consideration

There are no RCRA units remaining for consideration in the North Area with regards to soil. Groundwater and soil will be evaluated in Volume VIIb as part of the CMS if any RCRA units are identified during the data gaps process.

### 1.2.7 RCRA Units: To Be Considered Under the DSOA

There are no RCRA units in the North Area to be considered under the Duwamish Sediment Other Area (DSOA).

## 1.3 NON-RCRA UNITS

Non-RCRA Units are defined as locations at Plant 2 where Boeing has identified one or more potential subsurface environmental conditions. The non-RCRA units identified in the North Area are all former underground storage tanks (USTs). During the CMS Process, data from these locations will be compared to screening criteria. If exceedances of the criteria are found, the location will be proposed as a new RCRA Unit. Non-RCRA units in the North Area include an area where four former collocated USTs (PL-1, PL-2, PL-3 and PL-28) were removed. One additional historical UST (PL-4) was removed from in the south corner of the North Area. The following sections present a description of these former USTs and Figure 1-3 identifies their locations.

Groundwater and soil data will be evaluated in Volume VIIb as part of the CMS if any additional non-RCRA units are identified during the data gaps process.

### 1.3.1 USTs PL-1, PL-2, PL-3 and PL-28

Four collocated USTs PL-1, PL-2, PL-3 and PL-28 were closed by removal in an area located approximately 30 feet southeast of Building 2-124. PL-1 (294 gallon diesel tank), PL-2 (12,500 gallon PS 300 tank) and PL-28 (680 gallon oil tank) were closed between January and May 1986. Boeing files indicate that there was no evidence of a release based on field screening associated with any of these three USTs.

PL-3 (12,500 gallon PS 300 tank) was removed and closed in September, 1991. During the removal impacted soil was noted on the sidewalls of the UST excavation. The tank's structural integrity appeared to be uncompromised and the impacted soil occurred near the fill pipe. Soil samples were collected in accordance with UST site assessment requirements (Weston, 1992). Analytical results indicted soil was impacted above the MTCA Method A cleanup level (200 mg/Kg) applicable at that time for diesel range petroleum hydrocarbons (DRPH). Excavation and disposal of impacted soil continued in two successive events and soils were resampled until concentrations of DRPH in sidewall and bottom samples were less than 200 mg/kg with one exception. One soil sample collected from the bottom of the UST excavation (below the water table) had a concentration of 420 mg/kg DRPH, which is less than the current MTCA Method A Cleanup level of 2,000 mg/kg. No groundwater samples were collected in association with this UST closure.

### 1.3.2 UST PL-4

PL-4 (294 gallon diesel tank) was closed and removed from an area approximately 150 feet south of the current Waste Containment Structure. The Boeing UST file indicates that the UST

was closed in May 1986 and that there was no evidence of a release based on field screening associated with this UST.

## 1.4 CONSTRUCTION PROJECTS

Five construction projects in the North Area since late 2005 have generated additional soil analytical data. Construction has generally included removal of asphalt or portions of building slabs and excavation to accommodate foundation construction and installation of subgrade utilities. During construction, soil sampling was conducted within and around excavation areas to support health and safety procedures and to identify soil handling strategies. Analytical methods were selected to be consistent with those used in the CMS data gap investigations. Sampling was conducted in accordance with project-specific technical memoranda and the *Compendium of Sampling and Analysis Plans and Quality Assurance Project Plans for Boeing Plant 2 Seattle* (Golder, 2003a). The resulting analytical data are maintained in the Plant 2 RCRA database. Several of the samples represent soil that was excavated and removed during construction. In these instances samples are identified as removed in the database and are not included in the data presented in this report, and data for soil that was not removed are included in this work plan. In several instances concentrations of constituents were detected in removed soil that marginally exceeded data gap evaluation screening levels.

### 1.4.1 Building 2-124

In late 2006, Boeing constructed a new storage building, Building 2-124, in the parking area adjacent to Building 2-122. Preconstruction soil samples were collected at five locations using a hand auger. Sample depths were based on planned excavation depths (2 to 4 feet bgs). Soil samples were collected as outlined in the August 3, 2005 technical memorandum (Golder, 2005a). The excavations did not extend down to the water table; therefore, groundwater samples were not collected.

Soil samples were analyzed for VOCs, TPH, PCBs, and metals. Analytical results for the preconstruction samples were presented in the September 6, 2005 technical memorandum on this construction project. Arsenic, copper, and mercury were the only COCs detected above screening levels. Several samples in which (Golder, 2005b) constituents exceeded screening levels represent soil that was excavated for the building foundation. Analytical results for samples representative of soil that remains in place are presented in the data tables and COC figures and included in the data gap evaluation.

### 1.4.2 Wastewater Containment Structure

Boeing built a wastewater containment structure in the parking area on the south side of Building 2-122 in 2005. During construction, soil sampling was conducted within and around the excavation areas. Soil samples were collected before excavation activities at six locations using a hand auger. One soil sample was collected during excavation to determine if PCBs remained at depth following excavation of a utility trench to the north of the waste containment structure.

Samples were collected from soils between 2 and 6 feet bgs as outlined in the September 16, 2005 technical memorandum (Golder, 2005c). The excavations did not extend down to the water table; therefore, groundwater samples were not collected.

Soil samples were analyzed for VOCs, SVOCs, TPH, PCBs, and metals. Aside from PCBs, arsenic and mercury were the only constituents detected above screening levels. Analytical results for the preconstruction samples were presented in a November 7, 2005 technical memorandum on this construction project (Golder, 2005f). Most of the samples in which constituents exceeded screening levels represent soil excavated for the building foundation and associated utility trench. Analytical results for samples representative of soil that remains in place are presented in the data tables and COC figures and included in the data gap evaluation.

### 1.4.3 Building 2-122 Foundations

Boeing constructed foundations to support the Integrated Test Vehicle Lab inside the 2-122 Building in late 2006. Nineteen footings were installed in the northeast portion of the building, ranging in size from 4 feet by 4 feet to 23.5 feet by 6 feet. The foundations extended approximately 2.5 feet below the soil surface (3.5 feet below the top of the floor slab). Soil samples were collected from the bottom of several foundation excavations, which were selected based on spatial coverage of the excavations. Sampling was conducted as outlined in a September 16, 2005 technical memorandum (Golder, 2005d).

Soil samples were analyzed for VOCs, TPH, PCBs, and metals. PCBs, arsenic and mercury were detected above screening levels. Analytical results for the preconstruction samples were presented in an October 10, 2005 technical memorandum on this construction project (Golder, 2005e). Most of the samples in which constituents exceeded screening levels represent soil excavated for the building foundation and associated utility trench. Analytical results for samples representative of soil that remains in place are presented in the data tables and COC figures and included in the data gap evaluation. No groundwater samples were collected in association with this construction project.

### 1.4.4 Building 2-122 Tank Line

Boeing completed construction of structures related to a new tank line inside Building 2-122 in April 2006. Excavations for numerous equipment footings and sumps were required in the west portion of the building. Samples were collected from foundation excavations at three locations between 3 and 6 feet bgs, as outlined in the December 16, 2005 technical memorandum (Golder, 2005h). Samples represent bottom or sidewall soil remaining in place in each of the excavations.

Soil samples were analyzed for VOCs, TPH, PCBs, and metals. PCBs were detected above screening levels in one sample. Analytical results for the preconstruction sampling effort were presented in a March 27, 2007 technical memorandum on this construction project (Golder, 2007a). The results are presented in the data tables and COC figures, and are included in the data gap evaluation. No groundwater samples were collected in association with this construction project.

### 1.4.5 Building 2-122 LAR Pad

Boeing completed construction of a cryogenic equipment pad, the Liquid Argon (LAR) Tank & Vaporizer, adjacent to Building 2-122 in December 2005. Soil was excavated to a depth of approximately 2 feet bgs. One soil sample was collected from the excavation, as outlined in the December 7, 2005 technical memorandum (Golder, 2005g). The sample represents soil remaining in place at the bottom of the excavation.

Soil samples were analyzed for VOCs, TPH, PCBs, and metals. None were detected above screening levels. Analytical results for the construction sampling effort were presented in a March 27, 2007 technical memorandum on this construction project (Golder 2007b). The results are presented in the data tables and COC figures, and are included in the data gap evaluation. No groundwater samples were collected in association with this construction project.

## 1.5 OFF-SITE FACILITIES AFFECTING THE NORTH AREA

There are currently no off-site facilities affecting the North Area.

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# 2.0 Data Gap Analysis

## 2.1 APPROACH

During the CMS remedy selection for groundwater and soil, it became increasingly evident that several key data gaps existed that were limiting the evaluation of corrective measures. These data gaps had not been as evident when the unit-by-unit approach was applied to identify corrective measures. This section is designed to identify those data gaps that are limiting the ability to proceed with the CMS, and to propose investigative solutions to those data gaps. Section 3.0 outlines the specific field methods, in the form of a sampling and analysis plan, to fill those gaps in a focused manner. This volume of the CMS is limited to the North Area; other volumes of the CMS will address data gaps, if any, in the remaining areas of Plant 2.

The data gap analysis presented in this section is focused on those data gaps that must be filled to proceed with the corrective measure analysis in the remainder of the CMS. Uncertainties in contaminant extent alone are not considered by Boeing to be a data gap unless the information is required to select or conceptually design a corrective measure for a RCRA unit or remediation action area. That is, this information is intended to allow for remedy selection and conceptual design in the CMS, and to support the Statement of Basis for the decision; further information may be necessary for planning a specific remedy in a specific area for final design or for performance monitoring purposes during the Corrective Measures Implementation. Data gaps were identified by considering the following CMS questions:

- **Physical Conceptual Site Model for North Area:** Is there any area-specific information that is needed to support the physical conceptual site model?
    - **Geologic Data:** Is additional geologic information needed to screen or conceptually design remedies?
    - **Hydrogeologic Data:** Is additional hydrogeologic information needed to screen or conceptually design groundwater remedies?
- **Current Data:** Are the existing groundwater data sufficiently current to allow for the identification of existing groundwater plumes, a designation of their current extent, and evaluation of whether they are likely to grow, remain steady, or reduce over time? Finally, are there sufficient nature and extent data to screen and conceptually design groundwater remedies?
- **Source Control:** Does sufficient information exist to select source control remedies?
    - **Hot Spots:** Are RCRA units characterized in sufficient detail to select and conceptually design source control remedies?
    - **New Sources:** Have areas of contamination been identified outside of existing RCRA units that need further definition to select and conceptually design source control remedies, and to assign RCRA unit designation, if appropriate?

EPA has set a 40-foot standard for characterization of COCs in soil. That is, the extent of a soil constituent detected above screening levels must generally be delineated on a minimum of three sides to within 40 feet. EPA allowed for exceptions to the standard (e.g., a building with sensitive instrumentation occupies the area where a sample should be collected to complete the delineation). In these circumstances alternative data is to be collected as practical.

- **Completed Pathways:** Do sufficient data exist at specific units to determine whether a specific pathway from one media to another is complete? Complete means that the pathway has the potential to impact the affected media above screening levels.
    - What are the physical properties governing transport/migration of the constituent through the subsurface? What is its relative distance from the waterway?
    - Are any other constituents present that may facilitate the migration of the constituent? For example, TPH and other solvents can affect the solubility of PCBs and facilitate their transport through soil and groundwater.
    - **Soil to Groundwater Pathway:** Are COCs present in soil that impact groundwater above screening levels? Are there adequate groundwater data indicating that groundwater has not been impacted by soil at or downgradient of the location?
    - **Groundwater to Surface Water Pathway:** Are COCs present in groundwater that reaches surface water at concentrations that are above screening levels?
- **Background Data:** Background levels for some metal COCs in soil have been adjusted to Puget Sound Basin background levels set by Ecology (Ecology, 1994). Site-specific background levels for three metals, arsenic, copper, and manganese, in groundwater have been calculated using data supplied by EPA. These background groundwater levels were accepted by EPA in 2006. No other adjustments for background conditions are planned as part of this CMS.
- **Exceedance of Screening Levels by Analytical Reporting Limits (RLs):** For the analytical results reported as not detected ("U" qualified) for the individual COCs, do the RLs exceed the screening levels (SLs)? For constituents where RLs for nondetects ("U" qualified results) exceeded the SLs, the following questions were considered on a case-by-case basis to determine whether the circumstances present a data gap for CMS purposes:
    - Is the RL sufficiently close to the SL that soil or groundwater impacts for that COC can be adequately delineated and quantified for CMS purposes? Note that RLs for Total PCBs may be biased high due to the practice of using the highest individual reported aroclor RL for the Total PCBs RL.

- Are the soil RLs for nondetected metal constituents below Ecology's (Ecology, 1994) Puget Sound Basin natural background concentrations. For example, the RL for arsenic in soil is above its SL, but is commonly below its Puget Sound Basin natural background concentration.
- Are there additional data from adjacent locations or subsequent samples from the same location supporting either the presence or absence of the constituent in the groundwater or soil?
- Are there other analytical results associated with the sample that render further consideration unnecessary? (e.g., aroclor 1260 in soil is reported as not detected at an elevated RL (>33 micrograms per kilogram [µg/kg]), but aroclor 1254 is detected at a concentration above the screening level in the same sample.)

In the North Area, consideration of these questions resulted in the following data gaps:

- **Physical Conceptual Site Model for the North Area**
  - **Geologic Data:** There are no geologic data from the B and C levels of the aquifer in the North Area of Plant 2. However, the stratigraphy in the previously-investigated areas within Plant 2 is consistent because all of Plant 2 has a similar geologic history and fill history. Therefore, the geology of the North Area is expected to be similar to other areas of Plant 2. The lack of geologic data for the B and C levels of the aquifer in the North Area are not expected to affect remedy selection and is not considered a data gap. The lack of geologic data from the B and C levels of the aquifer in the North Area is discussed further in Section 2.2.2.
  - **Hydrogeologic Data:** Groundwater flow directions across the North Area are generally toward the Duwamish Waterway and likely to Slip 4. Horizontal groundwater flow directions and gradients are generally well understood throughout Plant 2 with the exceptions of the immediate area surrounding the sheetpile structure in the 2-66 Area and in the North Area. The limited groundwater flow direction data for the North Area is not expected to significantly affect remedy selection if a groundwater remedy is required for the North Area. Available groundwater data for the North Area indicate that it is unlikely that a remedy would be required. However, if groundwater and soil sampling results from this data gap investigation indicate that a remedy is required, a hydrogeologic investigation may be performed.
  - **Current Data:** Current groundwater data are needed in the North Area. This data gap is discussed in Section 2.3.1.

- **Source Control**
    - **Hot Spots:** SWMU 2-01.1 is the only RCRA unit in the North Area. This unit was sufficiently characterized for closure in 1991 per Ecology and EPA regulations. There are no hot spot data gaps for the North Area. However, concentrations of COCs near this unit require further characterization.
    - **New Sources:** Some data gaps potentially related to new source areas were identified and are discussed in Sections 2.3 and 2.4.
- **Completed Pathways**
    - **Soil to Groundwater:** Some data gaps have been identified and are discussed in Section 2.4.
    - **Groundwater to Surface Water:** Groundwater from the North Area extends to surface water in the Duwamish Waterway and Slip 4. Some data gaps have been identified and are discussed in Section 2.3.
- **Exceedance of Screening Levels by Analytical Reporting Limits:** Some data gaps associated with elevated RLs have been identified for specific COCs and are discussed in Sections 2.3 and 2.4.

The North Area has been the subject of a number of separate investigations. As a result of these investigations:

- Four monitoring wells have been installed. One monitoring well, PL2-270A, is still operational, the remaining three monitoring wells were decommissioned to allow construction of Building 2-122.
- Groundwater was collected at five push probes and four monitoring wells.
- Soil was collected at 50 locations

Samples were analyzed for VOCs, TPHs, and inorganics (metals) in both groundwater and soil, but not at all locations. SVOCs and PCBs in were analyzed in soil only not at all locations.

The North Area area-specific COCs for both groundwater and soil were identified using the same methodology presented in Volume II of the CMS, but applied to only the data from the North Area. A North Area COC for groundwater or soil is defined as any constituent detected at concentrations greater than the lowest screening level. As noted in Volume II of the CMS, screening levels were developed for the following pathways:

| Media: Groundwater | Media: Soil |
|---|---|
| **Surface Water Pathways** | **Surface Water Pathways** |
| Ingestion of Aquatic Organisms<br>Protection of Aquatic Organisms | Ingestion of Aquatic Organisms<br>Protection of Aquatic Organisms |
| **Direct Exposure Pathways** | **Direct Exposure Pathways** |
| Dermal Exposure by Fishermen or Recreational Swimmers<br>Trenching (Direct Exposure during construction) | Dermal Exposure by Industrial Workers<br>Ingestion Exposure by Industrial Workers<br>Trenching (direct exposure during construction) |
| **Air Exposure Pathways** | **Air Exposure Pathways** |
| Indoor Air Inhalation by Industrial Workers<br>Outdoor Air Inhalation by Industrial Workers<br>Trenching (inhalation during construction) | Indoor Air Inhalation by Industrial Workers<br>Outdoor Air Inhalation by Industrial Workers<br>Trenching (inhalation during construction) |

Risk-based screening levels were initially developed in 2004 for the surface water, direct contact, and air exposure pathways. The values were used to support the pathway evaluation and identify data gaps as outlined above. As the data gap process has proceeded, the initial pathway-specific screening levels developed in 2004 have been corrected or revised as follows:

- Revision 1 – In July 2005, an error was discovered in the calculations used to develop soil and groundwater screening levels for the protection of surface water. The averaging time was changed in the surface water quality equations (WAC 173-340-730), a correction that resulted in new surface water pathway screening levels (for both soil and groundwater) for 22 constituents.
- Revision 2 – Soil screening levels for protection of the surface water pathway were identified as being below the Puget Sound Basin natural background concentrations calculated by Ecology (1994) for five metals: arsenic, copper, manganese, mercury and nickel. In September 2005, EPA approved adjusting the screening levels for these metals to the calculated natural background concentrations with the acknowledgement that they exceeded the risk-based values.
- Revision 3 – The groundwater screening levels for the protection of the surface water pathway were revised for three metals (arsenic, copper, and manganese) based on Duwamish Basin groundwater data provided by EPA. In May 2006, EPA approved adjusting the screening levels for these metals to calculated background values based on data provided by EPA with the acknowledgement that the calculated values exceeded the risk-based values.
- Revision 4 – The 2004 site-wide screening levels for the air exposure pathway were revised using the results of the advanced J&E model with site-specific input data. Air exposure screening levels were developed for each Plant 2 subarea for site-wide VOC COCs and mercury. EPA approved the air exposure screening levels for Plant 2 subareas with modifications and stipulations in October 2006 (EPA, 2006).

The above risk-based exposures are grouped by general pathway applicable at Plant 2: Surface Water, Direct Contact, and Air. This grouping greatly clarifies the CMS evaluation by grouping discussions regarding fate and transport, points of compliance, remedy selection, and compliance monitoring according to respective pathways. For the COC analysis, the lowest screening level for a specific exposure is used as the screening level for the general pathway to ensure that the analysis is complete. As indicated in Volume II of the CMS, one adjustment made to risk calculations to arrive at screening levels has included increasing individual COC screening levels to laboratory reporting limits assuming a "clean" matrix. This is considered the practical quantitation limit (PQL), as discussed in Volume II.

The North Area COCs and screening levels are summarized in Table 2-1. There are COCs representing all five of the major analytical groups: VOCs, SVOCs (soil only), PCBs (soil only), inorganics (soil only), and TPHs (groundwater only).

To determine whether or not a specific data gap exists, COC concentrations in groundwater and soil are first compared to screening levels. Data gaps are then identified if there were insufficient data to answer any of the general data gap questions outlined previously.

Data gap analysis criteria are applied to each COC for each general pathway for each medium to ensure the analysis is complete.

The Sections 2.2 through 2.4 present this data gap analysis and the results for the North Area.

## 2.2 DATA GAPS: PHYSICAL CONCEPTUAL SITE MODEL

***Foreword to Section 2.2.1:***

*This section presents information that is presented in Section 2.2.1, Plant 2 Hydrogeological Description in Volumes III, IV, V and VI of the CMS. In the Draft Final version of the CMS, this section will appear in Volume I within the description of the Conceptual Site Model for Plant 2. It is included here at this time to assist the reader who is reviewing Volume VIIa as a stand alone discussion of investigative data gaps for the North Area.*

### 2.2.1 Plant 2 Hydrogeologic Description

Plant 2 is located in the central portion of the Duwamish Valley adjacent to the tidally-influenced Duwamish Waterway, as noted in Figure 1-1. The Duwamish Valley is bounded to the east by Beacon Hill, rising to an elevation of 300 feet and separating the valley from the Lake Washington drainage basin. The western boundary of the Duwamish Valley is a topographic divide that separates the valley from the Puget Sound.

The historical Duwamish River was dredged and realigned to form the current channel of the Duwamish Waterway. This realignment was completed in approximately 1918 and moved the river from its former location at the present day King County International Airport to its current location to the west (Weston, 1996a). Industrial development of the area beginning in the 1930s resulted in pavement or buildings covering a large portion of Plant 2.

The topographic divides that bound the Duwamish Valley to the west and east are composed of sedimentary bedrock of Tertiary age overlain by Quaternary glacial deposits. The Duwamish Valley consists of recent sediments underlain and bounded by older Quaternary glacial deposits and, locally, Tertiary bedrock. The near-surface sediments of the Duwamish Valley are set within the trough of the Duwamish estuary, carved by glacial ice and subsequently in-filled by river sediment. The lower boundary of that trough is reached sporadically by deep borings, particularly in the southern half of the study area. The pattern of those data indicate that the trough lies roughly 200 feet below the modern ground surface along the axis of the valley, generally becoming more shallow to the south and also towards the east and west valley walls. The boundary of these deposits is marked either by bedrock (where present to the south) or by very dense sediment that has been glacially overridden (Booth and Herman, 1998).

Above this boundary, the geologic history of the area suggests that a sequence of estuarine deposits. Typically fine sands and silts with shells are found and commonly progress up into a more complex interbedded river-dominated sequence of sand, silt, and gravel marking the advance of the sedimentary wedge fed by the Osceola Mudflow and later deposits. The mudflow itself would have been very thin and subaqueous along the Duwamish Valley when first deposited, so the chances of intersecting (and recognizing) that layer by drill cores is probably low. The upper part of the river-deposited sediment should, and does, show the classic signs of continued slow overbank deposition by fine sand and silt, colonization by marshland plants, and occasional erosion and refilling by coarser sediment associated with the main channel of the migrating Duwamish River (Booth and Herman, 1998).

The most recent phase of the valley's geologic history includes the filling of tideflats and floodplains, and the subsequent dredging of a straightened channel of the meandering Duwamish River. Completed between approximately 1913 and 1918 by the Duwamish Waterway District, the new channel was 4-1/2 miles in length south from the East and West Waterways. As a result of the waterway development, 12-1/2 miles of old river bed were abandoned. The excavated waterway material was used to fill the old channel areas and the lowlands above flood levels. Subsequent filling for land development purposes has resulted in a surficial layer of fill over most of the lower Duwamish Valley. The heterogeneous nature of fill materials can locally affect both infiltration characteristics and groundwater flow where the water table is below these fill materials. Because much of the thicker fills that occur below the water table were dredged from the Duwamish River, the silts and sands are difficult to distinguish from the native alluvium and have the same general hydrogeologic properties (Booth and Herman, 1998).

A generalized cross-sectional diagram of the stratigraphy beneath Plant 2 is presented in Volume I of the CMS. The oldest (deepest) sediments encountered during the RFI consist of marine silt (the lower silt unit) deposited on the underlying glacial till unit. These two low-permeability deposits form an aquitard that isolates the shallow aquifer from the deeper aquifers beneath Plant 2. Above the lower silt unit is a thick, water-bearing, coarsening-upward sequence consisting of interbedded sand and silty sand. A thin layer of fill material consisting of coarse sand with varying amounts of silt overlies the naturally-deposited sand that makes up the upper aquifer beneath Plant 2. The shallow portion of the upper aquifer consists of medium sand with varying amounts of silt. This includes an approximate 2-foot-thick layer of brownish to greenish-gray to black silt and soft organic silt at depths typically ranging from approximately

4 feet to 11 feet bgs. This silt layer appears in many boring logs throughout the site, though it appears to vary in thickness and depth.

Shallow wells, generally in the upper 30 feet, are referred to as A-level wells. Wells installed deeper in this sand unit, (generally from 30 to 60 feet bgs) are referred to as B-level wells. At approximately 60 feet bgs, the silt content increases in a gradational change that can be distinguished based on field observations (Weston, 1996b). The aquifer material below this layer is hereafter referred to as the "C level" of the upper aquifer, and wells installed below 60 feet are referred to as C-level wells. At approximately 80 feet bgs, a distinctive marine silt layer with shell fragments is noted in well logs from Plant 2. The contact between the silty sand and the marine silt is sharp and is readily noted in the field.

The distinction between the upper A and B levels and C level is supported by increasing silt content and decreasing hydraulic conductivity with depth. The sand unit in the A- and B-levels is generally more permeable than the deeper silty sand unit by approximately one order of magnitude. Hydraulic conductivity values, based on multiple-well aquifer test data and tracer studies in the A-level and B-level wells, are generally $10^{-2}$ to $10^{-1}$ centimeters per second (200 to 400 feet/day) while measured hydraulic conductivity levels in the C-level wells are generally $10^{-4}$ cm/s (approximately 0.3 to 2.6 feet/day).

Groundwater in C-level wells is also distinctly more saline and electrically conductive than water in the A- and B-level wells. Field data indicate that groundwater becomes more saline and conductive with depth. Groundwater in A-level wells generally exhibit conductivity values less than 500 microseimens per centimeter (µS/cm). Conductivity values for most B-level wells generally range between 1,000 and 4,000 µS/cm, while C-level wells generally range between 5,000 and 10,000 µS/cm. Wells closer to the Duwamish Waterway are generally more saline and conductive possibly due to influence from the saline groundwater wedge beneath the Duwamish Waterway.

Vertical hydraulic conductivities in each unit are consistently three to four orders of magnitude less than horizontal hydraulic conductivities, and are generally $10^{-5}$ cm/s in A and B wells and $10^{-7}$ cm/s in C-level wells indicating a high degree of anisotropy in all of the geologic units making up the A, B, and C levels of the upper aquifer.

There are two major influences that control much of the groundwater flow beneath Plant 2. These two influences are:

- Tidal influences from the Duwamish Waterway, which is affected by tidal levels in Elliott Bay and Puget Sound.
- Groundwater levels in the ridges flanking the Duwamish Valley.

Groundwater flows from areas of higher hydraulic head to areas with lower hydraulic head. The hydraulic head of groundwater in the Duwamish Valley is less than in the surrounding ridges flanking the valley, but is higher than the net level of the Duwamish Waterway. Groundwater ultimately discharges into the Duwamish Waterway because the waterway has lower hydraulic head than the Duwamish Valley or the ridges flanking the valley. The Duwamish Waterway acts

as a long linear groundwater sink along the axis of the valley, causing groundwater at Plant 2 to flow toward the waterway rather than down the valley northward toward Elliott Bay (Weston, 1996a).

Recharge to the shallow sand/silty sand aquifer is mainly from the surrounding ridges and direct infiltration in areas that are not paved or covered by buildings. Subsurface flow to valley aquifers from the adjacent uplands is expected to be uniform throughout the valley. Direct recharge to the shallow aquifer beneath Plant 2 is limited due to the high density of buildings and paved surfaces with most runoff directed to storm drains leading to the waterway.

Depth to groundwater at Plant 2 is generally within 9 to 12 feet of ground surface. On an area-wide scale the water table reflects the topography of the Duwamish Valley, with groundwater flowing toward the Duwamish Waterway. Groundwater close to the waterway is strongly influenced by tidal fluctuations. Tidal influence diminishes with increasing distance from the waterway and is negligible (less than 1 percent) at approximately 800 to 900 feet from the waterway in the A level of the aquifer and 600 feet from the waterway in the B and C levels of the aquifer. Tidal efficiency (i.e., the ratio of groundwater level fluctuation in monitoring wells divided by water level fluctuations in the waterway) appears to be similar in both the A and B levels. C level tidal efficiency has only been investigated at the south end of Plant 2. Tidal efficiency data from this portion of Plant 2 appear to be similar to the shallower A- and B-levels.

Groundwater flow at Plant 2 is primarily horizontal with a calculated average flow velocity of 876 feet per year in the upper A and B levels of the aquifer. This is based on a hydraulic conductivity of 300 feet/day, a horizontal gradient of 0.002, and an effective porosity of 0.25. The calculated average groundwater flow velocity for the C-level of the aquifer is 13 feet per year based on a hydraulic conductivity of 3 feet/day, a horizontal gradient of 0.003, and an effective porosity of 0.25. The difference in groundwater flow rate is due mainly to differences in hydraulic conductivity, which is lower in the C-level of the aquifer. Horizontal hydraulic gradients continually change in tidally-influenced areas in tidal fluctuation in the Duwamish Waterway. Groundwater flow directions temporarily reverse during high tide in areas immediately adjacent to the waterway. This phenomenon is temporary and does not prevent the eventual discharge of groundwater to the waterway. Groundwater discharge rates from Plant 2 to the waterway have been calculated at approximately 475 gallons per minute (gpm). This calculation is based on a hydraulic conductivity of 300 feet/day, a gradient of 0.002, and a seepage face area of 152,000 $ft^2$ (based on 3,800 feet by 40 feet seepage face).

Groundwater flow is also influenced by the presence of saline water that has intruded from the Duwamish Waterway. Following the initial dredging and realignment of the waterway in 1918, saline surface water extended back into the waterway and, driven by density differences, intruded downward below the waterway into the aquifer. As a result of this saltwater intrusion, a “saline groundwater wedge” has formed beneath the waterway. The presence of the salt water in the aquifer has been observed in several monitoring wells adjacent to the waterway and in deep wells, as indicated by very high specific conductance measurements and extremely elevated concentrations of dissolved sodium, chloride, bromide, and total dissolved solids (Weston, 1996a). Saltwater intrusion has been well documented in other tidally-influenced aquifers, and the same processes are expected to apply in the aquifers underlying Plant 2.

Saline groundwater has also been observed in deeper C-level monitoring wells at locations that are not immediately adjacent to the waterway. This saline water is similar in composition to seawater; however, concentrations of dissolved ions are substantially less than seawater. Isotope studies indicate that tritium was not detected in deeper C-level groundwater samples, but was detected in the upper A and B levels of the aquifer (Weston, 1996a). This study suggests that the saline groundwater in the C level of the aquifer may be significantly older than the fresh groundwater found in the upper A and B levels of the aquifer.

The apparent salinity stratification of the aquifer is not likely due to the intrusion of saltwater from the Duwamish Waterway. If that were the case, the position of the saltwater/freshwater interface would be closer to the waterway. Groundwater mixing may be limited by density differences between the deeper, more-saline water and the overlying fresh water and also by the two orders of magnitude lower vertical hydraulic conductivity of the C-level portion of the aquifer relative to the A and B levels.

The presence of a saline groundwater wedge will affect the movement of groundwater in the vicinity of the waterway with the saline groundwater wedge acting as a dense stable mass that is in dynamic equilibrium with the surrounding, less-saline and therefore less dense, groundwater. The less dense fresh groundwater that migrates toward the waterway will be forced to move upward over the dense saline groundwater wedge. Limited mixing between the saline and fresh groundwater would be expected along this interface.

Data gap analysis associated with the geology and hydrogeology specific to the North Area are presented in Sections 2.2.2 and 2.2.3 below.

### 2.2.2 Geology Data Gaps

The shallow (A level) geology underlying the North Area has been investigated and documented in sufficient extent and detail for the purposes of the CMS. Monitoring wells, soil borings, and HydropPunch™ probe locations drilled throughout the area provide adequate geologic data coverage in the A level of the aquifer. However, there are no North Area-specific geologic data from the B and C levels of the aquifer. The lack of B and C level geologic data is not anticipated to result in a data gap for the North Area because existing data indicate that a groundwater remedy might not be required.

The geology of the upper 80 to 100 feet of the previously-investigated areas has been consistent throughout Plant 2. This consistency in geology was expected because all of Plant 2 has the same geologic history and a similar fill history. Therefore, the geology of the North Area is expected to be similar to other areas of Plant 2. Minor variations in the shallow geology at Plant 2 are not significant enough to affect remedy selection, and therefore, the lack of geologic data for the B and C levels of the aquifer in the North Area is not considered a data gap. B- and C-level geology, however, will be further evaluated at three North Area locations as part of the Data Gaps Investigation. Three cluster well locations consiting of A- and B-level wells and C-level probes will be installed at the PL2-270, PL2-608, and PL2-610 sampling locations. In addition to geologic logging, grain size analysis will be performed at specific sampling points and intervals in the C-level probes for geologic characterization purposes.

If data gaps investigation data from the North Area indicate that groundwater remedies are required for this area and, if there are insufficient geologic data to select a remedy, direct-push probes will be used to obtain the soil samples capable of providing the data required for remedy selection.

### 2.2.3 Hydrogeology Data Gaps

Groundwater flow directions at Plant 2 were investigated as part of the RCRA Facility Investigation (RFI) (Weston, 1996a). Groundwater flow directions in the North Area were shown to flow generally toward the Duwamish Waterway with the groundwater flow path approximately perpendicular to the waterway. There is also a component of groundwater flow toward Slip 4; however, limited data are available to draw meaningful groundwater elevation contour maps for this area and will be addressed in this investigation.

The current level of understanding of horizontal groundwater flow directions in the North Area is adequate for the purposes of the CMS. The limited groundwater flow direction data for the North Area is not expected to significantly affect remedy selection if a groundwater remedy is required for the North Area. Available groundwater data for the North Area indicate it is unlikely that a groundwater remedy will be required. However, if groundwater and soil sampling results from the North Area data gap investigation indicate that a remedy is required, a hydrogeologic investigation may be performed if these data are needed for remedy selection. This additional work would be addressed as a second phase to this data gaps investigation.

There is a potential property boundary issue with groundwater flow along the property boundary between Plant 2 and Emerald to the north. However, COCs have not been detected at concentrations greater than their applicable screening or background levels in groundwater in the property boundary area. Detecting COCs at concentrations greater than screening or background levels will trigger a re-evaluation of the need for additional hydrogeologic data to determine whether impacted groundwater flows onto or off site across the property boundary.

As noted in Section 2.2.1, available data indicate that the C-level of the aquifer is more saline than the A or B levels of the aquifer throughout Plant 2. Boeing will perform vertical profiling for salinity, total dissolved solids (TDS) and major cations/anions. These constituents will be sampled at 10-foot intervals beginning with the screened interval in B-level wells (40-45 feet bgs), continued in the associated C-level probe, and terminated approximately five feet into the low permeability layer at the base of the C-level of the aquifer.

## 2.3 GROUNDWATER QUALITY DATA GAPS

The following sections present the data gaps analysis and evaluation for groundwater in the North Area. The analysis is organized by COC rather than by unit because this allows for a better understanding of area-wide groundwater issues.

Area-specific COCs are identified using the following steps: If a site-wide COC was detected in the North Area existing analytical data at concentrations greater than or equal to the respective screening level, the site-wide COC is considered an area-specific COC for the North Area.

Resulting area-specific COCs are listed and summarized in Tables 2-1 and A-2 (in Attachment A). Table A-2 also identifies the number of samples with COC detections at concentrations greater than screening levels for each exposure pathway.

### 2.3.1 Current Data - Data Gap

During the site investigation at Plant 2 and in the North Area, a large portion of groundwater samples were collected on a unit-by-unit basis. This unit-by-unit approach is consistent with RCRA procedures and works well for soils. The unit-by-unit approach can also work well for groundwater if the groundwater plumes do not commingle. However, in much of Plant 2, groundwater plumes commingle and lose their ties to any individual RCRA unit. In these cases, an area-wide sampling approach provides the data necessary to gain a current view of area-wide groundwater conditions and to more accurately delineate and track the commingled plumes.

The data associated with the North Area of Plant 2 are generally older than data for other areas of the site. Shoreline monitoring, in which groundwater sampling is performed quarterly in a network of selected wells throughout most of Plant 2, does not extent to the North Area. The most recent groundwater data from the North Area are from an August 2002 sampling event in which well PL2-270A was sampled. In addition to being older than data from other areas of Plant 2, there are also fewer sampling locations in the North Area because of the limited manufacturing operations in this area.

One round of groundwater sampling in existing well PL2-270A and four new monitoring wells will be performed to provide the data necessary to make decisions regarding corrective measures for use in the CMS. In addition, 46 direct-push probes will be driven to investigate soil and groundwater quality downgradient of several known or suspected areas of impacted groundwater and soils that are not adequately covered by the existing and proposed monitoring well network.

For consistency with other areas of Plant 2, all North Area data gap investigation sampling locations will be sampled for VOCs and metals. The COC groups SVOCs, TPH, PCBs, redox parameters, and major cations/anions will be included in the list of analyses at specific sampling points based on their locations, identified data gaps, and history of detected constituents.

### 2.3.2 Inorganics

Analytical results for all site-wide metals and cyanide COCs were screened to determine which site-wide constituents are also area-specific COCs for the North Area. The screening levels used for site-wide COCs are summarized in Table A-1 in Attachment A. If a site-wide COC was detected in the North Area analytical data at concentrations greater than or equal to the respective screening level, the site-wide COC is considered an area-specific COC for the North Area. Resulting area-specific COCs are listed and summarized in Table 2-1. Tables of maximum inorganics concentrations in the North Area are presented in Attachment A.

Based on the existing data, there are no inorganic COCs for groundwater in the North Area. However, as noted above, all North Area samples associated with the data gaps investigation will be analyzed for site-wide metals COCs.

### 2.3.3 Semivolatile Organic Compounds and Polychlorinated Biphenyls

Analytical results for all site-wide SVOC and PCB COCs were screened to determine which site-wide constituents are also COCs for the North Area. The screening levels used for site-wide COCs are summarized in Table A-1. If a site-wide COC was detected in the North Area groundwater analytical data at concentrations greater than or equal to the respective screening level, the site-wide COC is considered a COC for the North Area.

Based on the existing data, there are no SVOC or PCB COCs for groundwater in the North Area. However, SVOCs, specifically carcinogenic polycyclic aromatic hydrocarbons (cPAHs) will be analyzed in samples from selected groundwater sampling locations in support of the soil data gap investigation work.

### 2.3.4 Volatile Organic Compounds

Analytical results for all site-wide VOC COCs were screened to determine which site-wide constituents are also COCs for the North Area. The screening levels used for site-wide COCs are summarized in Table A-1. If a site-wide COC was detected in the North Area analytical data at concentrations greater than or equal to the respective screening level, the site-wide COC is considered an area-specific COC for the North Area. The only VOC detected in groundwater samples from the North Area at concentrations greater than its screening level was vinyl chloride. Resulting North Area area-specific COCs are listed and summarized in Table 2-1. Isoconcentration maps and tables of maximum VOC concentrations in the North Area are presented in Attachment A.

As noted above, one VOC, vinyl chloride is on the North Area area-specific COC list based on its occurrence at a concentration greater than screening level for the protection of surface water.

The occurrence of vinyl chloride in the North Area is evaluated for the surface water exposure pathway in the Section 2.3.4.1 below. The direct contact pathway and the air pathway are both valid for vinyl chloride, but screening levels calculated for the direct contact pathway and the air pathway are consistently higher than those for surface water and therefore the data gap evaluation is based on screening levels for the protection of surface water.

#### *2.3.4.1 Vinyl Chloride*

Vinyl chloride (VC) was analyzed in nine North Area groundwater samples and detected in one of those samples, from location HP-AL-34, at a concentration of 2.0 micrograms per liter (μg/L). This single detection is at a concentration greater than the surface water screening level of 0.731 μg/L. The detected concentration of 2.0 μg/L is less than the air screening level of 594 μg/L.

The groundwater sample with reported with the VC concentration of 2.0 μg/L was collected adjacent to RCRA SWMU 2-01.1, Landing Gear Cleaning Sump (see Table 2-3). This RCRA unit was clean closed in 1986 (PRC, 1992). Refer to the isoconcentration maps in Attachment A for the sampling location where VC was detected.

Data gaps for VC are identified using the five criteria from Section 2.1 and are summarized below.

- The existing data are insufficient to give a current view of the distribution of VC in groundwater; therefore, the sampling event discussed in Section 2.3.1 will include this COC as a constituent at every sampling location. This information will then be combined with historical data to develop inferences regarding whether the VC distribution has reached steady state.
- Hot Spots: Groundwater in the area around the single RCRA unit in the North Area appears to be adequately characterized for VC in terms of the number and locations of groundwater samples in the A level of the aquifer. There do not appear to be any hot spot data gaps for VC in the A level of the aquifer. VC was not analyzed in the B level of the aquifer at the location associated with the RCRA unit resulting in a data gap. The direct push probes NA-DP-36, NA-DP-37, NA-DP-38, and NA-DP-40, located at or around RCRA unit SWMU 2-01.1, will be extended to the B level of the aquifer to fill this data gap (see Table 2-2).
- New Sources: There is one sampling location containing a VC concentration in groundwater that is greater than its screening level in the A level of the North Area. This sampling location is associated with RCRA unit SWMU 2-01.1, Landing Gear Cleaning Sump. Therefore, based on existing data there is not a new source data gap for the North Area.
- Groundwater to Surface Water Pathway: The groundwater to surface water pathway currently might be complete for VC in the A level of the aquifer in the North Area. Groundwater samples will be obtained in monitoring wells and direct-push probes installed along Slip 4 and the Duwamish Waterway during the North Area data gap investigation to provide the additional data needed to further evaluate this pathway.
- Background Data: VC is not a naturally-occuring compound and there is no background level for this COC.
- Exceedance of Screening Levels by Analytical Reporting Limits: The reporting limit for VC in groundwater samples throughout the North Area is 1.0 μg/L, which is higher than the screening level of 0.731 μg/L resulting in a data gap. Samples from monitoring wells and direct-push probes sampled as part of the North Area data gap investigation will have a reporting limit of 0.2 μg/L to fill this reporting limit data gap for VC.

### 2.3.5 Petroleum Hydrocarbons

Analytical results for all site-wide petroleum hydrocarbon COCs were screened to determine which site-wide constituents are also COCs for the North Area. The screening levels used for

site-wide COCs are summarized in Table A-1. If a site-wide COC was detected in the North Area analytical data at concentrations greater than or equal to the respective screening level, the site-wide COC is considered a COC for the North Area. Resulting North Area-specific COCs are listed and summarized in Table 2-1. Isoconcentration maps and tables of maximum petroleum hydrocarbon concentrations in the North Area are presented in Attachment A.

Motor oil-range petroleum hydrocarbons (ORPH) is the only range of petroleum hydrocarbons that is included on the North Area area-specific COC list. This is based on its occurrence at concentrations greater than screening levels.

#### *2.3.5.1 Motor Oil-Range Petroleum Hydrocarbons*

ORPH was analyzed in nine North Area groundwater samples and detected in four of those samples. Three of the four detected ORPH concentrations were at concentrations greater than its screening level of 500 µg/L.

ORPH was detected at concentrations greater than its screening level at sampling locations HP-AL-27, HP-AL-31, and HP-AL-34 at concentrations of 12,000 µg/L, 800 µg/L, and 1,300 µg/L, respectively. The area containing groundwater samples with concentrations of ORPH greater than its screening level is located along the shoreline with the Duwamish Waterway and the northwestern shoreline with Slip 4.

The RCRA unit located at the location of ORPH concentrations above its screening level in groundwater is summarized in Table 2-3. Refer to the isoconcentration map in Attachment A for the sampling location where ORPH was detected.

Data gaps for ORPH are identified using the five criteria from Section 2.1 and are summarized below.

- The existing data are insufficient to give a current view of the distribution of ORPH in groundwater; therefore, the sampling event discussed in Section 2.3.1 will include this COC as a constituent at selected sampling locations. This information will then be combined with historical data to develop inferences regarding whether the ORPH distribution has reached steady state.
- Hot Spots: Groundwater in area around the single RCRA unit in the North Area appears to be adequately characterized for ORPH in terms of the number and locations of groundwater samples. Petroleum hydrocarbons, including ORPH, are less dense than water and are only expected in the A level of the aquifer. Therefore, there do not appear to be any hot spot data gaps for ORPH in the A level of the aquifer.
- New Sources: There are two sampling locations containing ORPH in groundwater at concentrations greater than its screening level in the A level of the North Area. These sampling locations are HP-AL-31 and HP-AL-27, and are not associated with RCRA unit SWMU 2-01.1, Landing Gear Cleaning Sump. Therefore, there is a new source data gap for the North Area that will be further investigated using a

combination of new monitoring wells and direct-push probes (see Table 2-2 for sampling locations where ORPH will be analyzed).

- Groundwater to Surface Water Pathway: The groundwater to surface water pathway currently might be complete for ORPH in the A level of the aquifer in the North Area. Groundwater samples will be obtained in monitoring wells and direct-push probes installed along Slip 4 and the Duwamish Waterway during the North Area data gap investigation to provide the additional data needed to further evaluate this pathway.
- Background Data: ORPH is not a naturally-occuring compound and there is no background level for this COC.
- Exceedance of Screening Levels by Analytical Reporting Limits: The reporting limit for ORPH in groundwater samples throughout the North Area ranges from 500 μg/L to 10,000 μg/L, which in some cases is higher than the screening level of 500 μg/L resulting in a data gap. Samples from monitoring wells and direct-push probes sampled as part of the North Area data gap investigation will have a reporting limit of 500 μg/L to fill this reporting limit data gap for ORPH.

### 2.3.6 Summary of Investigation Scope for Groundwater Data Gaps

The groundwater data gap investigation of the North Area will be performed to fill data gaps identified in the preceding sections. The six main work elements associated with the North Area data gap investigation are summarized below:

| Element | Scope | Rationale |
|---|---|---|
| 1 | Installation of four new A-level and three B-level monitoring wells at locations along Slip 4 and the Duwamish Waterway | Long-term groundwater monitoring points are needed in the North Area to evaluate the quality of groundwater as it enters the North Area, Slip 4, and the Duwamish Waterway. |
| 2 | Installation of 46 direct-push probes downgradient of historical groundwater impacts throughout the North Area as well as in areas requiring further delineation due to COCs detected in vadose zone soils. Three of the 46 probes will be installed in the C-level of the aquifer; the remaining 43 probes will be installed in the A-level of the aquifer. | Groundwater in the area near SWMU 2-01.1, Landing Gear Cleaning Sump was historically impacted by vinyl chloride. In addition, the shoreline along the northwest corner of the North Area historically contained groundwater ORPH at concentrations greater than screening levels. The three C-level probes will be installed to evaluate groundwater quality and C-level geology at one upgradient and two downgradient locations in the North Area. |
| 3 | Groundwater sampling for VOCs and metals at all new and existing monitoring wells and at 46 new direct-push probe locations. | A current groundwater sampling event will clarify many questions discussed above regarding the distribution of groundwater plumes. |

| Element | Scope | Rationale |
|---|---|---|
| 4 | Focused sampling at selected monitoring wells and direct-push probe locations in the North Area for TPH (diesel and oil range), cPAHs, VOCs, PCBs, and metals. | Current groundwater sampling data around historical isolated groundwater concentrations above screening levels will clarify whether the groundwater impacts are still present and help delineate the extent of their impacts. Data from this task will also be used to determine if the soil to groundwater pathway is complete for soil COCs detected above their respective screening levels protective of surface water. |
| 5 | Perform salinity, TDS, and major cation/anion vertical profiling in the three C-level probes NA-DP-44, NA-DP-45, and NA-DP-46. | The C-level of the aquifer is distinctly more saline than A and B levels and vertical profiles of salinity, TDS, and major anions/cations will also be a component of Volume I of the CMS Data Gaps Report. |
| 6 | Obtain samples for grain size analysis at selected 10-foot intervals in the three C-level probes. | The geology of the B and C levels of the aquifer is not as thoroughly documented in the North Area relative to other areas of Plant 2. |

A summary table showing the wells and probes to be sampled, constituent groups analyzed, and which general data gaps will be filled by the sampling is presented in Table 2-2. The rationale for sampling for specific constituent groups at each of the wells and probes is provided in the right hand column of the table.

## 2.4 SOIL DATA GAPS

Data gaps associated with the nature and extent of chemical constituents in the North Area soils are evaluated in Sections 2.4.1 through 2.4.4.

Analytical results for all site-wide COCs were screened to determine which are COCs for the North Area. Screening levels for site-wide COCs are presented in Table B-1. If a site-wide COC has been detected above its screening level in North Area soil, it is a COC for the North Area. North Area soil COCs are listed in Tables 2-1 and B-2. Table 2-1 also lists the exposure pathway screening levels. Table B-2 provides the number of exceedances for each exposure pathway.

Soil concentration maps for all COCs are presented in Attachment B. The maps present the data for three intervals (0 to 1 foot bgs, greater than 1 foot to 6 feet bgs, and greater than 6 feet to 12 feet bgs) within the vadose zone soil column from 0 to 12 feet bgs. Data tables summarizing all COC concentrations (including duplicate sample analysis results) in the North Area are also provided in Attachment B. Table 2-4 provides a list of the COCs associated with the single RCRA unit located in the North Area. North Area soil COC groups are discussed by constituent in the Section 2.4.1 through 2.4.4.

### 2.4.1 Inorganics

Analytical results for all site-wide metal COCs and cyanide were screened to determine which are COCs for the North Area. Chemical analysis was conducted for one or more inorganic constituents on 56 soil samples collected in the North Area from 12 feet bgs or less. Metals analysis comprised 23 constituents; screening levels have been established for 18 of these. The risk-based soil screening levels protective of surface water for five metals (arsenic, copper, manganese, mercury, and nickel) were below the Puget Sound Basin natural background concentration calculated by Ecology (1994), and were therefore adjusted to the background concentrations for data gap evaluation purposes (with acknowledgment that they exceed the risk-based screening levels). Cyanide analysis was conducted on four soil samples collected in the North Area. Five inorganic compounds comprise the North Area-specific soil COC list:

| | | |
|---|---|---|
| Arsenic | Copper | Zinc |
| Cadmium | Mercury | |

#### *2.4.1.1 Arsenic*

Arsenic was analyzed in 56 North Area soil samples and detected in 52. Of those samples in which arsenic was detected, 10 were reported at concentrations greater than the 7.3 milligrams per kilogram (mg/kg) soil screening level, which is based on the Puget Sound Basin natural background concentration calculated by Ecology (1994). The maximum concentration (15 mg/kg) detected in the North Area did not exceed the air pathway screening level (32,200 mg/kg) for inhalation (fugitive dust). The air pathway is not considered a viable exposure pathway for arsenic with respect to indoor air.

Concentrations of arsenic detected in the North Area above the soil screening level protective of surface water ranged from 8 to 15 mg/kg, 1.1 to 2.1 times the screening level. The sample with the maximum concentration (15 mg/kg) was collected from 7.6 feet bgs at PL2C-WCS-04a at the waste containment structure.

***Central Portion of Building 2-122:*** Arsenic was detected in nine samples collected from eight locations in the central portion of the 2-122 Building. Concentrations of arsenic in these samples ranged from 0.1 to 9 mg/kg. Arsenic was detected above the screening level in four samples collected from 2.5 to 9 feet bgs at four different locations (PL2C-2-122-C, PL2C-2-122-Q, PL2C-2-122-J, and B-3). Deeper soils were not sampled at these locations. The extent of arsenic in soil has not been adequately delineated in this area for CMS purposes based on the criteria in Section 2.1. Arsenic concentrations under the building do not exceed 9 mg/kg and may represent an area-wide background concentration. Arsenic has not been detected above the groundwater screening level in this area. Groundwater downgradient of this area will be analyzed for metals (including arsenic). The data will be evaluated to determine whether arsenic has impacted groundwater in this area.

***North Side of Building 2-122:*** Arsenic was detected above the screening levels in a single sample collected from 1.0 to 7.5 feet bgs at one location (B-8) on the north side of the 2-122 Building. Deeper soil was not sampled at this location. Arsenic was detected at a concentration of 5.3 mg/kg in a soil sample collected from 2.5 to 6 feet bgs at an adjacent

sample location (PL2-234A) to the north of B-8. The extent of arsenic in soil has not been adequately delineated to the south and northeast of this sample location for CMS purposes based on the criteria in Section 2.1. The analytical data indicates that concentrations above the screening level (adjusted for background) are present in soils at depth. Arsenic has not been detected above the groundwater screening level in this area. Groundwater in this area will be analyzed for metals (including arsenic). The data will be evaluated to determine whether arsenic has impacted groundwater in this area.

***2-124 Building:*** Arsenic was detected above the screening level in one sample at 3.6 feet bgs approximately 50 feet north of the 2-124 Building at PL2C-2124-04. The concentration of this sample was reported at 13 mg/kg. Deeper soil was not sampled at this location. The extent of arsenic at this location has not been adequately delineated for CMS purposes based on the criteria in Section 2.1. Arsenic has not been detected above the groundwater screening level in this area. However, groundwater in this area will be analyzed for metals (including arsenic). The data will be evaluated to determine whether arsenic has impacted groundwater in this area.

***Waste Containment Structure:*** Arsenic was detected in five samples from five locations near the waste containment structure. Concentrations of arsenic in these samples range between 5 to 15 mg/kg. Arsenic was detected above the screening level in four of the samples (PL2-WCS-01, PL2-WCS-02, PL2-WCS-04a, and PL2-WCS-05). The samples were collected from 2.8 to 7.6 feet bgs. Shallower soil at these locations was sampled and subsequently removed during construction excavation as described in Section 1.4. Deeper soil was not sampled at these locations. The extent of arsenic in soil has not been adequately delineated in this area for CMS purposes based on the criteria in Section 2.1. Soil in this area will be analyzed for metals (including arsenic) to delineate the vertical and horizontal extent of arsenic. Arsenic has not been detected above the groundwater screening level in this area. Groundwater data from these locations will be evaluated to determine whether arsenic has impacted groundwater in this area.

Soil and groundwater data for arsenic were evaluated to identify data gaps for CMS purposes using criteria from Section 2.1: Source Control, Completed Pathways, and Exceedances of Screening Levels by Analytical Reporting Limits. Results of this evaluation are summarized below.

- **Hot Spots:** Potential sources of arsenic in the North Area related to any RCRA units have been adequately characterized for CMS purposes.
- **New Sources:** Arsenic detected above the soil screening level near the waste containment structure has the potential to impact groundwater. Arsenic was also detected above the soil screening level beneath the 2-122 Building and near the 2-124 Building.

  Lateral and vertical delineation are incomplete in the central portion of the 2-122 Building. Arsenic will be analyzed in soil samples from up- and downgradient of locations where elevated concentrations of arsenic were detected to delineate the area impacted.

Lateral and vertical delineation are incomplete near sample location PL2C-2124-04, approximately 50 feet north of Building 2-124. Arsenic will be analyzed in soil samples from direct-push locations to the northeast, south, and west of PL2C-2124-04.

Lateral and vertical delineation will be completed near the waste containment structure. Arsenic will be analyzed in soil samples from direct-push locations to the north southeast, southwest and northwest of the waste containment structure.

- **Completed Pathways:**
  - **Direct Contact:** Arsenic was not detected above the direct contact pathway screening level (33.3 mg/kg) in North Area soil.
  - **Air Pathway:** The air pathway screening level for arsenic is based on inhalation of fugitive dust. Arsenic was not detected above the air pathway screening level (32,200 mg/kg) in North Area soil.
  - **Soil to Groundwater Pathway:** The data indicate that arsenic is present in soil near the waste containment structure and to the north of the 2-124 Building at concentrations that could impact groundwater. Concentrations of arsenic above background were detected beneath the 2-122 Building and north of the 2-124 Building. Metals, including arsenic, will be analyzed in soil and groundwater samples from direct push locations adjacent to the 2-122 Building, north of the 2-124 Building, and around the waste containment structure. The data will be used to determine if the pathway is currently complete, and if groundwater has been impacted by elevated concentrations of arsenic in the soil.

    However, soil samples will not be collected from inside the 2-122 Building as concentrations of arsenic detected in historic samples currently located underneath the building are relatively low with respect the screening level, the building slab provides a barrier to infiltration of water required to drive the exposure pathway, and groundwater downgradient of the areas where arsenic was detected above screening levels will be sampled for metals in part to provide an indication of possible arsenic migration.

- **Exceedances of Screening Levels by Analytical Reporting Limits:**
  - Reporting limits for all nondetected arsenic results are below applicable screening levels.

The data gaps identified above will be addressed by analyzing soil and groundwater samples for arsenic as follows:

Soil sampling and analysis will be conducted at the following locations:

North of Building 2-124
- NA-DP-23
- NA-DP-24
- NA-DP-25

Southeast of Building 2-124
- NA-DP-26
- NA-DP-27
- NA-DP-28

Central Portion of the 2-122
- NA-DP-29 through NA-DP-32

Waste Containment Structure
- NA-DP-17 through NA-DP-20

Groundwater sampling and analysis will be conducted at the following locations:

North of Building 2-124
- NA-DP-23
- NA-DP-24
- NA-DP-25

Southeast of Building 2-124
- NA-DP-26
- NA-DP-27
- NA-DP-28

Central Portion of Building 2-122
- NA-DP-29 through NA-DP-32

Waste Containment Structure
- NA-DP-17 through NA-DP-20

Laboratory analyses are presented in Table 2-2 and sample locations are presented on Figure 2-1.

#### *2.4.1.2 Cadmium*

Cadmium was analyzed in 56 North Area soil samples and detected in four. Of those samples where cadmium was detected, one was reported at a concentration (2.9 mg/kg) greater than the soil screening level protective of surface water (1.21 mg/kg). The sample was collected southeast of the 2-124 Building. The maximum cadmium concentration does not exceed either the direct contact or the air pathway (fugitive dust) screening levels (667 mg/kg and

77,000 mg/kg, respectively). The air pathway is not considered a viable exposure pathway for cadmium with respect to indoor air.

***Southeast of 2-124 Building.*** The sample in which cadmium was detected above the soil screening level was collected from 6 to 8.5 feet bgs at B-36, approximately 80 feet southeast of the 2-124 Building. Cadmium was not detected in the sample collected from shallower soil (3 to 5.5 feet bgs) at B-36; soil from below 8 feet bgs was not sampled. Cadmium has not been detected above the groundwater screening level in this area. The extent of cadmium in soil has not been adequately delineated in the area for CMS purposes based on the criteria in Section 2.1. Groundwater in this area will be analyzed for metals (including cadmium).

Soil and groundwater data for cadmium were evaluated to identify data gaps for CMS purposes using criteria from Section 2.1: Source Control, Completed Pathways, and Exceedances of Screening Levels by Analytical Reporting Limits. Results of this evaluation, along with any measures to be taken to fill data gaps, are summarized below.

- **Source Control:**
  - **Hot Spots:** Potential sources of cadmium in the North Area related to any RCRA units have been adequately characterized for CMS purposes.
  - **New Sources:** Cadmium detected above soil screening levels southeast of the 2-124 Building has the potential to impact groundwater.

    Lateral and vertical delineation of cadmium in soil approximately 80 feet southeast of Building 2-124 at B-36 is incomplete. Cadmium will be analyzed in soil samples collected from direct-push locations to the northeast, south, and west of B-36.
- **Completed Pathways:**
  - **Direct Contact:** Cadmium was not detected above the direct contact pathway screening level (667 mg/kg) in North Area soil.
  - **Air Pathway:** The air pathway screening level for cadmium is based on inhalation of fugitive dust. Cadmium was not detected above the air pathway screening level (77,000 mg/kg) in North Area soil.
  - **Soil to Groundwater Pathway:** The data indicate cadmium is present in soil at B-36 at concentrations that could impact groundwater. Metals, including cadmium, will be analyzed in soil and groundwater samples from direct push around B-36. The data will be used to determine if the pathway is currently complete and if groundwater has been impacted by elevated concentrations of cadmium in the soil.
- **Exceedances of Screening Levels by Analytical Reporting Limits:**
  - Reporting limits for all non-detected cadmium results are below applicable screening levels.

The data gaps identified above will be addressed by analyzing soil and groundwater samples for cadmium as follows.

Soil sampling and analysis will be conducted at the following locations:

Southeast of Building 2-124

- NA-DP-26
- NA-DP-27
- NA-DP-28

Groundwater sampling and analysis will be conducted at the following locations

Southeast of Building 2-124

- NA-DP-26
- NA-DP-27
- NA-DP-28

Laboratory analyses are presented in Table 2-2 and sample locations are presented on Figure 2-1.

#### *2.4.1.3 Copper*

Copper was analyzed in 56 North Area soil samples and detected in all 56. Of those samples in which copper was detected, two were reported at concentrations greater than the 36.4 mg/kg soil screening level, which is based on the Puget Sound Basin natural background concentration calculated by Ecology (1994). The maximum concentration of copper detected in the North Area (310 mg/kg) does not exceed the direct contact pathway screening level (49,300 mg/kg). The air pathway is not considered a viable exposure pathway for copper.

Copper was detected above the background adjusted soil screening level (36.4 mg/kg) at 40 mg/kg and 310 mg/kg, 1.1 and 8.5 times the screening level, respectively. The maximum concentration of copper was detected in a sample approximately 80 feet southeast of the 2-124 Building.

***2-124 Building:*** Copper was detected above the screening level in two samples from 3.6 to 8.5 feet bgs at two locations (PL2C-2124-04 and B-36) approximately 50 feet north of the 2-124 Building and approximately 80 feet southeast of the building. Concentrations in these samples were 40 mg/kg and 310 mg/kg. Deeper soil was not sampled at either location. The extent of copper at these locations has not been adequately delineated for CMS purposes based on the criteria in Section 2.1. Copper has not been detected above the groundwater screening level in this area. However, groundwater in this area will be analyzed for metals (including copper). The data will be evaluated to determine whether copper has impacted groundwater in this area.

Soil and groundwater data for copper were evaluated to identify data gaps for CMS purposes using criteria from Section 2.1: Source Control, Completed Pathways, and Exceedances of

Screening Levels by Analytical Reporting Limits. Results of this evaluation, along with any measures to be taken to fill data gaps, are summarized below.

- **Source Control:**
  - **Hot Spots:** Potential sources of copper in the North Area related to any RCRA units have been adequately characterized for CMS purposes.
  - **New Sources:** Copper detected above soil screening levels southeast and north of the 2-124 Building has the potential to impact groundwater.

    Lateral and vertical delineation are incomplete near B-36, approximately 80 feet southeast of Building 2-124. Copper will be analyzed in soil samples from direct-push locations to the northeast, south, and west of B-36.

    Lateral and vertical delineation are incomplete near PL2C-2124-04, approximately 50 feet north of Building 2-124. Copper will be analyzed in soil samples from direct-push locations to the northeast, south, and west of PL2C-2124-04.

- **Completed Pathways:**
  - **Direct Contact:** Copper was not detected above the direct contact pathway screening level (49,300 mg/kg) in 2-40s Area soil.
  - **Air Pathway:** The air pathway is not considered a viable exposure pathway for copper.
  - **Soil to Groundwater Pathway:** The data indicate that copper in soil may impact groundwater near PL2C-2124-04 and B-36. Metals, including copper, will be analyzed in soil and groundwater samples from direct push locations around PL2C-2124-04 and B-36. The data will be used to determine if the pathway is complete and groundwater has been impacted by copper in the soil.

- **Exceedances of Screening Levels by Analytical Reporting Limits:**
  - Copper was detected in all North Area soil samples; therefore, there were no exceedances of screening levels by analytical reporting limits.

The data gaps identified above will be addressed by analyzing soil and groundwater samples for copper as follows:

Soil sampling and analysis will be conducted at the following locations:

North of Building 2-124
- NA-DP-23
- NA-DP-24
- NA-DP-25

Southeast of Building 2-124

- NA-DP-26
- NA-DP-27
- NA-DP-28

Groundwater sampling and analysis will be conducted at the following locations:

North of Building 2-124

- NA-DP-23
- NA-DP-24
- NA-DP-25

Southeast of Building 2-124

- NA-DP-26
- NA-DP-27
- NA-DP-28

Laboratory analyses are presented in Table 2-2 and sample locations are presented on Figure 2-1.

#### *2.4.1.4 Mercury*

Mercury was analyzed in 41 North Area soil samples and detected in seven samples. Of those samples in which mercury was detected, three were reported at concentrations greater than the soil screening level (0.07 mg/kg), which is based on the Puget Sound Basin natural background concentration calculated by Ecology (1994). The adjusted soil screening level applies to both the screening level protective of surface water and the air pathway screening level. The maximum concentration of mercury detected in the North Area did not exceed the direct contact exposure pathway screening level (41.9 mg/kg) or Area specific air pathway screening level (6.1 mg/kg).

Concentrations of mercury detected above screening levels ranged from 0.12 to 0.2 mg/kg, 1.7 to 2.9 times the soil screening level. The maximum concentration of mercury was detected in a sample collected approximately 80 feet southeast of the 2-124 Building.

***2-124 Building:*** Mercury was detected above the screening level (adjusted for background) in two samples from 3.6 to 8.5 feet bgs at two locations (PL2C-2124-04 and B-36) near the 2-124 Building. Mercury was detected at a concentration of 0.2 mg/kg in a sample from 6 to 8.5 feet bgs at B-36, approximately 80 feet southeast of the 2-124 Building. Mercury was also detected at 0.12 mg/kg in a sample from 3.6 feet bgs at PL2C-2124-04, approximately 50 north of the 2-124 Building. Deeper soil was not sampled at either location. The extent of mercury at these locations has not been adequately delineated for CMS purposes based on the criteria in Section 2.1. Mercury has not been detected above the groundwater screening level in this area. However, groundwater in this area will be analyzed for metals (including mercury). The data will be evaluated to determine whether mercury has impacted groundwater in this area.

***Central Portion of the 2-122 Building:*** Mercury was detected above the screening levels in a single sample from 2.5 to 3.5 feet bgs at PL2C-2-122-A, in the central portion of the 2-122 Building. Deeper soil was not sampled at this location. The extent of mercury in soil has not been adequately delineated to the south and northeast of this sample location for CMS purposes based on the criteria in Section 2.1. The analytical data indicates that mercury is present in soils at depth at concentrations above the screening level (adjusted for background). Mercury has not been detected above the groundwater screening level in this area. Groundwater in this area will be analyzed for metals (including mercury). The data will be evaluated to determine whether mercury has impacted groundwater in this area.

Soil and groundwater data for mercury were evaluated to identify data gaps for CMS purposes using criteria from Section 2.1: Source Control, Completed Pathways, and Exceedances of Screening Levels by Analytical Reporting Limits. Results of this evaluation, along with any measures to be taken to fill data gaps, are summarized below.

- **Source Control:**
  - **Hot Spots:** Potential sources of mercury in the North Area related to any RCRA units have been adequately characterized for CMS purposes.
  - **New Sources:** Mercury detected above soil screening levels southeast and north of the 2-124 Building and underneath the 2-122 Building has the potential to impact groundwater.

    Lateral and vertical delineation are incomplete near B-36, approximately 80 feet southeast of Building 2-124. Mercury will be analyzed in soil samples from direct-push locations to the northeast, south, and west of B-36.

    Lateral and vertical delineation are incomplete near PL2C-2124-04, approximately 50 feet north of Building 2-124. Mercury will be analyzed in soil samples from direct-push locations to the northeast, south, and west of PL2C-2124-04.

    Lateral and vertical delineation are incomplete near PL2C-2-122-A in the central portion of the 2-122 Building. Mercury will be analyzed in soil samples adjacent to the 2-122 Building upgradient and downgradient of PL2C-2-122-A to delineate the impacted area.

- **Completed Pathways:**
  - **Direct Contact:** Mercury was not detected above the direct contact screening level (41.9 mg/kg) in the North Area.
  - **Air Pathway:** The air pathway screening level for mercury is based on indoor air. Mercury has not been detected above the area-specific J&E air pathway screening level.
  - **Soil to Groundwater Pathway:** The data indicate that mercury is present near the 2-124 Building and underneath the central portion of the 2-122 Building. Mercury will be analyzed in groundwater samples from direct-push locations in

and adjacent to the 2-124 Building. Soil and groundwater samples will be collected from direct-push probes outside of the 2-122 Building up- and downgradient of PL2C-2-122-A. The data will be used to evaluate whether the groundwater has been impacted by mercury.

However, soil samples will not be collected from inside the 2-122 Building as concentrations of mercury detected in historic samples currently located underneath the building are relatively low with respect the screening level, the building slab provides a barrier to infiltration of water required to drive the exposure pathway, and groundwater downgradient of the areas where mercury was detected above screening levels will be sampled for metals in part to provide an indication of possible mercury migration.

- **Exceedances of Screening Levels by Analytical Reporting Limits:**
    - All reporting limits for nondetected mercury results are below the applicable screening levels.

The data gaps identified above will be addressed by analyzing groundwater samples for mercury as follows.
Soil sampling and analysis will be conducted at the following locations:

North of Building 2-124
- NA-DP-23
- NA-DP-24
- NA-DP-25

Southeast of Building 2-124
- NA-DP-26
- NA-DP-27
- NA-DP-28

Central Portion of Building 2-122
- NA-DP-29 through NA-DP-32

Groundwater sampling and analysis will be conducted at the following locations:

North of Building 2-124
- NA-DP-23
- NA-DP-24
- NA-DP-25

Southeast of Building 2-124
- NA-DP-26
- NA-DP-27
- NA-DP-28

Central Portion of Building 2-122

- NA-DP-29 through NA-DP-32

Laboratory analyses are presented in Table 2-2 and sample locations are presented on Figure 2-1.

#### *2.4.1.5 Zinc*

Zinc was detected in all of the 56 soil samples analyzed for metals in the North Area. Of those samples where zinc was detected, one was reported at a concentration (220 mg/kg) greater than the soil screening level protective of surface water (101 mg/kg). This sample was collected southeast of the 2-124 Building. This concentration does not exceed the direct contact pathway screening level (40,000 mg/kg). The air pathway is not considered a viable exposure pathway for zinc.

***Southeast of 2-124 Building:*** Zinc was detected (220 mg/kg) above the soil screening level in a sample from 6 to 8.5 feet bgs at B-36, approximately 80 feet southeast of the 2-124 Building. Zinc was not detected above the screening level in a sample from 3 to 5.5 feet bgs at this location; deeper soil was not sampled. Zinc has not been detected above the groundwater screening level in this area. The extent of zinc in soil has not been adequately delineated to in this area for CMS purposes. Groundwater in this area will be analyzed for metals (including zinc).

Soil and groundwater data for zinc were evaluated to identify data gaps for CMS purposes using criteria from Section 2.1: Source Control, Completed Pathways, and Exceedances of Screening Levels by Analytical Reporting Limits. Results of this evaluation, along with any measures to be taken to fill data gaps, are summarized below.

- **Source Control:**
  - **Hot Spots:** Potential sources of zinc in the North Area related to any RCRA units have been adequately characterized for CMS purposes.
  - **New Sources:** Zinc detected above soil screening levels southeast of the 2-124 Building has the potential to impact groundwater.

    Lateral and vertical delineation are incomplete near B-36, approximately 80 feet southeast of Building 2-124. Zinc will be analyzed in soil samples from direct-push locations to the northeast, south, and west of B-36.
- **Completed Pathways:**
  - **Direct Contact:** Zinc was not detected above the direct contact pathway screening level (40,000 mg/kg) in North Area soil.
  - **Air Pathway:** The air pathway is not considered a viable exposure pathway for zinc.

- **Soil to Groundwater Pathway:** The data indicate that the soil to groundwater pathway may be complete near B-36. Metals, including zinc, will be analyzed in soil and groundwater samples from direct-push locations around B-36. The data will be used to determine if the pathway is complete and groundwater has been impacted by zinc in the soil.

- **Exceedances of Screening Levels by Analytical Reporting Limits:**
  - Reporting limits for all non-detected zinc results are below applicable screening levels.

The data gaps identified above will be addressed by analyzing soil and groundwater samples for zinc as follows.

Soil sampling and analysis will be conducted at the following locations:

Southeast of Building 2-124
- NA-DP-26
- NA-DP-27
- NA-DP-28

Groundwater sampling and analysis will be conducted at the following locations:

Southeast of Building 2-124
- NA-DP-26
- NA-DP-27
- NA-DP-28

Laboratory analyses are presented in Table 2-2 and sample locations are presented on Figure 2-1.

### 2.4.2 Semivolatile Organic Compounds and Polychlorinated Biphenyls

Analytical results for all site-wide SVOC and PCB COCs were screened to determine which are COCs for the North Area. Analysis for SVOCs was conducted on 42 soil samples. PCB analyses (aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260) were conducted on 57 samples. Aroclors 1242, 1248, and 1254, and total PCBs, as well as the following six SVOCs, all of which are polycyclic aromatic hydrocarbons (cPAHs), were identified as COCs for the North Area:

- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene

- Benzo(k)fluoranthene
- Chrysene
- Indeno(1,2,3-cd)pyrene

The presence of these constituents in North Area soil is evaluated for the soil to surface water and direct contact pathways in the Sections 2.4.2.1 and 2.4.2.2. The air exposure pathway is not evaluated because SVOCs and PCBs are not volatile. In the foregoing discussion of SVOC and PCB COCs, the term "screening level" will refer to the soil screening level protective of surface water, unless otherwise noted.

#### *2.4.2.1 Carcinogenic Polycyclic Aromatic Hydrocarbons*

SVOCs, including the cPAH constituents, were analyzed in 42 soil samples. One or more of the six cPAHs was detected in eight soil samples. In every sample where a cPAH other than chrysene was detected above its screening level, chrysene was also detected above its screening level. Therefore, the pathway evaluation for cPAHs will be conducted using chrysene as an indicator for the entire group. Chrysene concentrations exceeded the soil screening level protective of surface water (46.6 µg/kg) in six of 42 samples. Concentrations in these samples ranged from 80 to 2,900 µg/kg. Chrysene was not detected above the direct contact screening level (3,420 µg/kg).

***North Portion of the North Area:*** Chrysene was detected above its screening level in two samples from 7.5 to 11 feet bgs at B-16 and B-35. Chrysene was detected at 200 and 150 µg/kg, respectively. B-35 and B-16 are approximately 120 and 300 feet inland of the central portion of Slip 4. B-16 is within the footprint of the 2-122 Building. Deeper soil was not sampled at these locations. The horizontal extent of chrysene in soil has not been adequately delineated at these locations for CMS purposes. The analytical soil data indicates that cPAHs are present at depth at concentrations above the soil screening level. CPAHs have not been analyzed in groundwater in this area. Groundwater in this area will be analyzed for cPAHs (including chrysene). The data will be evaluated to determine whether cPAHs have impacted groundwater in this area.

***South Corner of the North Area:*** Chrysene was detected in three samples from three locations (B-23, B-24, and HP-AL-20) in the south corner of the North Area upland of the waterway. Concentrations of chrysene in these samples range from 160 µg/kg to 2,900 µg/kg. The samples were collected from 2.5 to 11.5 feet bgs. Deeper soils were not sampled at these locations. The extent of chrysene in soil has not been adequately delineated in this area for CMS purposes. Groundwater from this area has not been analyzed for SVOCs or cPAHs. Groundwater downgradient of this area will be analyzed for cPAHs (including chrysene). The data will be evaluated to determine whether cPAHs have impacted groundwater in this area.

***West Corner of North Area:*** Chrysene was detected (80 µg/kg) above its screening level in a sample from 2.5 to 6.5 feet bgs at B-32, inland approximately 60 feet from the southwest end of Slip 4. Chrysene was not detected above its analytical reporting limit of 71 µg/kg in a deeper soil sample from this location. Neither the vertical nor horizontal extent of chrysene in soil has

been adequately delineated for CMS purposes near this location. The data indicates that chrysene is present at depth at concentrations above the soil screening level. Groundwater from this area has not been analyzed for SVOCs or cPAHs. Groundwater samples will be collected from this area and analyzed for cPAHs (including chrysene). The data will be evaluated to determine whether cPAHs have impacted groundwater in this area.

***Analytical Reporting Limits.*** There were approximately 30 samples in which cPAHs were not detected with RLs above the soil screening level protective of surface water. RLs above the screening level ranged from 50 to 65 µg/kg. RLs did not exceed the direct contact screening level for any of the cPAH constituents. A number of the samples in which the RLs exceeded the SL protective of surface water were collected at depth (>6 feet bgs) in the North Area. Therefore, groundwater will be sampled and analyzed to verify that cPAHs are not present in groundwater within the North Area at concentrations exceeding screening levels.

Soil and groundwater data for cPAHs were evaluated to identify data gaps for CMS purposes using criteria from Section 2.1: Source Control, Completed Pathways, and Exceedances of Screening Levels by Analytical Reporting Limits. Results of this evaluation, along with any measures to be taken to fill data gaps, are summarized below.

- **Source Control:**
    - **Hot Spots:** Potential sources of cPAHs in the North Area RCRA unit have been adequately delineated for CMS purposes:
    - **New sources:** cPAHs detected above soil screening levels in both the north portion and south corner of the North Area and to the southwest of Slip 4 have the potential to impact groundwater.
    - Lateral and vertical delineation are incomplete in the north portion of the North Area at B-35 and B-16. CPAHs will be analyzed in soil samples from direct-push locations to the northeast, south and west of B-35 and to the west of B-16 adjacent to the 2-122 Building.
    - Lateral and vertical delineation are incomplete in the west corner of the North Area at B-23, B-24 and HP-AL-20. CPAHs will be analyzed in soil samples from direct-push locations to the east, southwest and northwest of each of these locations.
    - Lateral and vertical delineation are incomplete at B-32 in the south corner of the North Area near Slip 4. CPAHs will be analyzed in soil samples from direct-push locations to the northeast and south and a monitoring well to the west of B-32.
- **Completed Pathways:**
    - **Direct Contact:** CPAHs were not detected above their direct contact pathway screening levels in the North Area soil.
    - **Air Pathway:** The air pathway is not considered a viable exposure pathway for cPAHs.

- **Soil to Groundwater Pathway:** The analytical data indicate that one or more cPAHs are present above the screening level protective of surface water at depth in the both in the north portion and south corner of the North Area and to the southwest of Slip 4. CPAHs will be analyzed in groundwater samples from direct-push and monitoring well locations in and adjacent to these areas. The data will be used to evaluate whether groundwater has been impacted by cPAHs.

  However, soil samples will not be collected from inside the 2-122 Building as concentrations of cPAHs detected in historic samples currently located underneath the building are relatively low with respect the screening level, the building slab provides a barrier to infiltration of water required to drive the exposure pathway, and groundwater downgradient of the areas where cPAHs were detected above screening levels will be sampled for SVOCs in part to provide an indication of possible SVOC migration.

- **Exceedances of Screening Levels by Analytical Reporting Limits:**

  - The RLs for cPAHs were above the soil screening level protective of surface water at depth for a number of samples, particularly below and adjacent to the northeast half of the 2-122 Building and along the Duwamish Waterway. Groundwater samples from direct-push locations (and monitoring wells where available) on the northeast and southwest sides of the 2-124 Building and along the waterway in these areas will be analyzed for cPAHs to evaluate whether the soil to groundwater pathway is complete.

The data gaps identified above will be filled by soil and groundwater sampling as follows:

Soil sampling will be conducted at the following locations:

North Portion of North Area and Building 2-122
- NA-DP-29 through NA-DP-35

South Corner of North Area
- NA-DP-08 through NA-DP-16

West Corner of North Area
- NA-DP-38
- NA-DP-39
- PL2-609A

Duwamish Waterway
- NA-DP-01 through NA-DP-07
- NA-DP-41 through NA-DP-43
- PL2-611

Groundwater sampling and analysis will be conducted at the following locations:

North Portion of North Area and Building 2-122
- NA-DP-29 through NA-DP-35

South Corner of North Area
- NA-DP-08 through NA-DP-16

West Corner of North Area
- NA-DP-38
- NA-DP-39
- PL2-609A

Duwamish Waterway
- NA-DP-01 through NA-DP-07
- NA-DP-41 through NA-DP-43
- PL2-611

All analyses to be conducted in association with these locations are identified on Table 2-2 and their locations are presented on Figure 2-1.

#### *2.4.2.2 Total Polychlorinated Biphenyls*

PCBs (reported as aroclors) were analyzed in 57 North Area soil samples. The total PCB concentration is the sum of the individual aroclor concentrations detected within a single sample. PCBs were detected above the surface water pathway screening level (33 µg/kg) in three of the 57 North Area samples. The screening level protective of surface water was adjusted to the laboratory's RL for data gap evaluation purposes (with the acknowledgment that it exceeds the risk-based level). Direct contact screening levels have been established for aroclors 1016/1242 (46,700 µg/kg) and 1254 (13,300 µg/kg) only. Neither aroclor 1016/1242 nor aroclor 1254 was detected above the direct contact screening level in North Area soil samples. The air pathway is not considered a viable exposure pathway for PCBs.

Tables of the analytical results for the individual aroclors (1242, 1248, and 1254) are provided in Attachment B, along with maps presenting total PCB concentrations. Concentrations of total PCBs exceeding the adjusted surface water pathway screening level (33 µg/kg) ranged from 47 to 114 µg/kg. The maximum concentration was detected in a sample from 3.5 feet bgs at PL2C-2-122-J within the footprint of the 2-122 Building. There were a number of samples in which aroclors were not detected with RLs above the surface water screening level.

***Central Portion of the North Area:*** PCBs were detected in two samples (PL2C-2-122-J and PL2C-2-122-A) from the central portion of the 2-122 Building at 47 µg/kg and 114 µg/kg. The samples were collected between 2.5 and 3.5 feet bgs. Deeper soils were not sampled at these locations. The extent of PCBs in soil has not been adequately delineated to the northeast and south of PL2C-2-122-A and the south and west of PL2C-2-122-J. PCBs were detected at 82 µg/kg in a sample from 3.0 to 3.3 feet bgs at PL2C-2-122-OU, approximately 20 feet

southeast of Building 2-122 between Building 2-124 and the waste containment structure. This sample was collected during recent construction activities associated with the 2-122 Building. Deeper soils were not sampled at this location. The extent of PCBs in soil has not been adequately delineated to the northeast and southwest of this location based on the criteria in Section 2.1.

Groundwater samples from this area have not been analyzed for PCBs. Groundwater from downgradient of this area will be sampled and analyzed for PCBs. The data will be evaluated to determine whether PCBs have impacted groundwater.

***Analytical Reporting Limits.*** There were 44 samples, from four general areas, in which aroclors were not detected, with RLs above the screening level protective of surface water.

- RLs of 47-50 µg/kg were reported for samples collected in and around the 2-122 Building during the Phase I Subsurface Environmental Assessment for the Integrated Aircraft Systems Laboratory Building (Weston, 1990) before the construction of the building. In addition, a sample from 7.5 to 9.0 feet bgs in B-16, in the northwest portion of the 2-122 Building, had a RL of 260 µg/kg.
- RLs (37 to 210 µg/kg) exceeded the screening level in soil samples collected between 0.5 to 8.5 feet bgs in the central portion of the North Area near the 2-124 Building.
- Elevated RLs (180 to 260 µg/kg) were reported for a number of samples collected between 2.5 and 11.5 feet bgs adjacent to the Duwamish Waterway and southwest portion of Slip 4 and along the southwest half of the border with the 2-10 Area.

The RLs for both aroclor 1016/1242 and aroclor 1254 did not exceed direct contact screening levels.

Soil and groundwater data for PCBs were evaluated to identify data gaps for CMS purposes using criteria from Section 2.1: Source Control, Completed Pathways, and Exceedances of Screening Levels by Analytical Reporting Limits. Results of this evaluation, along with any measures to be taken to fill data gaps, are summarized below.

Data gaps for PCBs via the surface water pathway are identified using the criteria from Section 2.1 and are summarized below.

- **Source Control:**
    - **Hot Spots:** Potential sources of PCBs in the North Area RCRA unit have been adequately delineated for CMS purposes:
    - **New Sources:** PCBs detected above soil screening levels underneath the central portion of the 2-122 Building and west of the 2-124 Building have the potential to impact groundwater.
    - Lateral and vertical delineation has not been completed to the northeast and south of PL2C-2-122-A and the south and west of PL2C-2-122-J. Both of these

samples are located beneath the building slab. PCBs will be analyzed in soil samples from direct-push locations adjacent to the 2-122 Building.

- Lateral and vertical delineation has not been completed to the northeast and southwest of PL2C-2-122-OU. PCBs will be analyzed in soil samples from two direct-push locations in this area.

- **Completed Pathways:**
  - **Direct Contact:** Detected concentrations of individual aroclors did not exceed direct contact pathway screening levels.
  - **Air Pathway:** The air pathway is not considered a viable exposure pathway for PCBs.
  - **Soil to Groundwater Pathway:** The data indicate that the soil to groundwater pathway is likely complete at two locations where PCBs were detected in shallow soils underneath the 2-122 Building, and at one location west of the 2-124 Building. However, deeper soils were not sampled. PCBs will be analyzed in groundwater from direct-push and monitoring well locations in and adjacent to these areas to evaluate whether groundwater has been impacted by PCBs.

    However, soil samples will not be collected from inside the 2-122 Building as concentrations of PCBs detected in historic samples currently located underneath the building are relatively low with respect the screening level, the building slab provides a barrier to infiltration of water required to drive the exposure pathway, and groundwater downgradient of the areas where PCBs were detected above screening levels will be sampled for PCBs in part to provide an indication of possible PCB migration.

- **Exceedances of Screening Levels by Analytical Reporting Limits:**
  - The RLs for PCBs were above the soil screening level protective of surface water for numerous soil samples from throughout the North Area, specifically along Slip 4, the Duwamish Waterway, and the southwest border with the 2-10 Area. PCBs will be analyzed in soil and/or groundwater from direct-push and monitoring well locations in and adjacent to these areas. The data will be used to confirm groundwater has not been impacted by PCBs in these areas.

The data gaps identified above will be filled by soil and groundwater sampling as follows.

Soil sampling will be conducted at the following locations:

Central Portion of the North Area

- NA-DP-20
- NA-DP-21
- NA-DP-22
- NA-DP-29 through NA-DP-32

Duwamish Waterway

- NA-DP-01 through NA-DP-08
- NA-DP-41 through NA-DP-43
- PL2-609
- PL2-611

Groundwater sampling and analysis will be conducted at the following locations:

Central Portion of the North Area

- NA-DP-20
- NA-DP-21
- NA-DP-22
- NA-DP-29 through NA-DP-32

Duwamish Waterway

- NA-DP-01 through NA-DP-08
- NA-DP-41 through NA-DP-43
- PL2-609
- PL2-611

All analyses are presented on Table 2-2 and their locations are presented on Figure 2-1.

### 2.4.3 Volatile Organic Compounds

Analytical results for all site-wide VOC COCs were screened to determine which are COCs for the North Area. Analyses for one or more VOC constituents were conducted on 108 soil samples from the North Area. VOC analyses comprised the 21 constituents for which screening levels have been established. Trichloroethene was the only VOC identified as a COC in the North Area:

The detected concentration of trichloroethene exceeded the soil screening level protective of surface water but not air exposure pathway screening levels. The direct contact pathway is valid for VOCs, but the maximum detected concentration or trichloroethene is below the direct contact pathway screening level. Therefore, in the foregoing discussion of VOC COCs, the term “screening level” will refer to the soil screening level protective of surface water, unless otherwise noted. All soil and groundwater locations, in addition to those associated with data gaps in the following sections will be sampled for VOCs as part of the data gap investigation.

#### *2.4.3.1 Trichloroethene*

Trichloroethene was analyzed in 70 North Area soil samples and detected in one, at a concentration (9 µg/kg) above the screening level protective of surface water (2.0 µg/kg). This concentration does not exceed the area-specific indoor air screening level (36 µg/kg) or the direct contact pathway screening level (136,000 µg/kg). The sample was collected from HP-AL-34, adjacent to the location of the former SWMU 2-01.1 (Landing Gear Cleaning Sump).

***SWMU 2-01.1 (Landing Gear Cleaning Sump).*** Trichloroethene was detected above the soil screening level protective of surface water in one sample from 2.5 to 4 feet bgs at HP-AL-34. Trichloroethene was not detected in a sample collected from deeper soil (7.5 to 9 feet bgs) at this location. The lateral extent of trichloroethene has not been adequately characterized at this unit. Samples will be collected from direct push probes to the north, south, east, and west of this location. Trichloroethene will also be analyzed in groundwater samples to confirm that it has not impacted groundwater in this area.

***Analytical Reporting Limits.*** Trichloroethene was not detected at an elevated RL (6 µg/kg) in a sample from 2.5 to 4 feet bgs at HP-AL-27, adjacent to the Duwamish Waterway. Trichloroethene was not detected at a lower RL (<2 µg/kg) in a sample from 7.5 to 9 feet bgs at the same location. The RL was elevated (<5 µg/kg) in a sample collected from 7.5 to 9 feet bgs at HP-AL-33 near SWMU 2-01.1 (Landing Gear Cleaning Sump) and adjacent to HP-AL-34. The RL was elevated (<5 µg/kg) in a sample collected from 2.5 to 7.5 feet bgs at HP-AL-20 near the border with the 2-10 Area. Deeper soil was not sampled at either of these two locations.

Soil and groundwater data for trichloroethene were evaluated to identify data gaps for CMS purposes using criteria from Section 2.1: Source Control, Completed Pathways, and Exceedances of Screening Levels by Analytical Reporting Limits. Results of this evaluation, along with any measures to be taken to fill data gaps, are summarized below.

- **Source Control:**
  - **Hot Spots:** Potential sources of trichloroethene in North Area RCRA units have been adequately delineated for CMS purposes with the following exception:

    Additional lateral delineation is required at SWMU 2-01.1 (Landing Gear Cleaning Sump), particularly to the northwest, northeast, and south of HP-AP-34. Trichloroethene will be analyzed in a soil sample from a direct-push location in this area.
  - **New Sources:** All potential sources of trichloroethene in the North Area are related to a RCRA unit.
- **Completed Pathways:**
  - **Soil to Groundwater Pathway:** The analytical data indicate that the soil to groundwater pathway may be complete for trichloroethene at SWMU 2-01.1 (Landing Gear Cleaning Sump) VOCs, including trichloroethene, will be analyzed in groundwater samples from direct-push and monitoring locations within and downgradient of these areas.
- **Exceedances of Screening Levels by Analytical Reporting Limits:**
  - Trichloroethene RLs were elevated above the screening level in three samples. Trichloroethene will be analyzed in both soil and groundwater from all sampling locations in the North Area. The data will be used to confirm that the soil to groundwater pathway is not complete at these locations.

The data gaps identified above will be filled by soil and groundwater sampling to be conducted in all North Area direct-push locations, new monitoring wells, and selected existing monitoring wells.

Soil sampling will be conducted at the following locations to complete delineation of trichloroethene:

SWMU 2-01.1 (Landing Gear Cleaning Sump)

- NA-DP-36
- NA-DP-37
- NA-DP-38
- NA-DP-40

Groundwater sampling and analyses will be conducted at the following locations:

SWMU 2-01.1 (Landing Gear Cleaning Sump)

- NA-DP-36
- NA-DP-37
- NA-DP-38
- NA-DP-40

In addition, VOCs, including trichloroethene, will be analyzed in both soil and groundwater from all sampling locations in the North Area. The data will be used to further evaluate the soil to groundwater pathway.

All analyses are presented in Table 2-2 and their locations are presented on Figure 2-1.

### 2.4.4 Petroleum Hydrocarbons

Analytical results for all site-wide petroleum hydrocarbons COCs were screened to determine which site-wide constituents are also COCs for the North Area. The screening levels used for site-wide COCs are summarized in Table B-1. If a site-wide COC was detected in the North Area soil analytical data at concentrations greater than or equal to the respective screening level, the site-wide COC is considered a COC for the North Area.

Based on the existing data, there are no petroleum hydrocarbons present in soil at concentrations that exceed screening levels. Therefore, there are no petroleum hydrocarbon COCs for soil in the North Area. However, groundwater was not sampled during the tank closure/cleanup conducted for UST PL-3 in 1991.

Soil and groundwater will be sampled at NA-DP-26 through NA-DP-28 for DRPH to evaluate whether the soil to groundwater pathway is complete in this area.

### 2.4.5 Summary of Investigative Scope for Soil Data Gaps

The soil data gap investigation for the North Area will be conducted to fill the data gaps identified above. The main elements of the North Area Soil data gap investigation are:

| Scope Item | Rationale |
|---|---|
| Installation and sampling of 46 direct-push probes and seven new monitoring wells in the North Area for additional VOC, SVOCs, PCB, metals, and cPAH analyses. | Better define the extent of soil impacted by trichloroethene in association with RCRA Unit SWMU 2-01.1 (Landing Gear Cleaning Sump)<br><br>Better define the extent of impacted soil not associated with existing RCRA units, including metals and cPAH constituent impacts near Building 2-124, the Waste Containment Structure, and associated with Building 2-122: PCB impacts near Building 2-122; cPAH constituent impacts in the north portion, and south and west corners of the North Area.<br><br>Confirm non-detect results with lower RLs for PCBs and cPAHs contained in the historical data. |
| Installation and sampling of the direct-push probes and selected groundwater monitoring wells to determine if the soil to groundwater portion of the surface water pathway is complete, and to identify whether COCs related to sources in the soil are present in groundwater at concentrations that exceed the surface water pathway screening levels. | Groundwater sampling throughout the North Area to evaluate whether the soil to groundwater portion of the surface water pathway is complete. |

Groundwater and soil sampling will be conducted from 46 direct-push probe locations and one existing and seven new monitoring wells downgradient of potential source areas, and the one RCRA unit. Groundwater samples to evaluate soil data gaps will be collected from the A level only although groundwater will be sampled at three B-level monitoring wells and three C-level probes as part of the North Area data gap investigation. Groundwater sampling conducted in support of soil data gap investigations will be coordinated with the groundwater sampling activities under the groundwater data gaps evaluation presented Section 2.1.

A summary table showing the wells and probes to be sampled, constituent groups analyzed, and the general soil data gaps that will be filled by the sampling is presented in Table 2-2. The rationale for sampling at each location is provided in the right hand column of the table.

Locations of existing well PL2-270A, new probes, and new wells to be sampled as part of both the groundwater and soil North Area data gap investigation are presented in Figure 2-1.

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# 3.0 Data Gap Investigation Methods

This section specifies investigation methods for sampling groundwater and soil in the North Area to fill the data gaps discussed in Section 2. In general, the methods cover:

- Installation of 46 direct-push (probe) sampling locations located adjacent to and downgradient of existing RCRA units and areas of soil impacts located in the North Area. Probes will be used to sample soil in the vadose zone and groundwater in the A and C levels of the aquifer. The 46 probes will also be used to provide water quality data to fill data gaps identified in Sections 2.2 and 2.3.
- Soil sampling where probes and wells are installed. Soil sampling is conducted for one of two purposes, 1) to provide data to support characterization of the extent of impacted soil, and 2) to indicate if overlying soils could impact the groundwater samples versus impacts from upgradient sources that the wells/probes are intended to monitor.
- Soil sampling at the three C-level probe locations for grain size analysis to delineate the low permeability hydrostratigraphy in the deeper portion of the C-level of the aquifer. The Hazen equation, or equivalent, will be used along with grain size analysis results to empirically quantify C-level geology.
- Groundwater sampling and analysis of samples from one existing A-level well, four new A-level wells, and three new B-level wells in the North Area to provide additional data used to delineate the extent and concentrations of groundwater impacted by North Area COCs and to provide data to fill data gaps identified in Sections 2.2 and 2.3.

Sample Analysis and Quality Assurance Plans that cover standard operating procedures at Plant 2 are referenced from the *Compendium of Sampling and Analysis Plans and Quality Assurance Project Plans for Boeing Plant 2, Seattle/Tukwila Washington* (Golder, 2003a).

## 3.1 MONITORING WELL INSTALLATION

Seven new groundwater monitoring wells will be installed in the North Area at locations noted on Figure 2-1. The seven new monitoring wells are:

- PL2-270B will be installed near existing well PL2-270A to provide data regarding B-level groundwater quality as it enters Plant 2 from upgradient areas and to help fill data gaps identified in Sections 2.2 and 2.3.
- PL2-608A will be installed near the shoreline along Slip 4 to provide a long-term groundwater monitoring point in that section of the North Area, to help fill data gaps identified in Section 2.3, and to provide a downgradient monitoring point for potential PCB, SVOC and metal impacts to be investigated by direct push locations NA-DP-31 through NA-DP-35

- PL2-608B will be installed near PL2-608A to provide data regarding B-level groundwater quality as it moves toward Slip 4 of the Duwamish Waterway and to help fill data gaps identified in Sections 2.2 and 2.3.
- PL2-609A will be installed near SWMU 2-01.1 to provide a long-term groundwater monitoring point in that section of the North Area, to help fill data gaps identified in Section 2.3, and to provide a downgradient groundwater monitoring point for potential VOC impacts to be investigated by direct push locations NA-DP-36 through NA-DP-38 and SVOC impacts to be investigated by direct push locations NA-DP-38 and NA-DP-39
- PL2-610A will be installed near the shoreline along the Duwamish Waterway to provide a long-term groundwater monitoring point in that section of the North Area, to help fill data gaps identified in Section 2.3, and to provide a downgradient monitoring point for for potential SVOCs, VOC PCB and metal impacts to be investigated by direct push locations NA-DP-08 through NA-DP-29 in the upgradient area southeast of Building 2-122.
- PL2-610B will be installed near PL2-610A to provide data regarding B-level groundwater quality as it moves toward the Duwamish Waterway and to help fill data gaps identified in Sections 2.2 and 2.3.
- PL2-611A will be installed near the shoreline along the Duwamish Waterway to provide a long-term groundwater monitoring point in that section of the North Area, to help fill data gaps identified in Section 2.3, and to provide a downgradient monitoring point for for potential SVOCs, VOC PCB and metal impacts to be investigated by direct push locations NA-DP-08 through NA-DP-29 in the upgradient area southeast of Building 2-122.

New monitoring wells will be installed at the locations shown in Figure 2-1. The wells will be installed using standard hollow-stem-auger (HSA) drilling, air rotary drilling, or sonic drilling techniques as required by the well depth and geology. All borings will be logged and sampled following the guidance described in Technical Procedure TP-1.2-5, Drilling, Sampling, and Logging of Soils referenced in Golder (2003a).

Monitoring wells will be drilled and installed to meet resource protection well construction standards found in WAC 173-160-420, Minimum Standards for Construction and Maintenance of Wells. The monitoring wells will be installed generally following the guidance documented in Standard Operating Procedure 4.3 in Golder (2003a). The wells will be constructed of 2-inch diameter, flush-threaded, Schedule 40 PVC well casing and screen in conformance with WAC 173-160-430. For A-level wells, screen assemblies will consist of a 15-foot length of 0.01-inch (10-slot) flush-threaded, machine-slotted, Schedule 40 PVC installed from 6 to 21 feet bgs and set in a 20-40 CSSI, 2/12 Monterey, or equivalent silica sand filter pack. B-level wells will be constructed in a similar manner with 5-foot screen lengths installed from 40 to 45 feet bgs.

The well design for both A and B level wells includes a 0.5-foot-long flush-threaded Schedule 40 PVC sump with a flush-threaded end cap. Flush-threaded, Schedule 40 PVC well casing extends from the top of the screened interval to approximately 6 inches bgs. A 2-inch diameter,

locking, watertight PVC well cap will be installed to secure the well casing. Stainless steel centralizers will be installed immediately above and below the screened interval on A and B-level wells. An additional stainless steel centralizer will be installed at 20 feet bgs on the three B-level wells.

Well screens will be set in 20-40 CSSI, 2/12 Monterey or equivalent silica sand filter pack that will extend from the bottom of the well screen to 1 foot above the top of the screened interval. A minimum 2-foot thick seal of hydrated bentonite chips will be installed in the annular space immediately above the sand filter pack. The remainder of the annular space will be sealed with bentonite grout or bentonite chips, hydrated in place, to within approximately 1 foot of the ground surface. The new monitoring wells will be secured in flush-completion steel protective monument set in concrete. The monuments will be raised approximately 1-inch above the existing grade with a sloping concrete pad to minimize the potential for surface water entering the monument. A generalized construction diagrams for the A-level and B-level wells are presented in Figure 3-1 and Figure 3-2, respectively.

All down-hole well components will be either factory-decontaminated and in their original sealed packaging or decontaminated to the satisfaction of the on-site Environmental Partners, Inc. (EPI) engineer before installation. All down-hole drilling equipment will be decontaminated as discussed in Section 3.8. and per the approved QAPP.

### 3.1.1 Monitoring Well Development

New monitoring wells will be developed by the drilling subcontractor using a combination of surging and overpumping generally following the guidance documented in Standard Operating Procedure 4.4 in Golder (2003a). Well development will be completed by continuous pumping at a steady rate using a submersible pump, or equivalent. Well development equipment used inside a well will be either new single-use equipment, or will be decontaminated to the satisfaction of the EPI engineer by pressure washing before use and between wells.

In general, well development should be performed soon after installation but ideally no sooner than 24 hours after grouting. Well development will be performed until the well is free of sediment and the appropriate water volumes have been removed. Sediment free is considered achieved when turbidity measurement is 5 nephelometric turbidity units (NTUs) or less. For wells where installation is completed without the use of drilling fluid such as water, a minimum of five volumes of standing water in the well (volume of the water inside the well screen and casing plus saturated annulus) will be removed. For wells where drilling fluid was used, five times the volume of added water shall be removed along with five times the standing water volume in the well.

For instances where groundwater recharge is insufficient to produce water for removal, clean potable water may be introduced into the wells to facilitate sediment removal, at the approval of EPI engineer. An equivalent of five volumes of the water added must be removed to ensure that all the water introduced into well has been removed. Wells should be allowed to recover for approximately one week before sampling for analytical parameters.

The field parameters pH, temperature, conductivity, and turbidity will be measured and recorded during well development. In addition, color changes of water before, during, and after development will be observed and recorded. Removed water from wells will be kept in closed containers pending disposal. Characterization and disposal of well development water will be completed by Boeing following the procedures noted in Section 3.9.

## 3.2 PROBE INSTALLATION

A series of 46 locations will be sampled by direct-push methods at the locations shown in Figure 2-1. Soil samples will be collected from three depths in the vadose zone: 0 to 1 feet, 4 to 5 feet, and 9 to 10 feet bgs. Additional intervals will be sampled at select locations near the Duwamish Waterway to support potential shoreline projects. Groundwater samples will be collected and analyzed to determine current COC concentrations and to conduct confirmation data analysis of fate and transport modeling results. A summary of locations, sampling intervals, and analytical requirements for the probe locations is presented in Table 2-2.

Groundwater sampling procedures are described in Section 3.3. Soil sampling procedures are described in Section 3.4

## 3.3 GROUNDWATER SAMPLING

Groundwater sampling procedures include water-level measurements, well purging, collection of field parameter data during purging, and sample collection for laboratory analysis. Sampling procedures that are common for all data gap investigation sampling events at the site are listed in the Technical Procedure TP-1.2-20 Collection of Groundwater Quality Samples and Technical Procedure TP-1.0 in Golder (2003a). Construction details for wells sampled as part of the North Area data gap investigation are summarized in Table A-3.

Monitoring wells and probe locations will be purged before sampling using low-flow (minimal drawdown) purging procedures. Low-flow purging procedures are used to minimize disturbance associated with turbidity and to provide quicker stabilization time for the measured field parameters, pH, dissolved oxygen (DO), temperature, conductivity and oxidation-reduction potential (ORP). Procedures and guidance for low-flow purging and sampling are in the document titled Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures (EPA, 1996).

In general, purging should start at a low-flow rate and increase to a rate of approximately 0.5 liters per minute (L/min). The depth to water in the well being purged will be measured periodically, approximately every 3 to 5 minutes. If drawdown is more than 0.3 foot below the original static water level, reduce the pumping rate to stabilize drawdown. Typical pumping rates range between 0.2 L/min and 0.5 L/min. Purging will continue until field parameters are stabilized, as discussed in Section 3.3.2. To the extent possible, wells will not be purged to dryness. However, if a well exhibits very slow water level recovery and is purged to dryness, groundwater samples will be collected after sufficient recovery. Sufficient recovery is considered as recovery to at least 80 percent of original static water level before purging. An alternative procedure for wells that historically have been pumped dry during purging is to purge at least

80 percent of the well volume before sampling. After 80 percent of the original well volume has been purged, samples will be collected and water parameters recorded. The most appropriate method for purging and sampling low-yield wells and probes will be evaluated and decided in the field at the time of sampling. A note will be included in the field logbook and in the subsequent report reflecting this limited purging effort.

Purge water will be temporarily contained in the 5-gallon buckets. After purging, the buckets will be collected for immediate disposition, as noted in Section 3.9.

Stabilized readings for ORP and DO will be collected at the end of low-flow purging and recorded as part of the redox parameter suite. A flow-through cell will be used during field parameter measurements to minimize the effects of atmospheric gases on field parameter results.

Groundwater samples will be collected following Low-Flow Well Sampling Procedures following field parameter stabilization. For wells that are purged to dryness, sample collection will occur after sufficient recovery to at least 80 percent of the original water level before purging. Procedures for groundwater sampling are in the technical document TP-1.2-20 in Golder (2003a). The appropriate use of field equipment and decontamination protocols will be followed to minimize or eliminate the potential for cross-contamination. Nitrile gloves, or equivalent, will be changed, at a minimum, between wells and whenever the potential for cross- contamination is suspected.

Groundwater samples from direct-push probes will be field-filtered for metal analyses. In-line 0.45-micron filters will be used to avoid introduction of oxygen into the sample. This will be critical, as ferrous iron is expected to be present in some samples and its precipitation before filtering and preservation can result in low bias in metal concentrations due to co-precipitation. Groundwater samples from monitoring wells will use total (unfiltered) and dissolved (filtered) samples for metal analyses. In addition, both filtered and unfiltered samples will be collected at all locations where redox parameters are analyzed (see Table 2-2). Filtering will be accomplished in the field using the same method as for the direct-push samples.

Groundwater samples will be collected into laboratory-cleaned, pre-labeled sample bottles and preserved as appropriate for the analytical parameters. Table 3-1 lists requirements for sample containers, preservatives, and related handling instructions. Sample bottles should be filled starting with the most sensitive sample aliquot and ending with the least sensitive aliquot. The sample aliquots will be collected in the following order:

1. Ferrous iron (Field kit)
2. VOCs
3. Inorganic Redox Parameters (sulfide, sulfate, nitrate, nitrite, and ammonia)
4. Gasoline-range petroleum hydrocarbons (GRPH)
5. Diesel-range petroleum hydrocarbons (DRPH)
6. SVOCs

7. PCBs
8. Total organic carbon (TOC)
9. Major cations/anions
10. Salinity
11. Total metals
12. Dissolved metals

### 3.3.1 Surveying and Water Level Measurements

After installation, the new direct-push probe locations and new wells will be surveyed. Elevations will be surveyed from the National Geodetic Datum 1929 (NGVD, 1929) or the North American Vertical Datum (NAVD, 1988) to an accuracy of within 0.01 foot. Horizontal control accuracy will be within 0.1 foot. Probe sampling locations will be surveyed for horizontal control and ground surface elevation. Monitoring wells will be surveyed for horizontal control, ground surface elevation, and measuring point elevation.

Groundwater level measurements (depth to water) will be obtained before sampling at each well. Technical Procedures for Water Level Measurements are in TP-1.4-6a and -6b in Golder (2003a).

In general, groundwater levels will be measured to the top of the well casing, a marked measuring point or to the north side of the casing if no measuring point is visible. Water-level measurements, with a precision of 0.01 foot, will be recorded on the Water Level Measurement Field Record.

### 3.3.2 Field Parameter Measurements

Temperature, DO, ORP, pH, specific conductance, and the turbidity of the purged water will be measured during purging and recorded in the field notebook approximately every 3 to 5 minutes. In addition, notes will be taken describing the appearance or odor of the water. The purge stabilization criteria are based on three successive readings of the field water quality parameters. The following are the stabilization criteria for low-flow purging:

- pH ± 0.1 pH units
- Specific conductance ± 3 percent
- ORP ± 10 millivolts (optional)
- Turbidity ± 10 percent (when turbidity is greater than 10 NTUs)
- Dissolved oxygen ± 0.3 mg/L (optional)
- Temperature ± 0.1°C

When the above stabilization criteria have been met, groundwater at the sampling point is stabilized and sample collection can begin. Dissolved oxygen and ORP may not always be an appropriate stabilization parameter and its use as a stabilization parameter will depend on site-specific conditions. The total volume of water purged from each well will be recorded in the field notebook. However, if a well exhibits very slow water-level recovery and is purged to dryness, groundwater samples at that well will be collected upon sufficient recovery defined as 80 percent recovery of the pre-purge water column.

Before measurements, field instruments will be calibrated according to instructions in the EPIs TP-1.0 Standard Procedures for Field Parameter Measurement in Golder (2003a). The probes for DO and ORP will be housed in a flow-through cell to avoid entrainment of atmospheric gases during measurement, which can affect results.

### 3.3.3 Groundwater Laboratory Analysis

The proposed constituent groups for chemical laboratory analysis are based primarily on the COCs historically present at the wells and the need to fill data gaps due to the lack of concurrent and recent data. This statement is generally applicable to VOCs, metals, and TPH. For PCBs and SVOCs, data needs are based on the previously considered likelihood of potential migration pathway to individual well locations from impacted soil sources.

Table 2-2 provides an overall summary of the groundwater laboratory analyses for this sampling event. In general, VOCs and total and dissolved metals are proposed for all sampled wells and direct-push locations. TPH analyses are proposed for selected wells and probes in and around known areas of historical TPH detections to confirm current site conditions. Redox parameters (part of natural attenuation parameters) are proposed to better define geochemical conditions related the reductive dechlorination of chlorinated VOCs. Redox parameters will be analyzed in sampled from monitoring wells only because direct push probes may not provide accurate geochemical data.

SVOCs (including cPAHs and bis(2-ethylhexyl)phthalate) and PCB analyses are specified for selected wells and probes to confirm current groundwater conditions and fate and transport modeling results. Generally, these analyses are limited to areas downgradient of areas with SVOC or PCB impacts in soil for confirmation of fate and transport modeling.

## 3.4 SOIL SAMPLING

Soil samples will be collected for laboratory analysis as part of installation of five of the seven new monitoring wells and for geologic logging in all seven new monitoring wells. Soil samples will also be obtained for laboratory analysis and geologic logging at 43 of the 46 direct-push probe sampling points. Soil samples from the remaining three probe locations; NA-DP-44, NA-DP-45, and NA-DP-46 will be obtained for geologic logging and grain size analysis but not for laboratory analysis. Soil samples will be collected at only one well location for new monitoring wells that are co-located. See Table 2-2 for a summary of soil sampling locations and depths.

Soil samples will be obtained using decontaminated split-spoon samplers or equivalent. The split-spoon sampler (or equivalent) will be equipped with new single-use liners unless the samples are intended for geologic logging or grain size analysis purposes only. Soil samples intended for geologic logging or grain size analysis only may be obtained without the use of liners in the sampler.

### 3.4.1 Geologic Soil Logging

Soils encountered will be logged in accordance with the Unified Soil Classification System (USCS) Standard Practice Description and Identification of Soils (Visual Manual procedure) (ASTM 2488D-00) as documented in Technical Procedure TP1.2-6, in Golder (2003a). Samples for geologic logging only will be taken at 5-foot intervals (at a minimum) or whenever a change in drilling rate, noise, or drill cuttings signals a possible change in the geology. Samples collected for geologic logging only will be obtained using decontaminated split spoon samplers without a liner. The direct-push probe will be advanced to the top of the desired sample interval and the probe rod will be removed. A decontaminated steel split-spoon sampler, or equivalent, is then inserted into the probe hole. The split-spoon sampler, or equivalent, will be driven through the desired sample interval using the hydraulic hammer on the probe rig. Observed soil information at each probe location will be recorded on a soil log sheet.

### 3.4.2 Field Screening

For all soil samples, the nonslough portion of the soil samples will be field screened to check for indications of the presence of VOCs or separate-phase hydrocarbons. Field personnel will use a photoionization detector (PID) to test for the presence of VOCs. Field personnel will also perform sheen testing to screen for the presence of separate-phase hydrocarbons.

For PID screening, a portion of the soil sample will be placed in a sealed plastic bag, disaggregated and allowed to equilibrate for approximately 10 minutes. The PID inlet tube will then be inserted into the bag and the highest observed reading will be recorded in the field logbook and on the boring logs. The PID will be calibrated with 100 parts per million (ppm) isobutylene calibration gas before use each day following the manufacturer's calibration guidelines and as documented in Quality Procedure QP-11.1, in Golder (2003a).

For sheen testing, a portion of the sample will be placed in a clean polytetrafluoroethylene (PTFE)-coated pan, or equivalent, sprayed with a small amount of distilled water and a qualitative assessment of any observed sheen or nonaqueous-phase-liquid (NAPL) will be recorded. The results of field screening will be noted in the field logbook and on the boring logs.

### 3.4.3 Soil Grain Size Analysis

Soil samples from the three C-level direct-push probes will be collected for grain size analysis with hydrometer by ASTM D-421/422. The samples for grain size analysis will be obtained from the low permeability layer at the base of the C-level of the aquifer. If two or more types of low-permeability materials are encountered they will be divided into separate samples for grain size analysis as sample volume allows. Results from the grain size analyses will be used to

positively classify the material and also to calculate empirical hydraulic conductivity values for the B- and C-levels of the aquifer and the low permeability material underlying the C-level.

### 3.4.4 Soil Laboratory Analysis

Soil samples obtained for laboratory analysis will be collected from direct-push probe locations at three intervals in the vadose zone. Soil sampling intervals for laboratory analysis will be 0 to 1, 4 to 5, and 9 to 10 feet bgs. Additional intervals will be sampled at select locations near the Duwamish Waterway to support potential shoreline projects. The split-spoon sampler, or equivalent, will be decontaminated before use and between each sample, as discussed in Section 3.8.2.

Soil samples will be collected into pre-cleaned laboratory-provided containers. Constituent groups for laboratory analysis of soil samples are VOCs, SVOCs, metals, TPH, TOC, and PCBs. Refer to Table 3-1 for laboratory methods associated with these constituent groups. Table 3-1 also lists the anticipated number of field samples and quality control (QC) samples include equipment blanks, trip blanks, matrix spikes, and matrix spike duplicates (MS/MSD).

For VOC samples, the bottommost of the intact and relatively undisturbed sample (i.e., generally the bottommost section of liner) will be submitted for laboratory analysis using EPA sample collection Method 5035. Samples collected for other non-VOC analyses may be transferred immediately to appropriate sample jars using a decontaminated stainless steel scoop or equivalent. Immediately after collection, all samples will be labeled and placed in a cooler containing bagged ice pending submittal to the laboratory, Analytical Resources, Inc., for analysis. Sample labeling will follow procedures under the Sample Identification section of this Work Plan (Section 3.6.1). A portion of the sample, commonly the soil retained in the drive shoe of the sampler or the unused portion of the liner will be retained for geologic logging and field screening purposes.

For metals, SVOC, and PCB analysis, soil samples will be collected into 2-oz, 4-oz, or 8-oz wide-mouth borosilicate glass jars as appropriate. Table 3-1 lists requirements for sample containers, preservatives, and related handling instructions. All collected samples will be labeled and stored in a cooler containing bagged ice until transported to the laboratory.

## 3.5 QUALITY CONTROL SAMPLES

QC measures will be taken to evaluate laboratory precision, potential matrix interferences, and potential contamination from the ambient air.

Field duplicates, equipment blanks, trip blanks, and MS/MSD samples will be collected as part of the field QC program. Each of these sample types is described in the following sections along with their purpose and sample collection frequency. The number of QC samples collected for each COC group is summarized by media in Table 3-1.

### 3.5.1 Trip Blank Samples

The potential for contamination from the ambient air will be evaluated using trip blank samples. The trip blank will originate at the contract laboratory and be relabeled on arrival at the site. Trip blank samples accompany one cooler of samples during sampling and shipping for each day during a sampling event. Trip blank samples will be analyzed for VOCs and GRPH only.

### 3.5.2 Equipment Blank Samples

The potential for cross-contamination from non-dedicated multiple-use sampling devices will be evaluated using equipment blank samples. Some examples of a multiple-use, non-dedicated sampling devices potentially used for this investigation are the split-spoon samplers used to obtain soil samples during probing or non-dedicated sampling pumps used in monitoring wells. One equipment blank sample will be taken for each type of non-dedicated sampling equipment to evaluate the effectiveness of the decontamination steps. The equipment blank sample, if needed, will be analyzed for all North Area groundwater and soil COC constituent groups.

### 3.5.3 Field Duplicate Samples

Laboratory and field sampling precision of the groundwater sampling task will be evaluated by collecting blind field duplicate samples. Field duplicate samples will be collected at a rate of 10 percent or a fraction thereof of the total number of groundwater samples of that constituent group. Field duplicate samples will be collected under conditions as nearly identical as possible to the original sample and will be analyzed for the same constituent groups as the original sample. Field duplicate samples will not be collected for soils because it is not possible to homogenize soil samples sufficiently to produce representative duplicate sample volumes.

### 3.5.4 Co-located Samples

To assess possible effects of sample heterogeneity and source variability of the soil co-located soil samples will be collected at a rate of 10 percent or a fraction thereof of the total number of soil samples collected for VOC analysis. Co-located samples will be analyzed for VOC's only. Co-located samples shall be collected within one foot of one another and are not to be homogenized. Co-located samples will not be collected for groundwater samples.

### 3.5.5 Matrix Spike/Matrix Spike Duplicate Samples

Potential interferences from the sample matrix will be evaluated with MS/MSD samples. Triplicate volumes of samples will be collected at locations specified on the sample matrix. One MS/MSD sample will be obtained at a rate of 5 percent, or a fraction thereof, of the total number of samples of each constituent group collected per event. MS/MSD samples will be collected for both groundwater and soils and will be analyzed for the same constituent groups as the original sample.

## 3.6 SAMPLE HANDLING AND SHIPPING

After collection, all samples will be placed in coolers with enough bagged ice to maintain an internal temperature of 4°C for the duration of the sampling and transportation to the laboratory. Samples will be delivered to Analytical Resources, Inc. (ARI) for analysis after each day of sampling following the procedures outlined in TP-1.2-23 of the Compendium. ARI's address is given below.

Analytical Resources, Inc.
4611 South 134th Place
Suite 100
Tukwila, WA 98168
Contact: Ms. Kelly Bottem, (206) 695-6211

### 3.6.1 Sample Identification

All soil and groundwater samples collected will be assigned a unique identification code based on a consistent sample designation scheme. A sample tracking record will be kept as each sample is collected.

#### *3.6.1.1 Monitoring Well Samples*

Monitoring well soil and groundwater samples will be designated with unique alphanumeric sample identifiers (sample numbers) as follows:

NA-PL2-270A-Z-XX-T

Where:

| | |
|---|---|
| NA | North Area (project area) |
| PL2 | Boeing Plant 2 monitoring well |
| 270A | Specific well ID in the project area |
| Z | Media code: S = soil, W = water |
| XX | Top depth of sampler in feet (soil only, not used for groundwater) |
| T | Sample type 0 = primary field sample, 1 = field duplicate, 2- trip blank, 3 = equipment blank |

#### *3.6.1.2 Soil Samples*

Probe soil and groundwater samples will be designated with unique alphanumeric sample identifiers (sample numbers) as follows:

NA-DP-YY-XX-Z-T

Where:

| | |
|---|---|
| NA | North Area (project area) |
| DP | Sample collected from a direct-push sampling location |
| YY | Unique numeric location for a direct-push sampling location |
| XX | Top depth of sampler for soil or top of screened interval for groundwater |
| Z | Media code: S = soil, W = water |
| T | Sample type 0 = primary field sample, 1 = field duplicate, 2- trip blank, 3 = equipment blank, and 4 = co-located |

Sample numbers will be recorded in the field notebook, on sample container labels, and chain-of-custody forms. Other information recorded on the sample container label includes:

- Time and date of sample collection
- Initials of sampler(s)
- Laboratory analyses to be performed
- Preservatives used

More detailed information regarding sample labels, sample handling, chain of custody, custody seals, and sample shipping are documented in Section 7.0 and in Technical Procedure TP1.2-20 in Golder (2003a).

## 3.7 LABORATORY ANALYTICAL METHODS

Laboratory analytical methods for soil and groundwater samples collected for the North Area data gap investigation are listed in Tables 3-1.

In general, laboratory methods are selected based on:

- The media being sampled
- The constituent being analyzed
- The reporting limit necessary for comparison to constituent risk based screening level

Table 3-4 presents a list of constituents, which includes all of the COCs that are commonly tested for at Boeing Pant 2 and the associated laboratory reporting limits. The laboratory reporting limits are compared to the lowest risk calculation or applicable background concentration (various metal concentrations in soil and groundwater) to determine what analysis may be limiting evaluation of the site. Risk calculations were not completed for constituents that were never detected at the site or for constituents where EPA or Ecology does not provide toxicological data necessary for the risk calculations (e.g., aluminum and iron).

Based on this analysis, as presented in Table 3-4 the laboratory reporting limit for PCBs (33 µg/kg) was the only set of reporting limits greater than the lowest associated risk based calculation for soil. This reporting limit is the same value as the PQL presented in the *Technical Memorandum Appropriateness Evaluation Corrective Measure Study*, *Boeing Plant 2*, (Weston, 1999b).

Groundwater reporting limits for arsenic (0.2 µg/L), cyanide (5.0 µg/L), PCBs (0.01 µg/L), various polycyclic aromatic hydrocarbons (PAHs) (0.1 µg/L) and bis(2-ethylhexyl)phthalate (3 µg/L) are greater than the respective lowest risk based calculation. Of these constituents, the arsenic, PCB, and bis(2-ethylhexyl)phthalate reporting limits are less than the PQLs presented in the *Technical Memorandum Justification for No Further Action SWMUs/AOCs/OAx RCRA Corrective Measures Study* (Weston, 1999a). The arsenic reporting limit is also less than the EPA-approved site-specific background concentration of 8.0 µg/L for arsenic in groundwater; therefore, it is not expected to limit the utility of the analyses. The reporting limit used above is the standard reporting limit for PAHs using EPA Method 8070 as modified for larger sample volumes and lower detection limits.

Table 3-1 lists the estimated number of samples collected for each analytical constituent group and the number of QC samples collected for each constituent group by media (soil or groundwater) along with sample handling, bottle type, preservation, and holding time requirements.

## 3.8 DECONTAMINATION PROCEDURES

Purging and sampling equipment that comes into direct contact with sample media, sample containers, or the inside of a monitoring well will ideally be single-use disposable equipment that is replaced between each sampling event, or will be dedicated equipment, assigned to and used at only one well or probe location. If the sampling equipment is not single-use disposable equipment or dedicated equipment, it will be decontaminated between each sampling event using the procedures summarized in Section 3.8.1.

In general, drill augers will be decontaminated between wells by steam cleaning. Sampling split spoons will be decontaminated between sampling points by hot water pressure washing or steam cleaning using potable water. Particulate matters and surface film may be removed using a brush. Split-spoon samplers and other soil sampling devices will be decontaminated between sampling points using the procedures summarized in Section 3.8.2.

### 3.8.1 Aqueous Sampling Equipment Decontamination

Ideally, dedicated or single-use disposable equipment will be used for all groundwater sampling. However, if non-dedicated multiple-use sampling equipment is used for groundwater sampling, it will be decontaminated before use and between each sample according to the steps noted below.

1. Wash in a solution of Liquinox™ (or equivalent) and potable tap water
2. Rinse with potable tap water

3. Rinse with 10 percent nitric acid (trace metal or higher-grade $HNO_3$)
4. Rinse with distilled water
5. Rinse with reagent-grade isopropyl alcohol
6. Rinse with distilled water

### 3.8.2 Nonaqueous Sampling Equipment Decontamination

Single-use disposable sampling devices will be used for much of the soil sampling. When non-dedicated multiple-use sampling equipment is used for soil sampling, it will be decontaminated before use and between each sample according to the steps noted below.

1. Wash in solution of Liquinox™ (or equivalent) and potable tap water
2. Rinse with potable tap water
3. Rinse with distilled water

Note: If visual contamination persists or gross contamination is suspected, the decontamination steps used for aqueous sampling equipment will be used.

Decontamination fluids generated onsite will be retained in Department of Transportation (DOT)-approved steel drums, properly labeled and stored on-site pending characterization and disposal.

### 3.8.3 Decontamination of Workers and Personal Protective Equipment

It is anticipated that all work associated with monitoring well installation, direct-push probing, soil sampling, and groundwater sampling at the North Area at Boeing Plant 2 will be conducted in modified Level D protection. Requirements for upgrading to Level C protection are outlined in the Health and Safety Plan, which is provided in Attachment C.

Modified Level D protection includes the following components:

- Cotton or Tyvek™ coveralls
- Steel-toed and steel-shank rubber boots
- Safety glasses or equivalent
- Nitrile inner and outer gloves
- Hearing protection when appropriate (i.e., while drilling, probing or working around generators or other loud equipment)
- Hard hat (when working around drilling or probe rigs)

After completion of each day's activities, personnel will wash and rinse their boots in a solution of Liquinox™ (or equivalent) and potable tap water followed by a tap water rinse. Boot wash

containers will contain brushes to facilitate removal of soil and other contaminants. Following the boot wash station, sampling personnel will remove their outer gloves, remove their boots, remove their coveralls, and then remove their inner gloves. Personnel will then wash their hands and faces with soap and water before eating or leaving the site.

Inner and outer gloves will be discarded as solid waste. Cotton coveralls will be laundered at needed or replaced if excessive contamination is suspected. Hard hats will be washed when visibly dirty, or as necessary.

### 3.8.4 Decontamination of Sample Containers

All sample containers will be laboratory-prepared and precleaned to standards as required under EPA protocols in Section 4 of SW-846.

## 3.9 DISPOSAL OF INVESTIGATION DERIVED WASTE

Drill cuttings, sample spoils, and other Investigation Derived Waste will be retained onsite in properly labeled DOT-approved steel drums pending characterization for disposal. Boeing will coordinate characterization of drum contents and disposal according to established procedures. Disposal of well development water and purge water will be coordinated with Boeing. Hazardous wastes are managed per the requirements in *Dangerous Wastes Regulations*, Chapter 173-303 WAC. Wastes are either manifested to a treatment, storage, and disposal (TSD) facility permitted to accept the material or treated onsite in Boeing's Clean Water Act-permitted Groundwater Treatment System. Toxic Substance Control Act (TSCA)-regulated PCB wastes are managed per the requirements in *Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce and Use Prohibitions*, 40 CFR 761. TSCA-regulated PCB wastes will be shipped to facilities meeting the requirements of 40 CFR 761.

## 3.10 QUALITY ASSURANCE PROJECT PLAN

Quality assurance procedures and requirements documented in the *Approved Laboratory Quality Assurance Plan and Standard Operating Procedures – RFI Work Plan* (Weston, 2001b) and *Interim Measures Work Plan for Sheet Pile Structure at Building 2-66 – Boeing Plant 2 Seattle/Tukwila, Washington* (EPI, 2003) will be followed for the scopes of work related to well installation, soil, and groundwater sampling at the North Area. A copy of the QAPP documents is in the Compendium (Golder 2003a).

## 3.11 DATA VALIDATION AND USABILITY

The data validation review of analytical data packages will consist of a Level I QC Review. If problems with the data are identified during the Level I QC Review, a more thorough Level II QC Review will be conducted. Level I and Level II QC review requirements are outlined in *Interim Measures Work Plan for Sheet Pile Structure at Building 2-66 – Boeing Plant 2 Seattle/Tukwila, Washington* (EPI, 2003), which is in Golder (2003a). QC Review will include a review of

laboratory reporting limits against risk levels for site-wide COCs. Table 3-2 provides a summary of reporting limits compared to risk levels for site-wide COCs.

## 3.12 HEALTH AND SAFETY PLAN

A copy of the Health and Safety Plan is included in Attachment C.

## 3.13 SCHEDULE AND DELIVERABLES

EPA is reviewing this Work Plan in an expedited manner to facilitate an aggressive field schedule designed to collect data necessary for the CMS as quickly as possible. The following schedule and process is intended to support this aggressive schedule:

| Task | | Due Date |
|---|---|---|
| 1. | Draft North Area Work Plan submitted to EPA | October 16, 2007 |
| 2. | Receive EPA approval | TBD |
| 3. | Field Mobilization | To begin within 10 work days (2 weeks) after EPA Approval of Work Plan |
| 4. | Completion of Sample Collection | 35 work days (7 weeks) after field mobilization is completed |
| 5. | Completion of sample analysis, data validation and database entry | 70 work days (14 weeks) after completion of sampling |
| 6. | Draft Data Gaps Report and Final North Area Work Plan (see below for content) | 30 work days (6 weeks) after completion of Task 5. |

Notes:

Task 1: The Work Plan for the North Area comprises Volume VIIa of the Uplands CMS.

Task 6: The Draft Data Gaps Report for the North Area comprises Volume VIIb of the Uplands CMS, which presents the results and findings of the Data Gap Investigation for the area. In addition, Volume VIIb presents the revised list of COCs, units, and groundwater plumes for the North Area that will be carried into the CMS for remedy selection (Volume VIIc).

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# 4.0 References

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**Boeing Plant 2**
**Seattle/Tukwila, Washington**

# Uplands Corrective Measures
# Volume VIIa: North Area

# Data Gap Investigation Work Plan

# Tables

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**Table 1-1 Previous Investigations**
**North Area**
**Boeing Plant 2**

| Document Title | Date | Consultant |
|---|---|---|
| Subsurface Environmental Assessment Proposed Integrated Systems Laboratory Building Seattle, Washington | June 1990 | Roy F. Weston, Inc. |
| Phase I Subsurface Environmental Assessment Proposed Integrated Systems Laboratory Building Seattle, Washington | October 1990 | Roy F. Weston, Inc. |
| Phase II Subsurface Environmental Assessment Proposed Integrated Systems Laboratory Building Seattle, Washington | October 1990 | Roy F. Weston, Inc. |
| Leaking Underground Storage Tank Investigation Integrated Aircraft System Laboratory Construction Site, Plant II Seattle Washington. | January 1992 | Roy F. Weston, Inc. |
| **Site-wide Studies that Include the North Area** | | |
| Comprehensive RCRA Facility Investigation Report | August 1998 | Roy F. Weston, Inc. |
| Compendium of Sampling and Analysis Plans and Quality Assurance Plans for Boeing Plant 2, Seattle / Tukwila, Washington | July 2003 | Golder Associates Inc. |

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**Table 1-2 Summary of Available Unit Information**
**North Area**
**Boeing Plant 2**

| RCRA Unit | Unit Description | Years of Use | Function | Soil Samples | Groundwater Samples | Analytes |
|---|---|---|---|---|---|---|
| SWMU 2-01.1 | Landing gear cleaning sump | 1980-1990 | Contained wastes generated during repair and cleaning of landing gear assemblies. | 4 soil borings | 3 groundwater samples | VOCs, SVOCs, TPHs, and Metals |

Notes:

| | |
|---|---|
| SVOCs | Semivolatile organic compounds |
| TPHs | Total petroleum hydrocarbons |
| VOCs | Volatile organic compounds |

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**Table 2-1 Screening Levels for Constituents of Concern**
**North Area**
**Boeing Plant 2**

| CAS Number | Sitewide Constituent of Concern | Soil (see maximum detect units) | | | | | | | | Groundwater (ug/L) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sitewide Soil COC? | Area Soil COC? | Maximum Detect[1] in North Area | | Minimum Screening Level | Direct Contact Screening Level | Air Screening Level | Surface Water Screening Level | Sitewide GW COC? | Area GW COC? | Maximum Detect in North Area | Minimum Screening Level | Air Screening Level | Surface Water Screening Level |
| **Metals** | | | | | | | | | | | | | | | |
| 7440-36-0 | Antimony | X | | 7 U | mg/kg | 4.64E+02 | 5.33E+02 | - - | 4.64E+02 | | Not a Site-Wide COC in Groundwater | | | | |
| 7440-38-2 | Arsenic | X | X | **1.50E+01** | mg/kg | 7.30E+00** | 3.33E+01 | 3.22E+04 | 5.00E+00* | X | | 1.00E+00 | 8.00E+00** | - - | 2.00E-01* |
| 7440-43-9 | Cadmium | X | X | **2.90E+00** | mg/kg | 1.21E+00 | 6.67E+02 | 7.70E+04 | 1.21E+00 | X | | 2 U | 8.80E+00 | - - | 8.80E+00 |
| 18540-29-9 | Chromium (VI) | X | | N/A | mg/kg | 1.92E+01 | 4.00E+03 | 1.06E+04 | 1.92E+01 | | Not a Site-Wide COC in Groundwater | | | | |
| 7440-50-8 | Copper | X | X | **3.10E+02** | mg/kg | 3.64E+01** | 4.93E+04 | - - | 1.38E+00 | X | | 3.00E+00 | 8.00E+00** | - - | 3.10E+00 |
| 7439-92-1 | Lead | X | | 1.60E+02 | mg/kg | 1.00E+03 | 1.00E+03 | - - | 1.62E+03 | X | | 1.00E+00 | 8.10E+00 | - - | 8.10E+00 |
| 7439-96-5 | Manganese | X | | 2.65E+02 | mg/kg | 1.15E+03** | 1.87E+05 | - - | 1.30E+02 | X | | 6.40E+01 | 2.00E+03** | - - | 1.00E+02 |
| 7439-97-6 | Mercury | X | X | **2.00E-01** | mg/kg | 7.00E-02** | 4.19E+01 | 6.13E+00 | 5.00E-02* | X | | 0.1 U | 2.50E-02 | 4.64E+02 | 2.50E-02 |
| 7440-02-0 | Nickel (soluble salts) | X | | 3.10E+01 | mg/kg | 4.78E+01** | 2.67E+04 | - - | 1.07E+01 | X | | 2.80E+00 | 8.20E+00 | - - | 8.20E+00 |
| 7782-49-2 | Selenium | X | | 7 U | mg/kg | 7.38E+00 | 6.67E+03 | - - | 7.38E+00 | X | | 50 U | 7.10E+01 | - - | 7.10E+01 |
| 7440-22-4 | Silver | X | | 0.4 U | mg/kg | 3.23E-01 | 6.67E+03 | - - | 3.23E-01 | X | | 3 U | 1.90E+00 | - - | 1.90E+00 |
| 7440-28-0 | Thallium (soluble salts) | X | | 2.00E-01 | mg/kg | 6.69E-01 | 8.64E+01 | - - | 6.69E-01 | X | | 50 U | 4.70E-01 | - - | 4.70E-01 |
| 7440-66-6 | Zinc | X | X | **2.20E+02** | mg/kg | 1.01E+02 | 4.00E+05 | - - | 1.01E+02 | X | | 8.00E+00 | 8.10E+01 | - - | 8.10E+01 |
| 57-12-5 | Cyanide | X | | 0.15 U | mg/kg | 2.02E-01 | 2.67E+04 | - - | 2.02E-01 | X | | N/A | 5.00E+00 * | - - | 5.00E+00 * |
| **Semivolatile Organic Compounds (SVOCs) and Polychlorinated Biphenyls (PCBs)** | | | | | | | | | | | | | | | |
| 56-55-3 | Benzo(a)anthracene | X | X | **3.50E+03** | µg/kg | 4.19E+01 | 3.42E+03 | - - | 4.19E+01 | X | | N/A | 1.00E-01 * | - - | 1.00E-01 * |
| 205-99-2 | Benzo(b)fluoranthene | X | X | **3.10E+03** | µg/kg | 1.44E+02 | 3.42E+03 | - - | 1.44E+02 | X | | N/A | 1.00E-01 * | - - | 1.00E-01 * |
| 207-08-9 | Benzo(k)fluoranthene | X | X | **3.10E+03** | µg/kg | 1.44E+02 | 3.42E+03 | - - | 1.44E+02 | X | | N/A | 1.00E-01 * | - - | 1.00E-01 * |
| 50-32-8 | Benzo(a)pyrene | X | X | **1.70E+03** | µg/kg | 1.13E+02 | 3.42E+03 | 7.95E+07 | 1.13E+02 | X | | N/A | 1.00E-01 * | - - | 1.00E-01 * |
| 218-01-9 | Chrysene | X | X | **2.90E+03** | µg/kg | 4.66E+01 | 3.42E+03 | - - | 4.66E+01 | X | | N/A | 1.00E-01 * | - - | 1.00E-01 * |
| 53-70-3 | Dibenzo(a,h)anthracene | X | | 9.30E+01 | µg/kg | 2.10E+02 | 3.42E+03 | - - | 2.10E+02 | X | | N/A | 1.00E-01 * | - - | 1.00E-01 * |
| 105-67-9 | 2,4-Dimethylphenol | | | 130 U | µg/kg | 2.24E+03 | 1.33E+07 | - - | 2.24E+03 | X | | N/A | 2.73E+02 | - - | 2.73E+02 |
| 131-11-3 | Dimethylphthalate | | | 130 U | µg/kg | 1.69E+05 | 6.67E+08 | - - | 1.69E+05 | | Not a Site-Wide COC in Groundwater | | | | |
| 117-81-7 | bis(2-Ethylhexyl)phthalate | X | | 130 U | µg/kg | 1.57E+03 | 1.79E+06 | - - | 1.57E+03 | X | | N/A | 3.00E+00 * | - - | 3.00E+00 * |
| 206-44-0 | Fluoranthene | X | | 12000 D | µg/kg | 4.40E+04 | 2.67E+07 | - - | 4.40E+04 | | Not a Site-Wide COC in Groundwater | | | | |
| 193-39-5 | Indeno(1,2,3-cd)pyrene | X | X | **4.50E+02** | µg/kg | 4.06E+02 | 3.42E+03 | - - | 4.06E+02 | X | | N/A | 1.00E-01 * | - - | 1.00E-01 * |
| - | Aroclor 1242 | X | X | **3.80E+01** | µg/kg | 3.30E+01 | 4.67E+04 | - - | 3.30E+01 | X | | N/A | 1.00E-02* | - - | 1.00E-02* |
| 12672-29-6 | Aroclor 1248 | X | X | **4.00E+01** | µg/kg | 3.30E+01 | - - | - - | 3.30E+01 | | Not a Site-Wide COC in Groundwater | | | | |
| 11097-69-1 | Aroclor 1254 | X | X | **7.60E+01** | µg/kg | 3.30E+01* | 1.33E+04 | - - | 3.30E+01* | X | | N/A | 1.00E-02* | - - | 1.00E-02* |
| 11097-69-1 | Aroclor 1260 | X | | 260 U | µg/kg | 3.30E+01* | - - | - - | 3.30E+01* | X | | N/A | 1.00E-02* | - - | 1.00E-02* |
| | Total PCBs | X | X | **1.14E+02** | µg/kg | 3.30E+01* | - - | - - | 3.30E+01* | X | | N/A | 1.00E-02* | - - | 1.00E-02* |
| **Volatile Organic Compounds (VOCs)** | | | | | | | | | | | | | | | |
| 71-43-2 | Benzene | X | | 1.1 J | µg/kg | 2.53E+01 | 1.36E+06 | 5.05E+02 | 2.53E+01 | X | | 1 U | 4.48E+00 | 3.83E+03 | 4.48E+00 |
| 56-23-5 | Carbon Tetrachloride | | | Not a Site-Wide COC in Soil | | | | | | X | | 1 U | 5.26E-01 | 4.08E+02 | 5.26E-01 |
| 108-90-7 | Chlorobenzene | X | | 18 U | µg/kg | 1.85E+03 | 2.91E+07 | 1.85E+03 | 1.40E+04 | | Not a Site-Wide COC in Groundwater | | | | |
| 74-87-3 | Chloromethane | | | Not a Site-Wide COC in Soil | | | | | | X | | 1 U | 2.63E+01 | 8.02E+03 | 2.63E+01 |
| 104-51-8 | n-Butylbenzene | X | | 1.6 UJ | µg/kg | 4.64E+03 | - - | 4.64E+03 | - - | | Not a Site-Wide COC in Groundwater | | | | |
| 135-98-8 | sec-Butylbenzene | X | | 1.6 UJ | µg/kg | 7.86E+03 | - - | 7.86E+03 | - - | | Not a Site-Wide COC in Groundwater | | | | |
| 67-66-3 | Chloroform | X | | 6 U | µg/kg | 1.40E+02 | 7.03E+06 | 2.04E+02 | 2.98E+02 | | Not a Site-Wide COC in Groundwater | | | | |
| 75-35-4 | 1,1-Dichloroethene | X | | 6 U | µg/kg | 2.73E+00 | 1.24E+05 | 5.80E+01 | 2.73E+00 | X | | 1 U | 3.82E-01 | 1.23E+02 | 3.82E-01 |
| 107-06-2 | 1,2-Dichloroethane | | | Not a Site-Wide COC in Soil | | | | | | X | | 1 U | 1.17E+01 | 4.91E+03 | 1.17E+01 |
| 156-59-2 | cis-1,2-Dichloroethene | X | | 6 U | µg/kg | 7.94E+02 | 7.99E+06 | 7.94E+02 | 7.73E+03 | X | | 1 U | 1.55E+03 | 1.51E+04 | 1.55E+03 |
| 156-60-5 | trans-1,2-Dichloroethene | X | | 6 U | µg/kg | 9.06E+03 | 1.31E+07 | 8.21E+03 | 5.43E+04 | | Not a Site-Wide COC in Groundwater | | | | |
| 100-41-4 | Ethylbenzene | X | | 6 U | µg/kg | 2.52E+03 | 1.45E+08 | - - | 1.81E+04 | X | | 1 U | 2.10E+03 | - - | 2.10E+03 |
| 98-82-8 | Isopropylbenzene | X | | 1.6 UJ | µg/kg | 4.98E+04 | 1.45E+08 | - - | - - | | Not a Site-Wide COC in Groundwater | | | | |
| 75-09-2 | Methylene Chloride | X | | 9.00E+00 | µg/kg | 8.28E+02 | 9.94E+06 | 1.21E+04 | 8.28E+02 | X | | 1 U | 1.90E+02 | 1.32E+05 | 1.90E+02 |

**Table 2-1 Screening Levels for Constituents of Concern**
**North Area**
**Boeing Plant 2**

| CAS Number | Sitewide Constituent of Concern | Soil (see maximum detect units) | | | | | | | | Groundwater (ug/L) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sitewide Soil COC? | Area Soil COC? | Maximum Detect[1] in North Area | | Minimum Screening Level | Direct Contact Screening Level | Air Screening Level | Surface Water Screening Level | Sitewide GW COC? | Area GW COC? | Maximum Detect in North Area | Minimum Screening Level | Air Screening Level | Surface Water Screening Level |
| **VOCs (cont'd)** | | | | | | | | | | | | | | | |
| 91-20-3 | Naphthalene | X | | 28000 D | µg/kg | 3.94E+04 | 1.44E+07 | 9.82E+04 | 6.80E+04 | | Not a Site-Wide COC in Groundwater | | | | |
| 103-65-1 | n-Propylbenzene | X | | 1.6 UJ | µg/kg | 1.36E+04 | - - | 1.36E+04 | - - | | Not a Site-Wide COC in Groundwater | | | | |
| 79-34-5 | 1,1,2,2-Tetrachloroethane | X | | 18 U | µg/kg | 7.19E+00 | 2.73E+05 | 1.39E+03 | 7.19E+00 | | Not a Site-Wide COC in Groundwater | | | | |
| 127-18-4 | Tetrachloroethene | X | | 5.60E+00 | µg/kg | 8.72E+00 | 1.07E+06 | 4.89E+02 | 8.72E+00 | X | | 1 U | 8.22E-01 | 1.88E+03 | 8.22E-01 |
| 108-88-3 | Toluene | X | | 1.20E+01 | µg/kg | 1.90E+04 | 1.34E+08 | - - | 1.09E+05 | | Not a Site-Wide COC in Groundwater | | | | |
| 71-55-6 | 1,1,1-Trichloroethane | X | | 6.00E+00 | µg/kg | 2.78E+04 | 4.12E+08 | - - | 1.63E+06 | | Not a Site-Wide COC in Groundwater | | | | |
| 79-00-5 | 1,1,2-Trichloroethane | X | | 6 U | µg/kg | 2.78E+01 | 9.57E+05 | 1.31E+03 | 2.78E+01 | X | | 1 U | 5.00E+00 | 9.40E+03 | 5.00E+00 |
| 79-01-6 | Trichloroethene | X | X | **9.00E+00** | µg/kg | 2.00E+00 | 1.36E+05 | 3.60E+01 | 2.00E+00 | X | | 1 U | 3.02E-01 | 1.58E+02 | 3.02E-01 |
| 95-63-6 | 1,2,4-Trimethylbenzene | X | | 3.7 UJ | µg/kg | 4.03E+03 | 7.27E+07 | 1.01E+04 | - - | | Not a Site-Wide COC in Groundwater | | | | |
| 108-67-8 | 1,3,5-Trimethylbenzene | X | | 3 UJ | µg/kg | 4.21E+03 | 7.27E+07 | - - | - - | | Not a Site-Wide COC in Groundwater | | | | |
| 75-01-4 | Vinyl Chloride | X | | 6 U | µg/kg | 4.59E+00 | 4.97E+04 | 3.31E+02 | 4.59E+00 | X | X | **2.00E+00** | 7.31E-01 | 5.94E+02 | 7.31E-01 |
| **Total Petroleum Hydrocarbons (TPH)** | | | | | | | | | | | | | | | |
| - | TPH (range not defined) | X | | 25 U | mg/kg | 2.00E+03 | 2.00E+03 | | | X | | N/A | 5.00E+02 | 5.00E+02 | |
| - | TPH - Gasoline Range | X | | 1.60E+01 | mg/kg | 3.00E+01 | 3.00E+01 | | | X | | N/A | 8.00E+02 | 8.00E+02 | |
| - | TPH - Diesel Range | X | | 7.60E+01 | mg/kg | 2.00E+03 | 2.00E+03 | | | X | | N/A | 5.00E+02 | 5.00E+02 | |
| - | TPH - Mineral Spirits Range | X | | N/A | -- | 2.00E+03 | 2.00E+03 | | | | Not a Site-Wide COC in Groundwater | | | | |
| - | TPH - Oil Range | X | | 2.30E+02 | mg/kg | 2.00E+03 | 2.00E+03 | | | X | X | **1.20E+04** | 5.00E+02 | 5.00E+02 | |

Notes:

[1] In some cases, no detections were reported, therefore the maximum non-detect value is reported with a "U" qualifier (example: 1,1,2,2-Tetrachloroethane at 18 U µg/kg)

**Bold** indicates maximum detect exceeds minimum screening level.

All maximum detections for metals in groundwater represent dissolved metals.

Data qualifiers are defined in Attachment B, Table B-3.

- No CAS Number available.
- - Not calculated (generally, the exposure pathway is incomplete; refer to CMS Volume II for details).
* Screening level was adjusted to the reporting limit as referenced in Table 3-2.
** Screening level was adjusted to the background concentration.
COC Consituent of concern
N/A Not available or not analyzed

**Table 2-2:**
**North Area Proposed CMS Data Gaps Sampling**
**Boeing Plant 2**

| Sampling Locations in the North Area | Screened Interval (ft. bgs) | Constituent Groups with North Area COCs | | Other Constituent Groups (not Groundwater COCs for the North Area) | | | | Rationale for Selection of Laboratory Analyses |
|---|---|---|---|---|---|---|---|---|
| | | VOCs | TPH-G, TPH-Dx, TPH-O | Total and Dissolved Metals | SVOCs (cPAHs)s | PCBs | Redox Parameters | |
| **GROUNDWATER SAMPLING SUMMARY** | | | | | | | | |
| **New Wells** | | | | | | | | |
| PL2-270B | 40 to 45 | ● | | ● | | | ● salinity, cations, anions | Laboratory analyses selected to match A-level well |
| PL2-608A | 6 to 21 | ● | ● | ● | | | ● | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. |
| PL2-608B | 40 to 45 | ● | ● | ● | | | ● salinity, cations, anions | Laboratory analyses selected to match A-level well |
| PL2-609A | 6 to 21 | ● | ● | ● | ● | ● | ● | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. SVOC and PCB analyses to match soil analyses. |
| PL2-610A | 6 to 21 | ● | ● | ● | | | ● | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. |
| PL2-610B | 40 to 45 | ● | ● | ● | | | ● salinity, cations, anions | Laboratory analyses selected to match A-level well |
| PL2-611A | 6 to 21 | ● | ● | ● | ● | ● | ● | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. SVOC and PCB analyses to match soil analyses. |
| **Existing Wells** | | | | | | | | |
| PL2-270A | 12.5 to 17.5 | ● | | ● | | | ● | TPH not expected in this area based on historical groundwater data. |

**Table 2-2:**
**North Area Proposed CMS Data Gaps Sampling**
**Boeing Plant 2**

| Sampling Locations in the North Area | Screened Interval (ft. bgs) | Constituent Groups with North Area COCs | | Other Constituent Groups (not Groundwater COCs for the North Area) | | | | Rationale for Selection of Laboratory Analyses |
|---|---|---|---|---|---|---|---|---|
| | | VOCs | TPH-G, TPH-Dx, TPH-O | Total and Dissolved Metals | SVOCs (cPAHs)s | PCBs | Redox Parameters | |
| **GROUNDWATER SAMPLING SUMMARY** | | | | | | | | |
| **Direct-Push Probes** | | | | | | | | |
| NA-DP-01 | 10 to 14 | • | • | • | • | • | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. SVOC and PCB analyses to match soil analyses. |
| NA-DP-02 | 10 to 14<br>28 to 32 | • | • | • | • | • | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. SVOC and PCB analyses to match soil analyses. |
| NA-DP-03 | 10 to 14 | • | • | • | • | • | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. SVOC and PCB analyses to match soil analyses. |
| NA-DP-04 | 10 to 14 | • | • | • | • | • | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. SVOC and PCB analyses to match soil analyses. |

**Table 2-2:**
**North Area Proposed CMS Data Gaps Sampling**
**Boeing Plant 2**

| Sampling Locations in the North Area | Screened Interval (ft. bgs) | Constituent Groups with North Area COCs | | Other Constituent Groups (not Groundwater COCs for the North Area) | | | | Rationale for Selection of Laboratory Analyses |
|---|---|---|---|---|---|---|---|---|
| | | VOCs | TPH-G, TPH-Dx, TPH-O | Total and Dissolved Metals | SVOCs (cPAHs)s | PCBs | Redox Parameters | |
| **GROUNDWATER SAMPLING SUMMARY** | | | | | | | | |
| NA-DP-05 | 10 to 14 | ● | ● | ● | ● | ● | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. SVOC and PCB analyses to match soil analyses. |
| NA-DP-06 | 10 to 14 | ● | ● | ● | ● | ● | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. SVOC and PCB analyses to match soil analyses. |
| NA-DP-07 | 10 to 14 | ● | ● | ● | ● | ● | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. SVOC and PCB analyses to match soil analyses. |
| NA-DP-08 | 10 to 14 | ● | ● | ● | ● | ● | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. SVOC and PCB analyses to match soil analyses. |
| NA-DP-09 | 10 to 14 | ● | ● | ● | ● | | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. SVOC analyzed to match soil analyses |
| NA-DP-10 | 10 to 14 | ● | ● | ● | ● | | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. SVOC analyzed to match soil analyses |
| NA-DP-11 | 10 to 14 | ● | | ● | ● | | | TPH not expected in this area based on historical groundwater data. SVOC analyzed to match soil analyses. |
| NA-DP-12 | 10 to 14 | ● | | ● | ● | | | TPH not expected in this area based on historical groundwater data. SVOC analyzed to match soil analyses. |
| NA-DP-13 | 10 to 14 | ● | | ● | ● | | | TPH not expected in this area based on historical groundwater data. SVOC analyzed to match soil analyses. |
| NA-DP-14 | 10 to 14 | ● | | ● | ● | | | TPH not expected in this area based on historical groundwater data. SVOC analyzed to match soil analyses. |
| NA-DP-15 | 10 to 14 | ● | | ● | ● | | | TPH not expected in this area based on historical groundwater data. SVOC analyzed to match soil analyses. |
| NA-DP-16 | 10 to 14 | ● | | ● | ● | | | TPH not expected in this area based on historical groundwater data. SVOC analyzed to match soil analyses. |

**Table 2-2:**
**North Area Proposed CMS Data Gaps Sampling**
**Boeing Plant 2**

| Sampling Locations in the North Area | Screened Interval (ft. bgs) | Constituent Groups with North Area COCs | | Other Constituent Groups (not Groundwater COCs for the North Area) | | | | Rationale for Selection of Laboratory Analyses |
|---|---|---|---|---|---|---|---|---|
| | | VOCs | TPH-G, TPH-Dx, TPH-O | Total and Dissolved Metals | SVOCs (cPAHs)s | PCBs | Redox Parameters | |
| **GROUNDWATER SAMPLING SUMMARY** | | | | | | | | |
| NA-DP-17 | 10 to 14 | ● | ● | ● | | | | TPH analyzed because of historical detections at |
| NA-DP-18 | 10 to 14 | ● | | ● | | | | TPH not expected in this area based on historical groundwater data. |
| NA-DP-19 | 10 to 14 | ● | | ● | | | | TPH not expected in this area based on historical groundwater data. |
| NA-DP-20 | 10 to 14 | ● | | ● | | ● | | TPH not expected in this area based on historical groundwater data. PCB analyzed to match soil analyses. |
| NA-DP-21 | 10 to 14 | ● | | ● | | ● | | TPH not expected in this area based on historical groundwater data. PCB analyzed to match soil analyses. |
| NA-DP-22 | 10 to 14 | ● | | ● | | ● | | TPH not expected in this area based on historical groundwater data. PCB analyzed to match soil analyses. |
| NA-DP-23 | 10 to 14 | ● | ● | ● | | | | TPH sampled because of former UST in area. |
| NA-DP-24 | 10 to 14 | ● | | ● | | | | TPH not expected in this area based on historical groundwater data. |
| NA-DP-25 | 10 to 14 | ● | | ● | | | | TPH not expected in this area based on historical groundwater data. |
| NA-DP-26 | 10 to 14 | ● | ● | ● | | | | TPH sampled because of former UST in area. |
| NA-DP-27 | 10 to 14 | ● | ● | ● | | | | TPH sampled because of former UST in area. |
| NA-DP-28 | 10 to 14 | ● | ● | ● | | | | TPH sampled because of former UST in area. |
| NA-DP-29 | 10 to 14 | ● | | ● | ● | ● | | TPH not expected in this area based on historical groundwater data. SVOC and PCB analyzed to match soil analyses. |
| NA-DP-30 | 10 to 14 | ● | | ● | ● | ● | | TPH not expected in this area based on historical groundwater data. SVOC and PCB analyzed to match soil analyses. |

**Table 2-2:**
**North Area Proposed CMS Data Gaps Sampling**
**Boeing Plant 2**

| Sampling Locations in the North Area | Screened Interval (ft. bgs) | Constituent Groups with North Area COCs | | Other Constituent Groups (not Groundwater COCs for the North Area) | | | | Rationale for Selection of Laboratory Analyses |
|---|---|---|---|---|---|---|---|---|
| | | VOCs | TPH-G, TPH-Dx, TPH-O | Total and Dissolved Metals | SVOCs (cPAHs)s | PCBs | Redox Parameters | |
| **GROUNDWATER SAMPLING SUMMARY** | | | | | | | | |
| NA-DP-31 | 10 to 14 | ● | | ● | ● | ● | | TPH not expected in this area based on historical |
| NA-DP-32 | 10 to 14 | ● | | ● | ● | ● | | TPH not expected in this area based on historical groundwater data. SVOC and PCB analyzed to match soil |
| NA-DP-33 | 10 to 14 | ● | | ● | ● | | | TPH not expected in this area based on historical groundwater data. SVOC analyzed to match soil analyses. |
| NA-DP-34 | 10 to 14 | ● | | ● | ● | | | TPH not expected in this area based on historical groundwater data. SVOC analyzed to match soil analyses. |
| NA-DP-35 | 10 to 14 | ● | | ● | ● | | | TPH not expected in this area based on historical groundwater data. SVOC analyzed to match soil analyses. |
| NA-DP-36 | 10 to 14<br>41 to 45 | ● | ● | ● | | | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. |
| NA-DP-37 | 10 to 14<br>41 to 45 | ● | ● | ● | | | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. |
| NA-DP-38 | 10 to 14<br>41 to 45 | ● | ● | ● | ● | | | TPH not expected in this area based on historical groundwater data. SVOC analyzed to match soil analyses. |
| NA-DP-39 | 10 to 14<br>41 to 45 | ● | ● | ● | ● | | | TPH not expected in this area based on historical groundwater data. SVOC analyzed to match soil analyses. |
| NA-DP-40 | 10 to 14<br>41 to 45 | ● | ● | ● | | | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. |
| NA-DP-41 | 10 to 14<br>12 to 16<br>41 to 45 | ● | ● | ● | ● | ● | | TPH not expected in this area based on historical groundwater data. SVOC analyzed to match soil analyses. Intermediate interval collected to support potential shoreline projects. |
| NA-DP-42 | 10 to 14<br>28 to 32<br>41 to 45 | ● | ● | ● | ● | ● | | TPH not expected in this area based on historical groundwater data. SVOC analyzed to match soil analyses. Intermediate interval collected to support potential shoreline projects. |
| NA-DP-43 | 10 to 14<br>41 to 45 | ● | ● | ● | ● | ● | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. |

**Table 2-2:**
**North Area Proposed CMS Data Gaps Sampling**
**Boeing Plant 2**

| Sampling Locations in the North Area | Screened Interval (ft. bgs) | Constituent Groups with North Area COCs | | Other Constituent Groups (not Groundwater COCs for the North Area) | | | | Rationale for Selection of Laboratory Analyses |
|---|---|---|---|---|---|---|---|---|
| | | VOCs | TPH-G, TPH-Dx, TPH-O | Total and Dissolved Metals | SVOCs (cPAHs)s | PCBs | Redox Parameters | |
| **GROUNDWATER SAMPLING SUMMARY** | | | | | | | | |
| NA-DP-44 | C-level, Top of Silt | • | | • | Redox parameters, salinity profile, anions/cations | | | TPH not expected in this area based on historical groundwater data. |
| NA-DP-45 | C-level, Top of Silt | • | • | • | Redox parameters, salinity profile, anions/cations | | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. |
| NA-DP-46 | C-level, Top of Silt | • | • | • | Redox parameters, salinity profile, anions/cations | | | TPH analyzed because of historical detections at concentrations greater than screening levels in the area. |

**Table 2-2:**
**North Area Proposed CMS Data Gaps Sampling**
**Boeing Plant 2**

| Proposed Probe Locations in the North Area | Sampling Intervals (ft. bgs) | Constituent Groups with North Area COCs | | | | | Rationale for Selection of Laboratory Analyses |
|---|---|---|---|---|---|---|---|
| | | VOCs | TPH-G, TPH-Dx, TPH-O | Metals | SVOCs (cPAHs)s | PCBs | |
| **SOIL SAMPLING SUMMARY** | | | | | | | |
| **New Wells** | | | | | | | |
| PL2-270B | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | | | Soil analyses conducted to match groundwater |
| PL2-608A | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | | | TPH soil analyses conducted to match groundwater. |
| PL2-608B | | | | | | | Vadose zone soil samples taken at PL2-608A location. |
| PL2-609A | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | • | TPH soil analyses conducted to match groundwater. PCB analysis conducted to verify historical non-detect data with elevated RLs. SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| PL2-610A | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | | | TPH soil analyses conducted to match groundwater |
| PL2-610B | | | | | | | Vadose zone soil samples taken at PL2-610A location. |
| PL2-611A | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | • | TPH soil analyses conducted to match groundwater. PCB analysis conducted to verify historical non-detect data with elevated RLs. SVOC (cPAHs) analysis conducted for COC delineation in soil. |

**Table 2-2:**
**North Area Proposed CMS Data Gaps Sampling**
**Boeing Plant 2**

| Proposed Probe Locations in the North Area | Sampling Intervals (ft. bgs) | Constituent Groups with North Area COCs | | | | | Rationale for Selection of Laboratory Analyses |
|---|---|---|---|---|---|---|---|
| | | VOCs | TPH-G, TPH-Dx, TPH-O | Metals | SVOCs (cPAHs)s | PCBs | |
| **SOIL SAMPLING SUMMARY** | | | | | | | |
| **Direct-Push Probes** | | | | | | | |
| NA-DP-01 | 0 to 1<br>4 to 5<br>9 to 10<br>11 to 12 | • | • | • | • | • | TPH soil analyses conducted to match groundwater. PCB and SVOC (cPAHs) analysis conducted to verify historical non-detect data with elevated RLs. Additional interval below 10 feet collected to support potential shoreline |
| NA-DP-02 | 0 to 1<br>4 to 5<br>9 to 10<br>15 to 16<br>20 to 21<br>25 to 26<br>26 to 29 | • | • | • | • | • | TPH soil analyses conducted to match groundwater. PCB and SVOC (cPAHs) analysis conducted to verify historical non-detect data with elevated RLs. Additional intervals below 10 feet collected to support potential shoreline projects. |
| NA-DP-03 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | • | TPH soil analyses conducted to match groundwater. PCB and SVOC (cPAHs) analysis conducted to verify historical non-detect data with elevated RLs. |
| NA-DP-04 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | • | TPH soil analyses conducted to match groundwater. PCB and SVOC (cPAHs) analysis conducted to verify historical non-detect data with elevated RLs. |
| NA-DP-05 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | • | TPH soil analyses conducted to match groundwater. PCB and SVOC (cPAHs) analysis conducted to verify historical non-detect data with elevated RLs. |
| NA-DP-06 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | • | TPH soil analyses conducted to match groundwater. PCB and SVOC (cPAHs) analysis conducted to verify historical non-detect data with elevated RLs. |
| NA-DP-07 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | • | TPH soil analyses conducted to match groundwater. PCB and SVOC (cPAHs) analysis conducted to verify historical non-detect data with elevated RLs. |

**Table 2-2:**
**North Area Proposed CMS Data Gaps Sampling**
**Boeing Plant 2**

| Proposed Probe Locations in the North Area | Sampling Intervals (ft. bgs) | Constituent Groups with North Area COCs | | | | | Rationale for Selection of Laboratory Analyses |
|---|---|---|---|---|---|---|---|
| | | VOCs | TPH-G, TPH-Dx, TPH-O | Metals | SVOCs (cPAHs)s | PCBs | |
| **SOIL SAMPLING SUMMARY** | | | | | | | |
| NA-DP-08 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | • | TPH soil analyses conducted to match groundwater. PCB and SVOC (cPAHs) analysis conducted to verify historical non-detect data with elevated RLs. |
| NA-DP-09 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | | TPH soil analyses conducted to match groundwater. SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-10 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | | TPH soil analyses conducted to match groundwater. SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-11 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | • | | SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-12 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | • | | SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-13 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | • | | SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-14 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | • | | SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-15 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | • | | SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-16 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | • | | SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-17 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | | | TPH soil analyses conducted to match groundwater. Metals analysis conducted for COC delineation in soil. |

**Table 2-2:**
**North Area Proposed CMS Data Gaps Sampling**
**Boeing Plant 2**

| Proposed Probe Locations in the North Area | Sampling Intervals (ft. bgs) | Constituent Groups with North Area COCs | | | | | Rationale for Selection of Laboratory Analyses |
|---|---|---|---|---|---|---|---|
| | | VOCs | TPH-G, TPH-Dx, TPH-O | Metals | SVOCs (cPAHs)s | PCBs | |
| **SOIL SAMPLING SUMMARY** | | | | | | | |
| NA-DP-18 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | | | Metals analysis conducted for COC delineation in soil. |
| NA-DP-19 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | | | Metals analysis conducted for COC delineation in soil. |
| NA-DP-20 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | | • | Metals and PCB analysis conducted for COC delineation in soil. |
| NA-DP-21 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | | • | Metals and PCB analysis conducted for COC delineation in soil. |
| NA-DP-22 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | | • | Metals and PCB analysis conducted for COC delineation in soil. |
| NA-DP-23 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | | | TPH soil analyses conducted to match groundwater.<br>Metals analysis conducted for COC delineation in soil. |
| NA-DP-24 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | | | Metals analysis conducted for COC delineation in soil. |
| NA-DP-25 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | | | Metals analysis conducted for COC delineation in soil. |
| NA-DP-26 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | | | TPH soil analyses conducted to match groundwater.<br>Metals analysis conducted for COC delineation in soil. |
| NA-DP-27 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | | | TPH soil analyses conducted to match groundwater.<br>Metals analysis conducted for COC delineation in soil. |

**Table 2-2:**
**North Area Proposed CMS Data Gaps Sampling**
**Boeing Plant 2**

| Proposed Probe Locations in the North Area | Sampling Intervals (ft. bgs) | Constituent Groups with North Area COCs | | | | | Rationale for Selection of Laboratory Analyses |
|---|---|---|---|---|---|---|---|
| | | VOCs | TPH-G, TPH-Dx, TPH-O | Metals | SVOCs (cPAHs)s | PCBs | |
| **SOIL SAMPLING SUMMARY** | | | | | | | |
| NA-DP-28 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | | | TPH soil analyses conducted to match groundwater. Metals analysis conducted for COC delineation in soil. |
| NA-DP-29 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | • | • | Metals, PCB and SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-30 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | • | • | Metals, PCB and SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-31 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | • | • | Metals, PCB and SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-32 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | • | • | Metals, PCB and SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-33 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | • | | SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-34 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | • | | SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-35 | 0 to 1<br>4 to 5<br>9 to 10 | • | | • | • | | SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-36 | 0 to 1 | • | • | • | | | TPH soil analyses conducted to match groundwater. VOC |
| NA-DP-37 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | | | TPH soil analyses conducted to match groundwater. VOC analysis conducted for COC delineation in soil. |
| NA-DP-38 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | | TPH soil analyses conducted to match groundwater. VOC and SVOC (cPAHs) analysis conducted for COC delineation in soil. |

**Table 2-2:**
**North Area Proposed CMS Data Gaps Sampling**
**Boeing Plant 2**

| Proposed Probe Locations in the North Area | Sampling Intervals (ft. bgs) | Constituent Groups with North Area COCs | | | | | Rationale for Selection of Laboratory Analyses |
|---|---|---|---|---|---|---|---|
| | | VOCs | TPH-G, TPH-Dx, TPH-O | Metals | SVOCs (cPAHs)s | PCBs | |
| **SOIL SAMPLING SUMMARY** | | | | | | | |
| NA-DP-39 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | | TPH soil analyses conducted to match groundwater. SVOC (cPAHs) analysis conducted for COC delineation in soil. |
| NA-DP-40 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | | | TPH soil analyses conducted to match groundwater. VOC analysis conducted for COC delineation in soil. |
| NA-DP-41 | 0 to 1<br>4 to 5<br>7 to 8<br>9 to 10 | • | • | • | • | • | TPH soil analyses conducted to match groundwater. PCB and SVOC (cPAHs) analysis conducted to verify historical non-detect data with elevated RLs. |
| NA-DP-42 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | • | TPH soil analyses conducted to match groundwater. PCB and SVOC (cPAHs) analysis conducted to verify historical non-detect data with elevated RLs. |
| NA-DP-43 | 0 to 1<br>4 to 5<br>9 to 10 | • | • | • | • | • | TPH soil analyses conducted to match groundwater. PCB and SVOC (cPAHs) analysis conducted to verify historical non-detect data with elevated RLs. |
| NA-DP-44 | C-level, Top of Silt | Soil sample of low-permeability material at the base of the aquifer for grain size analysis, divide into two or more discrete samples if | | | | | Vadose zone soil samples taken at PL2-270B location. |
| NA-DP-45 | C-level, Top of Silt | Soil sample of low-permeability material at the base of the aquifer for grain size analysis, divide into two or more discrete samples if | | | | | Vadose zone soil samples taken at PL2-608A location. |
| NA-DP-46 | C-level, Top of Silt | Soil sample of low-permeability material at the base of the aquifer for grain size analysis, divide into two or more discrete samples if | | | | | Vadose zone soil samples taken at PL2-610A location. |

NOTES:

cPAHs = Carcinogenic Polycyclic Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
SVOCs = Semivolatile Organic Compounds
TPH = Total Petroleum Hydrocarbons
VOCs = Volatile Organic Compounds

**Table 2-3**
**North Area Locations of Constituents of Concern Detected above Screening Levels in Groundwater**
**Boeing Plant 2**

| CAS Number | Constituent of Concern | Range of Detects above Screening Levels (µg/L) | RCRA Unit Potentially Associated with COC Detection above Screening Levels | Non-RCRA Areas |
|---|---|---|---|---|
| | | | SWMU2-01 (Landing Gear Cleaning Sump) | COC Detect Not Associated with a RCRA Unit |
| **VOCs** | | | | |
| 75-01-4 | Vinyl Chloride | 2 | Max | |
| **Petroleum Hydrocarbons** | | | | |
| - | TPH-Motor Oil Range | 800 to 12,000 | X | Max |

NOTES:

X = COC detected above screening levels in this area
Max = Maximum COC detection noted at this unit

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**Table 2-4. Locations of COCs Detected Above Screening Levels in Soil**
**North Area**
**Boeing Plant 2**

| CAS Number | Constituent of Concern | Range of Detects Above Soil Screening Levels Protective of Surface Water and/or Direct Contact | RCRA Units | Non RCRA Units | |
|---|---|---|---|---|---|
| | | | SWMU 2-01.1 Landing Gear Cleaning Sump | USTs PL-1, PL-2, PL-3, and PL-28 | PL-4 |
| **Metals and Cyanide (mg/kg)** | | | | | |
| 7440-38-2 | Arsenic | 8 - 15 | | | |
| 7440-43-9 | Cadmium | 2.9 | | | |
| 7440-50-8 | Copper | 40 - 310 | | | |
| 7439-97-6 | Mercury | 0.12 - 0.2 | | | |
| 7440-66-6 | Zinc | 220 | | | |
| **Semivolatile Organic Compounds (SVOCs) and Polychlorinated Biphenyls (PCBs), (µg/kg)** | | | | | |
| 56-55-3 | Benzo(a)anthracene | 130 - 3,500 | | | |
| 50-32-8 | Benzo(a)pyrene | 1,700 | | | |
| 205-99-2 | Benzo(b)fluoranthene | 3,100 | | | |
| 207-08-9 | Benzo(k)fluoranthene | 3,100 | | | |
| 218-01-9 | Chrysene | 80 - 2,900 | | | |
| 193-39-5 | Indeno(1,2,3-cd)pyrene | 450 | | | |
| 53469-21-9 | Aroclor 1242 | 38 | | | |
| 12672-29-6 | Aroclor 1248 | 40 | | | |
| 11097-69-1 | Aroclor 1254 | 42 - 76 | | | |
| 1336-36-3 | Total PCB | 47 - 114 | | | |
| **Volatile Organic Compounds (VOCs), (µg/kg)** | | | | | |
| 79-01-6 | Trichloroethene | 9 | Max | | |

Notes:

| | |
|---|---|
| a | COC unit or area association is based on concentrations being exhibited above the Puget Sound Basin Ecology (1994) calculated background concentration. |
| X | COC detected above screening levels |
| Max | Maximum COC detection noted at this unit |
| * | COC status is based solely on preliminary soil to air pathway screening level. An air pathway evaluation will be performed in the addendum to the work plan. |

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**Table 3-1 Laboratory Methods and Sample Requirements**
**North Area**
**Boeing Plant 2**

| Constituent Group | Method | Estimated Number of Samples | Containers per Sample | Handling & Preservation | Holding Time |
|---|---|---|---|---|---|
| **Groundwater Samples** | | | | | |
| Volatile Organic Compounds (VOCs) | USEPA 8260B | 65 field samples, 6 duplicates, 1 trip blank per cooler, 3 MS, 3 MSD (77 total[3]) | Three 40-mL vials | Preserved with HCl to pH less than 2.0*<br>No headspace<br>Stored at $4^{O}C$ | 14 days (preserved) |
| Dissolved Metals[1] (wells and probes) | USEPA 200.8, 3500, 6010- and 7000-Series | 65 field samples, 6 duplicates, 3 MS, 3 MSD (77 total) | One 1-liter HDPE bottle | Filtered<br>Preserved with $HNO_3$ *<br>Stored at $4^{O}C$ | 6 months<br>28 days for mercury |
| Total Metals[1] (wells only) | USEPA 200.8, 3500, 6010- and 7000-Series | 8 field samples, 1 duplicate, 1 MS, 1 MSD (11 total) | One 1-liter HDPE bottle | Preserved with $HNO_3$ *<br>Stored at $4^{O}C$ | 6 months<br>28 days for mercury |
| Diesel- and Oil-Range Petroleum Hydrocarbons | NWTPH-Dx with silica gel cleanup | 42 field samples, 4 duplicates, 1 MS, 1 MSD (48 total) | Two 500-mL amber glass bottles | Stored at $4^{O}C$ | 7 days to extract<br>40 days to analyze extracts |
| Gasoline Range Petroleum Hydrocarbons | NWTPH-G | 42 field samples, 4 duplicates, 2 trip blanks, 1 MS, 1 MSD (50 total) | Two 40-mL vials | Preserved with HCl to pH less than 2.0*<br>No headspace<br>Stored at $4^{O}C$ | 7 days (unpreserved)<br>14 days (preserved) |
| SVOCs | USEPA 8270C | 38 field samples, 3 duplicates, 1 MS, 1 MSD, (43 total) | Two 1-liter amber glass bottles | Stored at $4^{O}C$ | 14 days to extract<br>40 days to analyze extracts |
| PCBs | USEPA 8082 | 26 field samples, 2 duplicates, 1 MS, 1 MSD (30 total) | Two 500-mL amber glass bottles | Stored at $4^{O}C$ | 7 days (40 days for extract) |
| Redox Parameters: Nitrate, Nitrite, Sulfate, | Various methods including USEPA 300-series | 8 field samples, 1 field duplicate, 1 MS, 1 MSD (11 total) | One 500 mL HDPE bottle | Stored at $4^{O}C$ | 48 hours for nitrate, nitrite<br>28 days for sulfate |

**Table 3-1 Laboratory Methods and Sample Requirements**
**North Area**
**Boeing Plant 2**

| Constituent Group | Method | Estimated Number of Samples | Containers per Sample | Handling & Preservation | Holding Time |
|---|---|---|---|---|---|
| **Groundwater Samples** | | | | | |
| Ammonia | USEPA 350.1 | 8 field samples, 1 field duplicate, 1 MS, 1 MSD (11 total) | One 500 mL HDPE bottle | Preserved with $H_2SO_4$* to pH of < 2 Stored at $4^{O}C$ | 28 days |
| Ferrous Iron | Hach Kit or equivalent | 8 field samples, 1 field duplicates, (9 total) | Analysis performed in the field | Analysis performed in the field | Analysis performed in the field |
| Sulfide | 376.2 | 8 field samples, 1 field duplicates, 1 MS, 1 MSD (11 total) | One 500-mL HDPE bottle | Preserved with NaOH to pH greater than 9, Zinc Acetate (2N 4 drops/100 mL), no headspace Stored at $4^{O}C$ | 7 days |
| Total Organic Carbon | USEPA 415.1 | 8 field samples, 1 field duplicates, 1 MS, 1 MSD (11 total) | One 250-mL amber glass bottle | Preserved with $H_2SO_4$* to pH of < 2 Stored at $4^{O}C$ | 28 days |
| Salinity | SM 2520 | | One 500-ml HDPE | Stored at $4^{O}C$ | 28 days |
| Total Dissolved Solids | 160.1 | | One 1-Liter HDPE | Stored at $4^{O}C$ | 7 days |
| Cations/Anions – sulfate, chloride, calcium, magnesium, carbonate, bicarbonate, sodium, potassium | Various methods | | One 500-ml HDPE | Stored at $4^{O}C$ | 14 days (carbonate, bicarbonate)<br>28 days (sulfate, chloride)<br>6 months (calcium) |

**Table 3-1 Laboratory Methods and Sample Requirements**
**North Area**
**Boeing Plant 2**

| **Soil Samples** | | | | | |
|---|---|---|---|---|---|
| VOCs | 5035 (sampling)<br>USEPA 8260B (analysis) | 150 field samples, 15 co-located samples, 3 equipment blanks (water), 7 MS, 7 MSD (182 total) | (3) 40 mL VOA vials, | (1) with methanol<br>(2) with sodium bisulfate<br>Stored at $4^{O}C$ | 14 days |
| Percent Solids | Must accompany VOCs by 5035 | 150 field samples (150 total) | (1) 4-oz wide-mouth jar | Stored at $4^{O}C$ | NA |
| Metals[1] | USEPA 200.8 3500, 6010- and 7000-Series | 150 field samples, 3 equipment blanks (water), 7 MS, 7 MSD (167 total) | 4-oz wide-mouth jar | Stored at $4^{O}C$ | 6 months<br>28 days for mercury |
| Gasoline-range Petroleum Hydrocarbons | NWTPH-G | 87 field samples, 2 equipment blanks (water), 3 MS, 3 MSD (95 total) | 2-oz wide-mouth jar with septum cap | No headspace<br>Stored at $4^{O}C$ | 14 days to extract<br>40 days to analyze extracts |
| Diesel and Oil -range Petroleum Hydrocarbons | NWTPH-Dx with silica jel cleanup | 87 field samples, 2 equipment blanks (water), 3 MS, 3 MSD (95 total) | 4-oz wide-mouth jar | Stored at $4^{O}C$ | 14 days to extract<br>40 days to analyze extracts |
| SVOCs | USEPA 8270C | 96 field samples, 2 equipment blanks (water), 4 MS, 4 MSD (106 total) | 8-oz wide-mouth jar | Stored at $4^{O}C$ | 14 days to extract<br>40 days to analyze extracts |
| PCBs | USEPA 8082 | 66 field samples, 2 equipment blanks (water), 2 MS, 2 MSD (72 total) | 4-oz wide-mouth jar[4] | Stored at $4^{O}C$ | 7 days (40 days for extract) |
| Grain Size | ASTM D-421/422-63 with hydrometer | Approximately 6 field samples (approx. 6 total) | 16-oz wide-mouth jar | NA | NA |

**Table 3-1 Laboratory Methods and Sample Requirements**
**North Area**
**Boeing Plant 2**

Notes:

| | |
|---|---|
| * | Sample containers provided by the laboratory are pre-preserved. |
| MS | Matrix spike |
| MSD | Matrix spike duplicate |
| NA | Not applicable |
| PCBs | Polychlorinated biphenyls |
| SVOCs | Semivolatile organic compounds |
| TOC | Total organic carbon |
| VOCs | Volatile organic compounds |
| [1] | Metals analysis to include all Plant 2 site-wide groundwater and soil constituents of concern |
| [2] | Extraction of soil samples by ILM05.3, analysis of extracts by EPA 335.2. |
| [3] | Total number of samples does not include trip blanks. |
| [4] | When both SVOCs and PCBs are to be analyzed a single 8-oz wide-mouth jar may be collected and submitted for analysis. |
| [5] | Remove residual chlorine with 0.6 grams of ascorbic acid. Test for sulfide using lead acetate paper. If sulfide is present, remove with cadmium nitrate powder until a lead acetate paper spot test is negative. If sulfide is removed, field filter sample using a 0.45 $\mu$ filter prior to pH adjustment. |

**Table 3-2 Reporting Limits Compared to Screening Levels for Sitewide Constituents of Concern**
**North Area**
**Boeing Plant 2**

| | | Soil (refer to Laboratory RL Units) | | | | | | | | | | Groundwater (µg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAS Number | Analytes | Analytical Method | Laboratory RL | | Sitewide Soil COC | North Area Soil COC | Background (Metals) | Minimum Calculated Soil Screening Level | Direct Contact Screening Level | Air Pathway Screening Level | Surface Water Pathway Screening Level | Analytical Method | Laboratory RL | Sitewide Groundwater COC | North Area Groundwater COC | Minimum Calculated Groundwater Screening Level | Air Pathway Screening Level | Surface Water Pathway Screening Level |
| **Metals and Cyanide** | | | | | | | | | | | | | | | | | | |
| 7429-90-5 | Aluminum | 6010 | 5.0 | mg/kg | | | * | - - | - - | - - | - - | 6010 | 50.0 | | | - - | - - | - - |
| 7440-36-0 | Antimony | 6010 | 5.0 | mg/kg | X | | * | 4.64E+02 | 5.33E+02 | - - | 4.64E+02 | 6010 | 50.0 | | | 5.13E+02 | - - | 5.13E+02 |
| 7440-38-2 | **Arsenic** | 6010 | **5.0** | mg/kg | X | X | 7 | 1.13E-02 | 3.33E+01 | 3.22E+04 | 1.13E-02 | 200.8 | **0.2** | X | | 1.94E-02 | - - | 1.94E-02 |
| 7440-39-3 | Barium | 6010 | 0.3 | mg/kg | | | * | 9.33E+04 | 9.33E+04 | 4.62E+05 | - - | 6010 | 3.0 | | | - - | - - | - - |
| 7440-41-7 | Beryllium | 6010 | 0.1 | mg/kg | | | * | 2.22E+02 | 2.67E+03 | 2.64E+04 | 2.22E+02 | 6010 | 1.0 | | | 1.35E+02 | - - | 1.35E+02 |
| 7440-43-9 | Cadmium | 6010 | 0.2 | mg/kg | X | X | 1 | 1.21E+00 | 6.67E+02 | 7.70E+04 | 1.21E+00 | 6010 | 2.0 | X | | 8.80E+00 | - - | 8.80E+00 |
| 16065-83-1 | Chromium (III) | | | mg/kg | | | * | - - | 2.00E+06 | - - | - - | | | | | 8.82E+04 | - - | 8.82E+04 |
| 18540-29-9 | Chromium (VI) | 3500 | 0.2 | mg/kg | X | | * | 1.92E+01 | 4.00E+03 | 1.06E+04 | 1.92E+01 | 3500 | 10.0 | | | 5.00E+01 | - - | 5.00E+01 |
| 7440-47-3 | Chromium (Total) | 6010 | 0.5 | mg/kg | | | * | - - | - - | - - | - - | 6010 | 5.0 | | | - - | - - | - - |
| 7440-48-4 | Cobalt | 6010 | 0.3 | mg/kg | | | * | - - | - - | - - | - - | 6010 | 3.0 | | | - - | - - | - - |
| 7440-50-8 | Copper | 6010 | 0.2 | mg/kg | X | X | 36 | 1.38E+00 | 4.93E+04 | - - | 1.38E+00 | 200.8 | 0.5 | X | | 3.10E+00 | - - | 3.10E+00 |
| 7439-89-6 | Iron | 6010 | 5.0 | mg/kg | | | * | - - | - - | - - | - - | 6010 | 50.0 | | | - - | - - | - - |
| 7439-92-1 | Lead | 6010 | 2.0 | mg/kg | X | | 24 | 1.00E+03 | 1.00E+03 | - - | 1.62E+03 | 200.8 | 1.0 | X | | 8.10E+00 | - - | 8.10E+00 |
| 7439-95-4 | Magnesium | 6010 | 5.0 | mg/kg | | | * | - - | - - | - - | - - | 6010 | 50.0 | | | - - | - - | - - |
| 7439-96-5 | Manganese | 6010 | 0.1 | mg/kg | X | | 1,146 | 1.30E+02 | 1.87E+05 | - - | 1.30E+02 | 6010 | 1.0 | X | | 1.00E+02 | - - | 1.00E+02 |
| 7439-97-6 | **Mercury** | 7471 | **0.05** | mg/kg | X | X | 0.07 | 2.61E-02 | 4.19E+01 | 6.13E+00 | 2.61E-02 | 1631 | 0.03 | X | | 2.50E-02 | 4.64E+02 | 2.50E-02 |
| 7439-98-7 | Molybdenum | 6010 | 0.5 | mg/kg | | | * | 6.67E+03 | 6.67E+03 | - - | - - | 6010 | 5.0 | | | - - | - - | - - |
| 7440-02-0 | Nickel (soluble salts) | 6010 | 1.0 | mg/kg | X | | 48 | 1.07E+01 | 2.67E+04 | - - | 1.07E+01 | 200.8 | 0.5 | X | | 8.20E+00 | - - | 8.20E+00 |
| 7782-49-2 | Selenium | 6010 | 5.0 | mg/kg | X | | * | 7.38E+00 | 6.67E+03 | - - | 7.38E+00 | 6010 | 50.0 | X | | 7.10E+01 | - - | 7.10E+01 |
| 7440-22-4 | Silver | 6010 | 0.3 | mg/kg | X | | * | 3.23E-01 | 6.67E+03 | - - | 3.23E-01 | 200.8 | 0.5 | X | | 1.90E+00 | - - | 1.90E+00 |
| 7440-28-0 | Thallium (soluble salts) | 200.8 | 0.2 | mg/kg | X | | * | 6.69E-01 | 8.64E+01 | - - | 6.69E-01 | 200.8 | 0.2 | X | | 4.70E-01 | - - | 4.70E-01 |
| 7440-31-5 | Tin | 6010 | 1.0 | mg/kg | | | * | - - | 8.00E+05 | - - | - - | 6010 | 10.0 | | | - - | - - | - - |
| 7440-62-2 | Vanadium | 6010 | 0.3 | mg/kg | | | * | 9.33E+03 | 9.33E+03 | - - | 5.61E+04 | 6010 | 3.0 | | | 2.81E+03 | - - | 2.81E+03 |
| 7440-66-6 | Zinc | 6010 | 0.6 | mg/kg | X | X | 85 | 1.01E+02 | 4.00E+05 | - - | 1.01E+02 | 6010 | 6.0 | X | | 8.10E+01 | - - | 8.10E+01 |
| 57-12-5 | **Cyanide** | 335.2 | 0.1 | mg/kg | X | | * | 2.02E-01 | 2.67E+04 | - - | 2.02E-01 | 335.2 | **5.0** | X | | 1.00E+00 | - - | 1.00E+00 |
| **Semivolatile Organic Compounds (SVOCs) and Polychlorinated Biphenyls (PCBs)** | | | | | | | | | | | | | | | | | | |
| 83-32-9 | Acenaphthene | 8270 | 67.0 | µg/kg | | | * | 3.24E+04 | - - | - - | 3.24E+04 | 8270 | 0.1 | | | 3.18E+02 | - - | 3.18E+02 |
| 208-96-8 | Acenaphthylene | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 0.1 | | | - - | - - | - - |
| 120-12-7 | Anthracene | 8270 | 67.0 | µg/kg | | | * | 6.08E+06 | - - | - - | 6.08E+06 | 8270 | 0.1 | | | 1.28E+04 | - - | 1.28E+04 |
| 56-55-3 | **Benzo(a)anthracene** | 8270 (SIM) | 6.7 | µg/kg | X | X | * | 4.19E+01 | 3.42E+03 | - - | 4.19E+01 | 8270 (SIM) | **0.1** | X | | 5.86E-03 | - - | 5.86E-03 |
| 205-99-2 | **Benzo(b)fluoranthene** | 8270 (SIM) | 6.7 | µg/kg | X | X | * | 1.44E+02 | 3.42E+03 | - - | 1.44E+02 | 8270 (SIM) | **0.1** | X | | 5.86E-03 | - - | 5.86E-03 |
| 207-08-9 | **Benzo(k)fluoranthene** | 8270 (SIM) | 6.7 | µg/kg | X | X | * | 1.44E+02 | 3.42E+03 | - - | 1.44E+02 | 8270 (SIM) | **0.1** | X | | 5.86E-03 | - - | 5.86E-03 |
| 191-24-2 | Benzo(g,h,i)perylene | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 0.1 | | | - - | - - | - - |
| 50-32-8 | **Benzo(a)pyrene** | 8270 (SIM) | 6.7 | µg/kg | X | X | * | 1.13E+02 | 3.42E+03 | 7.95E+07 | 1.13E+02 | 8270 (SIM) | **0.1** | X | | 5.86E-03 | - - | 5.86E-03 |
| 65-85-0 | Benzoic Acid | 8270 | 670.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 10.0 | | | - - | - - | - - |
| 100-51-6 | Benzyl alcohol | 8270 | 330.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 101-55-3 | 4-Bromophenyl-phenylether | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 1.0 | | | - - | - - | - - |
| 85-68-7 | Butylbenzylphthalate | 8270 | 67.0 | µg/kg | | | * | 1.73E+05 | 1.33E+08 | - - | 1.73E+05 | 8270 | 1.0 | | | 6.20E+02 | - - | 6.20E+02 |
| 86-74-8 | Carbazole | 8270 | 67.0 | µg/kg | | | * | 1.25E+06 | 1.25E+06 | - - | - - | 8270 | 1.0 | | | - - | - - | - - |
| 106-47-8 | 4-Chloroaniline | 8270 | 200.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 3.0 | | | - - | - - | - - |
| 111-91-1 | bis(2-Chloroethoxy) Methane | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 1.0 | | | - - | - - | - - |
| 111-44-4 | Bis-(2-Chloroethyl) Ether | 8270 | 130.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 2.0 | | | - - | - - | - - |
| 59-50-7 | 4-Chloro-3-methylphenol | 8270 | 130.0 | µg/kg | | | * | 4.76E+05 | - - | - - | 4.76E+05 | 8270 | 2.0 | | | 1.83E+04 | - - | 1.83E+04 |
| 91-58-7 | 2-Chloronaphthalene | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 1.0 | | | - - | - - | - - |
| 95-57-8 | 2-Chlorophenol | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 1.0 | | | - - | - - | - - |
| 7005-72-3 | 4-Chlorophenyl-phenylether | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 1.0 | | | - - | - - | - - |
| 218-01-9 | **Chrysene** | 8270 (SIM) | 6.7 | µg/kg | X | X | * | 4.66E+01 | 3.42E+03 | - - | 4.66E+01 | 8270 (SIM) | **0.1** | X | | 5.86E-03 | - - | 5.86E-03 |
| 53-70-3 | **Dibenzo(a,h)anthracene** | 8270 (SIM) | 6.7 | µg/kg | X | | * | 2.10E+02 | 3.42E+03 | - - | 2.10E+02 | 8270 (SIM) | **0.1** | X | | 5.86E-03 | - - | 5.86E-03 |
| 132-64-9 | Dibenzofuran | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 0.1 | | | - - | - - | - - |
| 84-74-2 | Di-n-butylphthalate | 8270 | 67.0 | µg/kg | | | * | 5.09E+04 | 6.67E+07 | - - | 5.09E+04 | 8270 | 1.0 | | | 1.44E+03 | - - | 1.44E+03 |

**Table 3-2 Reporting Limits Compared to Screening Levels for Sitewide Constituents of Concern**
**North Area**
**Boeing Plant 2**

| | | Soil (refer to Laboratory RL Units) | | | | | | | | | | Groundwater (µg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAS Number | Analytes | Analytical Method | Laboratory RL | | Sitewide Soil COC | North Area Soil COC | Background (Metals) | Minimum Calculated Soil Screening Level | Direct Contact Screening Level | Air Pathway Screening Level | Surface Water Pathway Screening Level | Analytical Method | Laboratory RL | Sitewide Groundwater COC | North Area Groundwater COC | Minimum Calculated Groundwater Screening Level | Air Pathway Screening Level | Surface Water Pathway Screening Level |
| **SVOC's and PCB's (cont'd)** | | | | | | | | | | | | | | | | | | |
| 91-94-1 | 3,3'-Dichlorobenzidine | 8270 | 330.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 120-83-2 | 2,4-Dichlorophenol | 8270 | 200.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 10.0 | | | - - | - - | - - |
| 84-66-2 | Diethylphthalate | 8270 | 67.0 | µg/kg | | | * | 7.93E+04 | 5.33E+08 | - - | 7.93E+04 | 8270 | 1.0 | | | 1.41E+04 | - - | 1.41E+04 |
| 105-67-9 | 2,4-Dimethylphenol | 8270 | 200.0 | µg/kg | | | * | 2.24E+03 | 1.33E+07 | - - | 2.24E+03 | 8270 | 3.0 | X | | 2.73E+02 | - - | 2.73E+02 |
| 131-11-3 | Dimethylphthalate | 8270 | 67.0 | µg/kg | | | * | 1.69E+05 | 6.67E+08 | - - | 1.69E+05 | 8270 | 1.0 | | | 3.56E+04 | - - | 3.56E+04 |
| 534-52-1 | 4,6-Dinitro-2-methylphenol | 8270 | 670.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 10.0 | | | - - | - - | - - |
| 117-84-0 | Di-n-octylphthalate | 8270 | 67.0 | µg/kg | | | * | 1.33E+07 | 1.33E+07 | - - | - - | 8270 | 1.0 | | | - - | - - | - - |
| 51-28-5 | 2,4-Dinitrophenol | 8270 | 670.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 10.0 | | | - - | - - | - - |
| 121-14-2 | 2,4-Dinitrotoluene | 8270 | 330.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 606-20-2 | 2,6-Dinitrotoluene | 8270 | 330.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 117-81-7 | **bis(2-Ethylhexyl)phthalate** | 8270 | 67.0 | µg/kg | X | | * | 1.57E+03 | 1.79E+06 | - - | 1.57E+03 | 8270 | **3.0** | X | | 7.05E-01 | - - | 7.05E-01 |
| 206-44-0 | Fluoranthene | 8270 | 67.0 | µg/kg | X | | * | 4.40E+04 | 2.67E+07 | - - | 4.40E+04 | 8270 | 0.1 | | | 4.46E+01 | - - | 4.46E+01 |
| 86-73-7 | Fluorene | 8270 | 67.0 | µg/kg | | | * | 2.70E+05 | 2.67E+07 | - - | 2.70E+05 | 8270 | 0.1 | | | 1.71E+03 | - - | 1.71E+03 |
| 118-74-1 | Hexachlorobenzene | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 1.0 | | | - - | - - | - - |
| 77-47-4 | Hexachlorocyclopentadiene | 8270 | 330.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 67-72-1 | Hexachloroethane | 8270 | 130.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 2.0 | | | - - | - - | - - |
| 193-39-5 | **Indeno(1,2,3-cd)pyrene** | 8270 (SIM) | 6.7 | µg/kg | X | X | * | 4.06E+02 | 3.42E+03 | - - | 4.06E+02 | 8270 (SIM) | **0.1** | X | | 5.86E-03 | - - | 5.86E-03 |
| 78-59-1 | Isophorone | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 1.0 | | | - - | - - | - - |
| 91-57-6 | 2-Methylnaphthalene | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 0.1 | | | - - | - - | - - |
| 95-48-7 | 2-Methylphenol | 8270 | 67.0 | µg/kg | | | * | 5.93E+04 | 3.33E+07 | - - | 5.93E+04 | 8270 | 1.0 | | | 1.02E+04 | - - | 1.02E+04 |
| 106-44-5 | 4-Methylphenol | 8270 | 67.0 | µg/kg | | | * | 1.31E+04 | 3.33E+06 | - - | 1.31E+04 | 8270 | 1.0 | | | 1.03E+03 | - - | 1.03E+03 |
| 88-74-4 | 2-Nitroaniline | 8270 | 330.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 99-09-2 | 3-Nitroaniline | 8270 | 400.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 100-01-6 | 4-Nitroaniline | 8270 | 330.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 98-95-3 | Nitrobenzene | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 1.0 | | | - - | - - | - - |
| 88-75-5 | 2-Nitrophenol | 8270 | 330.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 100-02-7 | 4-Nitrophenol | 8270 | 330.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 621-64-7 | N-Nitroso-di-n-propylamine | 8270 | 130.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 2.0 | | | - - | - - | - - |
| 86-30-6 | N-Nitrosodiphenylamine | 8270 | 67.0 | µg/kg | | | * | 5.10E+06 | 5.10E+06 | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 108-60-1 | 2,2'-Oxybis(1-Chloropropane) | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 1.0 | | | - - | - - | - - |
| 87-86-5 | Pentachlorophenol | 8270 | 330.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 85-01-8 | Phenanthrene | 8270 | 67.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 0.1 | | | - - | - - | - - |
| 108-95-2 | Phenol | 8270 | 130.0 | µg/kg | | | * | 1.26E+06 | 2.00E+08 | - - | 1.26E+06 | 8270 | 2.0 | | | 2.75E+05 | - - | 2.75E+05 |
| 129-00-0 | Pyrene | 8270 | 67.0 | µg/kg | | | * | 1.75E+06 | 2.00E+07 | - - | 1.75E+06 | 8270 | 0.1 | | | 1.28E+03 | - - | 1.28E+03 |
| 95-95-4 | 2,4,5-Trichlorophenol | 8270 | 330.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 88-06-2 | 2,4,6-Trichlorophenol | 8270 | 330.0 | µg/kg | | | * | - - | - - | - - | - - | 8270 | 5.0 | | | - - | - - | - - |
| 12674-11-2 | Aroclor 1016 | 8082 | 33.0 | µg/kg | | | * | - - | - - | - - | - - | 8082 | 0.01 | | | - - | - - | - - |
| - | **Aroclor 1016/1242** | 8082 | **33.0** | µg/kg | X | | * | 1.38E-01 | 4.67E+04 | - - | 1.38E-01 | 8082 | **0.01** | X | | 6.40E-05 | - - | 6.40E-05 |
| 11104-28-2 | Aroclor 1221 | 8082 | 33.0 | µg/kg | | | * | - - | - - | - - | - - | 8082 | 0.01 | | | - - | - - | - - |
| 11141-16-5 | Aroclor 1232 | 8082 | 33.0 | µg/kg | | | * | - - | - - | - - | - - | 8082 | 0.01 | | | - - | - - | - - |
| 53469-21-9 | Aroclor 1242 | 8082 | 33.0 | µg/kg | X | X | * | 1.38E-01 | 4.67E+04 | - - | 1.38E-01 | 8082 | 0.01 | | | - - | - - | - - |
| 12672-29-6 | **Aroclor 1248** | 8082 | **33.0** | µg/kg | X | X | * | - - | - - | - - | - - | 8082 | 0.01 | | | - - | - - | - - |
| 11097-69-1 | **Aroclor 1254** | 8082 | **33.0** | µg/kg | X | X | * | 1.08E+00 | 1.33E+04 | - - | 1.08E+00 | 8082 | **0.01** | X | | 6.40E-05 | - - | 6.40E-05 |
| 11096-82-5 | **Aroclor 1260** | 8082 | **33.0** | µg/kg | X | | * | 1.05E+00 | - - | - - | 1.05E+00 | 8082 | **0.01** | X | | 6.40E-05 | - - | 6.40E-05 |
| 37324-23-5 | Aroclor 1262 | 8082 | 33.0 | µg/kg | | | * | - - | - - | - - | - - | 8082 | 0.01 | | | - - | - - | - - |
| 11100-14-4 | **Aroclor 1268** | 8082 | 33.0 | µg/kg | | | * | - - | - - | - - | - - | 8082 | **0.01** | | | 6.40E-05 | - - | 6.40E-05 |
| - | **Total PCBs** | 8082 | **33.0** | µg/kg | X | X | * | - - | - - | - - | 3.96E-01 | 8082 | **0.01** | X | | 6.40E-05 | - - | 6.40E-05 |
| **Volatile Organic Compounds (VOCs)** | | | | | | | | | | | | | | | | | | |
| 67-64-1 | Acetone | 8260 | 5.0 | µg/kg | | | * | 3.55E+05 | 3.05E+08 | 3.55E+05 | - - | 8260 | 1.0 | | | 6.43E+06 | 6.43E+06 | - - |
| 107-02-8 | Acrolein | 8260 | 50.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 5.0 | | | - - | - - | - - |

**Table 3-2 Reporting Limits Compared to Screening Levels for Sitewide Constituents of Concern**
**North Area**
**Boeing Plant 2**

| | | Soil (refer to Laboratory RL Units) | | | | | | | | | | Groundwater (µg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAS Number | Analytes | Analytical Method | Laboratory RL | | Sitewide Soil COC | North Area Soil COC | Background (Metals) | Minimum Calculated Soil Screening Level | Direct Contact Screening Level | Air Pathway Screening Level | Surface Water Pathway Screening Level | Analytical Method | Laboratory RL | Sitewide Groundwater COC | North Area Groundwater COC | Minimum Calculated Groundwater Screening Level | Air Pathway Screening Level | Surface Water Pathway Screening Level |
| **VOC's (cont'd)** | | | | | | | | | | | | | | | | | | |
| 107-13-1 | Acrylonitrile | 8260 | 5.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 71-43-2 | Benzene | 8260 | 1.0 | µg/kg | X | | * | 2.53E+01 | 1.36E+06 | 5.05E+02 | 2.53E+01 | 8260 | 0.2 | X | | 4.48E+00 | 3.83E+03 | 4.48E+00 |
| 108-86-1 | Bromobenzene | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 74-97-5 | Bromochloromethane | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 75-27-4 | Bromodichloromethane | 8260 | 1.0 | µg/kg | | | * | 2.88E+01 | 8.80E+05 | 1.49E+02 | 2.88E+01 | 8260 | 0.2 | | | 5.52E+00 | 2.69E+03 | 5.52E+00 |
| 74-96-4 | Bromoethane | 8260 | 2.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 75-25-2 | Bromoform | 8260 | 1.0 | µg/kg | | | * | 2.84E+02 | 8.11E+07 | 1.33E+06 | 2.84E+02 | 8260 | 0.2 | | | 4.33E+01 | 1.19E+05 | 4.33E+01 |
| 74-83-9 | Bromomethane | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 78-93-3 | 2-Butanone | 8260 | 5.0 | µg/kg | | | * | 8.02E+05 | 1.19E+09 | 8.02E+05 | - - | 8260 | 1.0 | | | 1.49E+07 | 1.49E+07 | - - |
| 104-51-8 | n-Butylbenzene | 8260 | 1.0 | µg/kg | X | | * | 4.64E+03 | - - | 4.64E+03 | - - | 8260 | 0.2 | | | 8.63E+06 | 8.63E+06 | - - |
| 135-98-8 | sec-Butylbenzene | 8260 | 1.0 | µg/kg | X | | * | 7.86E+03 | - - | 7.86E+03 | - - | 8260 | 0.2 | | | 4.40E+08 | 4.40E+08 | - - |
| 98-06-6 | tert-Butylbenzene | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 75-15-0 | Carbon Disulfide | 8260 | 1.0 | µg/kg | | | * | 3.64E+03 | 6.40E+07 | 3.64E+03 | - - | 8260 | 0.2 | | | 3.43E+04 | 3.43E+04 | - - |
| 56-23-5 | Carbon Tetrachloride | 8260 | 1.0 | µg/kg | | | * | 4.84E+00 | 5.73E+05 | 1.93E+02 | 4.84E+00 | 8260 | 0.2 | X | | 5.26E-01 | 4.08E+02 | 5.26E-01 |
| 108-90-7 | Chlorobenzene | 8260 | 1.0 | µg/kg | X | | * | 1.85E+03 | 2.91E+07 | 1.85E+03 | 1.40E+04 | 8260 | 0.2 | | | 1.60E+03 | 1.00E+04 | 1.60E+03 |
| 75-00-3 | Chloroethane | 8260 | 1.0 | µg/kg | | | * | 2.77E+02 | - - | 2.77E+02 | - - | 8260 | 0.2 | | | 4.05E+03 | 4.05E+03 | - - |
| 67-66-3 | Chloroform | 8260 | 1.0 | µg/kg | X | | * | 1.40E+02 | 7.03E+06 | 2.04E+02 | 2.98E+02 | 8260 | 0.2 | | | 5.61E+01 | 1.70E+03 | 5.61E+01 |
| 110-75-8 | 2-Chloroethylvinylether | 8260 | 5.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.5 | | | - - | - - | - - |
| 74-87-3 | Chloromethane | 8260 | 1.0 | µg/kg | | | * | 1.78E+03 | 4.63E+08 | 1.61E+03 | - - | 8260 | 0.2 | X | | 2.63E+01 | 8.02E+03 | 2.63E+01 |
| 95-49-8 | 2-Chlorotoluene | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 106-43-4 | 4-Chlorotoluene | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 124-48-1 | Dibromochloromethane | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 74-95-3 | Dibromomethane | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 96-12-8 | 1,2-Dibromo-3-chloropropane | 8260 | 5.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 2.0 | | | - - | - - | - - |
| 95-50-1 | 1,2-Dichlorobenzene | 8260 | 1.0 | µg/kg | | | * | 1.52E+04 | 1.54E+08 | 1.67E+06 | 1.52E+04 | 8260 | 0.2 | | | 1.30E+03 | - - | 1.30E+03 |
| 541-73-1 | 1,3-Dichlorobenzene | 8260 | 1.0 | µg/kg | | | * | 1.24E+04 | - - | 1.14E+05 | 1.24E+04 | 8260 | 0.2 | | | 9.60E+02 | - - | 9.60E+02 |
| 106-46-7 | 1,4-Dichlorobenzene | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 110-57-6 | trans-1,4-Dichloro-2-butene | 8260 | 5.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 1.0 | | | - - | - - | - - |
| 75-34-3 | 1,1-Dichloroethane | 8260 | 1.0 | µg/kg | | | * | 4.52E+04 | 6.69E+07 | 4.24E+04 | - - | 8260 | 0.2 | | | 4.27E+05 | 4.27E+05 | - - |
| 107-06-2 | 1,2-Dichloroethane | 8260 | 1.0 | µg/kg | | | * | 5.67E+01 | 8.19E+05 | 5.20E+02 | 5.67E+01 | 8260 | 0.2 | X | | 1.17E+01 | 4.91E+03 | 1.17E+01 |
| 75-35-4 | 1,1-Dichloroethene | 8260 | 1.0 | µg/kg | X | | * | 2.73E+00 | 1.24E+05 | 5.80E+01 | 2.73E+00 | 8260 | 0.2 | X | | 3.82E-01 | 1.23E+02 | 3.82E-01 |
| 156-59-2 | cis-1,2-Dichloroethene | 8260 | 1.0 | µg/kg | X | | * | 7.94E+02 | 7.99E+06 | 7.94E+02 | 7.73E+03 | 8260 | 0.2 | X | | 1.55E+03 | 1.51E+04 | 1.55E+03 |
| 156-60-5 | trans-1,2-Dichloroethene | 8260 | 1.0 | µg/kg | X | | * | 9.06E+03 | 1.31E+07 | 8.21E+03 | 5.43E+04 | 8260 | 0.2 | | | 1.00E+04 | 5.38E+04 | 1.00E+04 |
| 540-59-0 | 1,2-Dichloroethene (total) | 8260 | - | µg/kg | | | * | 1.79E+07 | 1.79E+07 | - - | - - | 8260 | - | | | - - | - - | - - |
| 78-87-5 | 1,2-Dichloropropane | 8260 | 1.0 | µg/kg | | | * | 2.36E+01 | 8.02E+05 | 6.92E+01 | 2.36E+01 | 8260 | 0.2 | | | 4.60E+00 | - - | 4.60E+00 |
| 142-28-9 | 1,3-Dichloropropane | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 594-20-7 | 2,2-Dichloropropane | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 563-58-6 | 1,1-Dichloropropene | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 10061-01-5 | cis-1,3-Dichloropropene | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 10061-02-6 | trans-1,3-Dichloropropene | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 100-41-4 | Ethylbenzene | 8260 | 1.0 | µg/kg | X | | * | 2.52E+03 | 1.45E+08 | - - | 1.81E+04 | 8260 | 0.2 | X | | 2.10E+03 | - - | 2.10E+03 |
| 106-93-4 | Ethylene Dibromide | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 87-68-3 | Hexachlorobutadiene | 8260 | 5.0 | µg/kg | | | * | 6.38E+03 | 2.91E+05 | 8.89E+03 | 6.38E+03 | 8260 | 0.5 | | | 5.91E+00 | - - | 5.91E+00 |
| 591-78-6 | 2-Hexanone | 8260 | 5.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 1.0 | | | - - | - - | - - |
| 98-82-8 | Isopropylbenzene | 8260 | 1.0 | µg/kg | X | | * | 4.98E+04 | 1.45E+08 | - - | - - | 8260 | 0.2 | | | 4.80E+04 | - - | - - |
| 99-87-6 | 4-Isopropyltoluene | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 75-09-2 | Methylene Chloride | 8260 | 2.0 | µg/kg | X | | * | 8.28E+02 | 9.94E+06 | 1.21E+04 | 8.28E+02 | 8260 | 0.3 | X | | 1.90E+02 | 1.32E+05 | 1.90E+02 |
| 74-88-4 | Methyl Iodide | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 108-10-1 | 4-Methyl-2-Pentanone | 8260 | 5.0 | µg/kg | | | * | 3.55E+04 | 1.16E+08 | 3.55E+04 | - - | 8260 | 1.0 | | | 1.56E+09 | 1.56E+09 | - - |
| 91-20-3 | Naphthalene | 8260 | 5.0 | µg/kg | X | | * | 3.94E+04 | 1.44E+07 | 9.82E+04 | 6.80E+04 | 8260 | 0.5 | | | 2.44E+03 | - - | 2.44E+03 |

**Table 3-2 Reporting Limits Compared to Screening Levels for Sitewide Constituents of Concern**
**North Area**
**Boeing Plant 2**

| | | Soil (refer to Laboratory RL Units) | | | | | | | | | | Groundwater (µg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CAS Number** | **Analytes** | **Analytical Method** | **Laboratory RL** | | **Sitewide Soil COC** | **North Area Soil COC** | **Background (Metals)** | **Minimum Calculated Soil Screening Level** | **Direct Contact Screening Level** | **Air Pathway Screening Level** | **Surface Water Pathway Screening Level** | **Analytical Method** | **Laboratory RL** | **Sitewide Groundwater COC** | **North Area Groundwater COC** | **Minimum Calculated Groundwater Screening Level** | **Air Pathway Screening Level** | **Surface Water Pathway Screening Level** |
| **VOC's (cont'd)** | | | | | | | | | | | | | | | | | | |
| 103-65-1 | n-Propylbenzene | 8260 | 1.0 | µg/kg | X | | * | 1.36E+04 | - - | 1.36E+04 | - - | 8260 | 0.2 | | | 4.00E+04 | 4.00E+04 | - - |
| 100-42-5 | Styrene | 8260 | 1.0 | µg/kg | | | * | 7.10E+01 | 1.82E+06 | 4.65E+05 | 7.10E+01 | 8260 | 0.2 | | | 3.17E+00 | - - | 3.17E+00 |
| 630-20-6 | 1,1,1,2-Tetrachloroethane | 8260 | 1.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 79-34-5 | 1,1,2,2-Tetrachloroethane | 8260 | 1.0 | µg/kg | X | | * | 7.19E+00 | 2.73E+05 | 1.39E+03 | 7.19E+00 | 8260 | 0.2 | | | 1.28E+00 | 6.18E+03 | 1.28E+00 |
| 127-18-4 | Tetrachloroethene | 8260 | 1.0 | µg/kg | X | | * | 8.72E+00 | 1.07E+06 | 4.89E+02 | 8.72E+00 | 8260 | 0.2 | X | | 8.22E-01 | 1.88E+03 | 8.22E-01 |
| 108-88-3 | Toluene | 8260 | 1.0 | µg/kg | X | | * | 1.90E+04 | 1.34E+08 | - - | 1.09E+05 | 8260 | 0.2 | | | 1.50E+04 | - - | 1.50E+04 |
| 87-61-6 | 1,2,3-Trichlorobenzene | 8260 | 5.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.5 | | | - - | - - | - - |
| 120-82-1 | 1,2,4-Trichlorobenzene | 8260 | 5.0 | µg/kg | | | * | 4.19E+03 | 1.45E+07 | 1.77E+05 | 4.19E+03 | 8260 | 0.5 | | | 1.12E+02 | - - | 1.12E+02 |
| 71-55-6 | 1,1,1-Trichloroethane | 8260 | 1.0 | µg/kg | X | | * | 2.78E+04 | 4.12E+08 | - - | 1.63E+06 | 8260 | 0.2 | | | 2.06E+05 | 1.33E+06 | 2.06E+05 |
| 79-00-5 | 1,1,2-Trichloroethane | 8260 | 1.0 | µg/kg | X | | * | 2.78E+01 | 9.57E+05 | 1.31E+03 | 2.78E+01 | 8260 | 0.2 | X | | 5.00E+00 | 9.40E+03 | 5.00E+00 |
| 79-01-6 | Trichloroethene | 8260 | 1.0 | µg/kg | X | X | * | 2.00E+00 | 1.36E+05 | 3.60E+01 | 2.00E+00 | 8260 | 0.2 | X | | 3.02E-01 | 1.58E+02 | 3.02E-01 |
| 75-69-4 | Trichlorofluoromethane | 8260 | 1.0 | µg/kg | | | * | 5.71E+03 | 5.96E+08 | 5.71E+03 | - - | 8260 | 0.2 | | | 1.16E+04 | 1.16E+04 | - - |
| 76-13-1 | 1,1,2-Trichlorotrifluoroethane | 8260 | 2.0 | µg/kg | | | * | 8.76E+05 | 5.96E+10 | 8.76E+05 | - - | 8260 | 0.2 | | | 1.17E+05 | 1.17E+05 | - - |
| 95-63-6 | 1,2,4-Trimethylbenzene | 8260 | 1.0 | µg/kg | X | | * | 4.03E+03 | 7.27E+07 | 1.01E+04 | - - | 8260 | 0.2 | | | 8.81E+03 | 8.81E+03 | - - |
| 108-67-8 | 1,3,5-Trimethylbenzene | 8260 | 1.0 | µg/kg | X | | * | 4.21E+03 | 7.27E+07 | - - | - - | 8260 | 0.2 | | | 1.73E+03 | - - | - - |
| 108-05-4 | Vinyl Acetate | 8260 | 5.0 | µg/kg | | | * | - - | - - | - - | - - | 8260 | 0.2 | | | - - | - - | - - |
| 75-01-4 | Vinyl Chloride | 8260 | 1.0 | µg/kg | X | | * | 4.59E+00 | 4.97E+04 | 3.31E+02 | 4.59E+00 | 8260 | 0.2 | X | X | 7.31E-01 | 5.94E+02 | 7.31E-01 |
| - | m,p-Xylene | 8260 | 1.0 | µg/kg | | | * | 2.91E+09 | 2.91E+09 | - - | - - | 8260 | 0.4 | | | - - | - - | - - |
| 95-47-6 | o-Xylene | 8260 | 1.0 | µg/kg | | | * | 1.43E+05 | 3.92E+08 | 1.43E+05 | - - | 8260 | 0.2 | | | 4.01E+04 | 4.01E+04 | - - |
| 1330-20-7 | Total Xylenes | 8260 | - | µg/kg | | | * | 2.91E+08 | 2.91E+08 | - - | - - | 8260 | - | | | - - | - - | - - |
| **Total Petroleum Hydrocarbons (TPH)** | | | | | | | | | | | | | | | | | | |
| - | TPH - Diesel Range | NWTPH-D | 5 | mg/kg | X | | * | 2.00E+03 | 2.00E+03 | | | NWTPH-D | 500 | X | | 5.00E+02 | 5.00E+02 | |
| - | TPH - Mineral Spirits Range | NWTPH-Dx | 5 | mg/kg | X | | * | 2.00E+03 | 2.00E+03 | | | NWTPH-Dx | 250 | | | - - | - - | - - |
| - | TPH - Oil Range | NWTPH-Dx | 10 | mg/kg | X | | * | 2.00E+03 | 2.00E+03 | | | NWTPH-Dx | 500 | X | X | 5.00E+02 | 5.00E+02 | |
| - | TPH - Gasoline Range | NWPTH-G | 5 | mg/kg | X | | * | 3.00E+01 | 3.00E+01 | | | NWPTH-G | 250 | X | | 8.00E+02 | 8.00E+02 | |

Notes:
**Bolded** analytes have reporting limits above lowest risk based calculation. Screening levels were adjusted on Table 2-1 accordingly. Analytes measured by the 8270 (SIM) method are also included in the 8270 analysis, but at a higher RL.
- No CAS number available
* 1994 Ecology calculated one natural background concentration for the Puget sound basin. Does not apply to constituent

**Boeing Plant 2**
**Seattle/Tukwila, Washington**

# Uplands Corrective Measures
# Volume VIIa: North Area

# Data Gap Investigation Work Plan

# Figures

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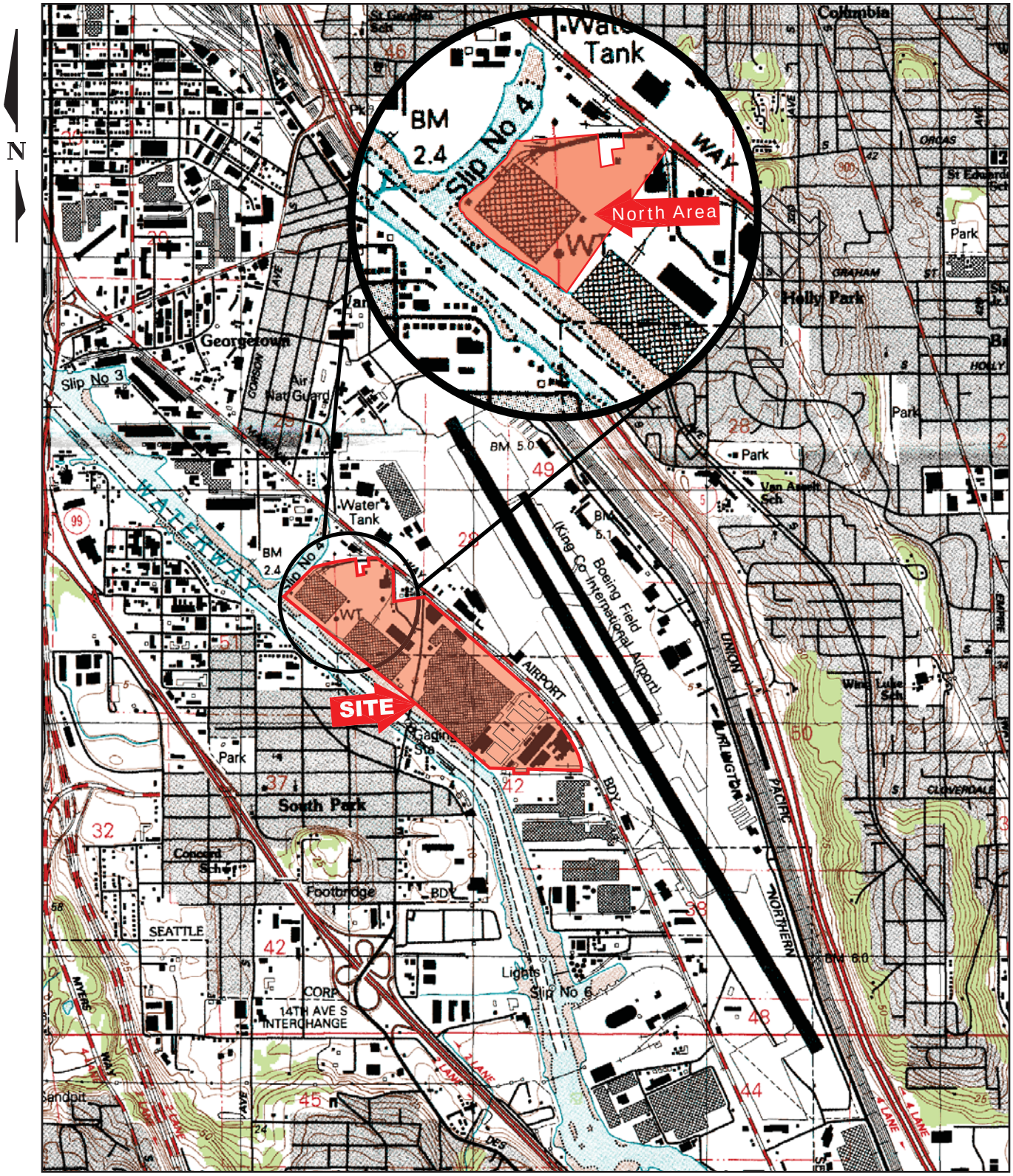


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| SHEET | DRAWN BY | REVIEWED BY | DATE |
|---|---|---|---|
| 1 of 1 | AMP | TN | 10/01/07 |

**Data Gaps Investigation Work Plan**
**North Area**
**Boeing Plant 2**
**Seattle/Tukwila, Washington**

**Figure 1-1**
**Vicinity Map**

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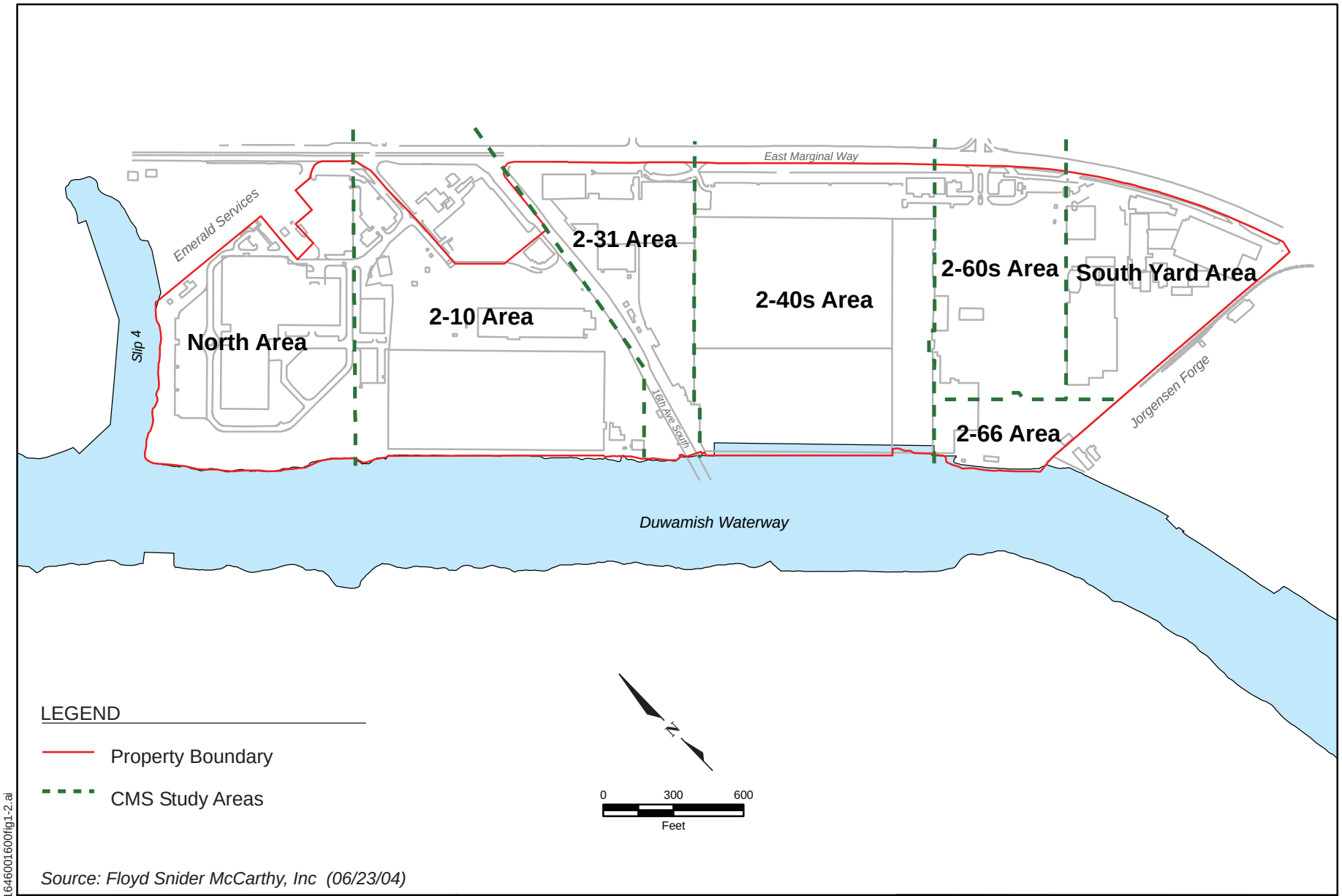


*Source: Floyd Snider McCarthy, Inc (06/23/04)*

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| TN | 04/02/08 |

**Data Gaps Investigation Work Plan**
**North Area**
**Boeing Plant 2**
**Seattle/Tukwila, Washington**

**Figure 1-2**
**Site Plan with CMS Study Areas**

DRAWING NO. 0131646001600fig1-2.ai

EMERALD SERVICE, INC.

Bldg 2-122

Bldg 2-124

SLIP 4

2-10 AREA

SWMU 2-01.1
Landing Gear
Cleaning Sump
*(Closed)*

WASTE CONTAINMENT
STRUCTURE

DUWAMISH WATERWAY

N

0 120 240

SCALE IN FEET

## LEGEND

CLOSED UNDER ECOLOGY NFA
APPROXIMATELY RCRA UNIT FOR SOIL

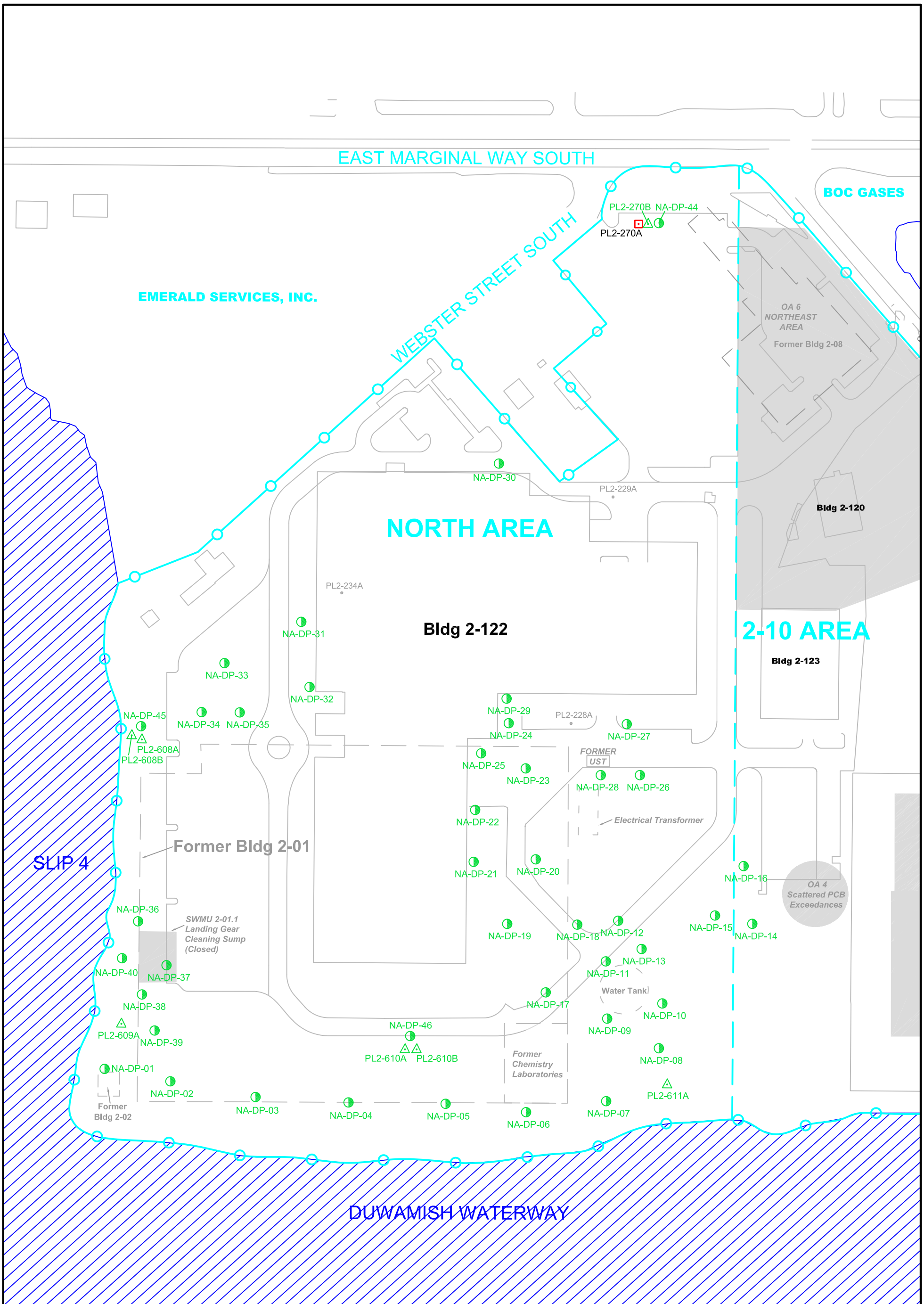
PLANT 2 SUB-AREA BOUNDARY

| SHEET | DRAWN BY |
|---|---|
| 1 OF 1 | KAN |
| REVIEWED BY | DATE |
| TN | 9/7/2007 |

**DATA GAPS INVESTIGATION WORK PLAN**
**NORTH AREA**
**BOEING PLANT 2**
**SEATTLE/TUKWILA, WASHINGTON**

**FIGURE 1-3**
**NORTH AREA**

K:□CAD□Projects□2001□0131646□x004□100□013_1646_004_100_F1-3.dwg | 11x17 | Mod: 09/07/2007, 12:37 | Plotted: 09/07/2007, 12:38 | KNewby




KEY:

- WELL SAMPLED FOR DATA GAPS
- PROPOSED MONITORING WELL LOCATION
- PROPOSED DIRECT PUSH PROBE LOCATION
- AREA BOUNDARY
- PROPERTY BOUNDARY
- DECOMMISSIONED WELL
- RCRA REGULATED UNIT

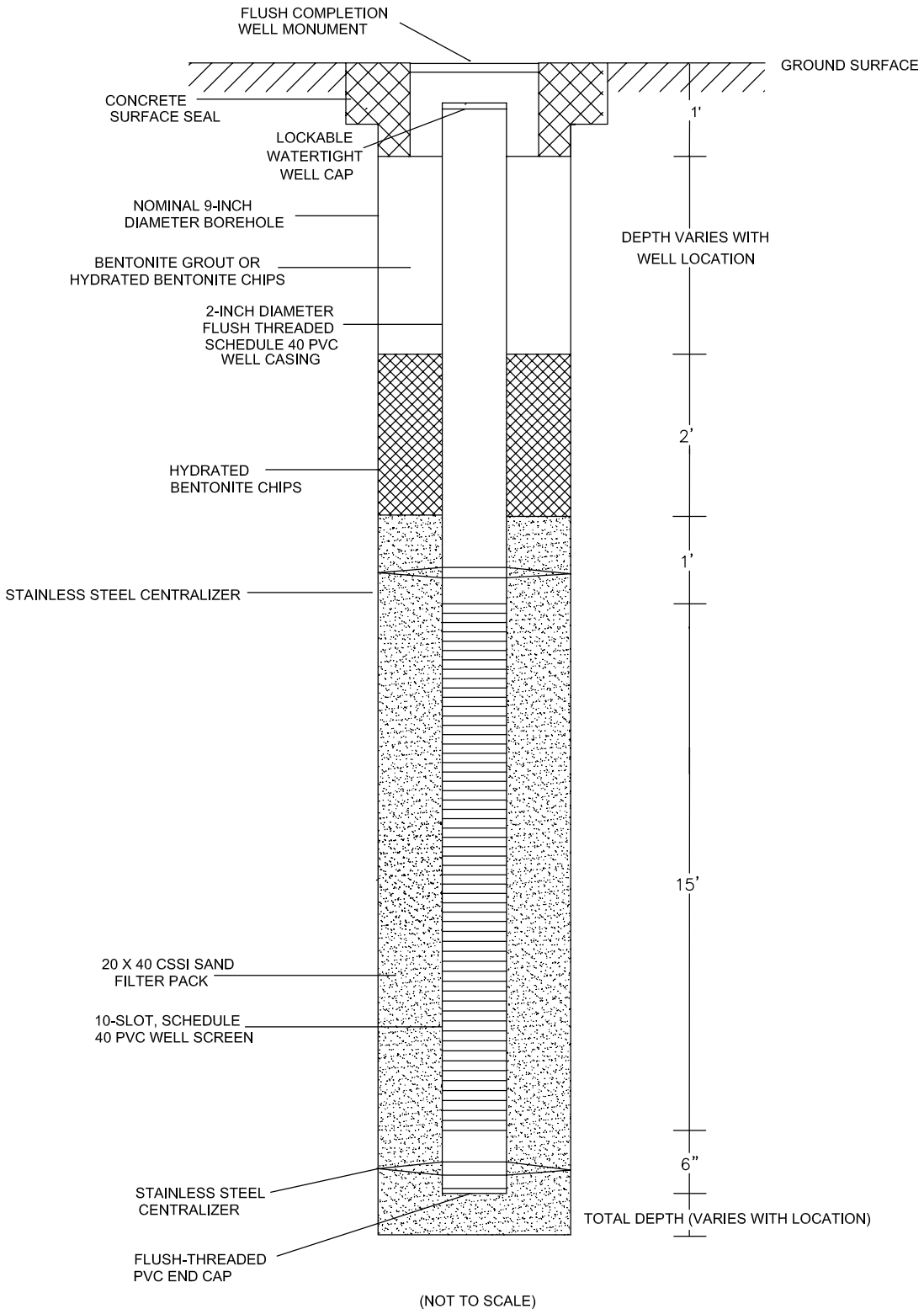
0 30' 60' 120'
SCALE: 1" = 120'

ENVIRONMENTAL PARTNERS INC
295 NE Gilman Boulevard, Suite 201
Issaquah, Washington 98027

**FIGURE 2-1**
**NORTH AREA**
**GROUNDWATER AND SOIL**
**DATA GAP SAMPLING LOCATIONS**

| | |
|---|---|
| PROJECT | BOEING PLANT 2 |
| PREPARED FOR | THE BOEING COMPANY |
| LOCATION | 7725 EAST MARGINAL WAY SEATTLE/TUKWILA, WASHINGTON |

| SHEET | DRAWN BY | REVIEWED BY | DATE |
|---|---|---|---|
| 1 of 1 | MMH | DCK | 03/31/08 |



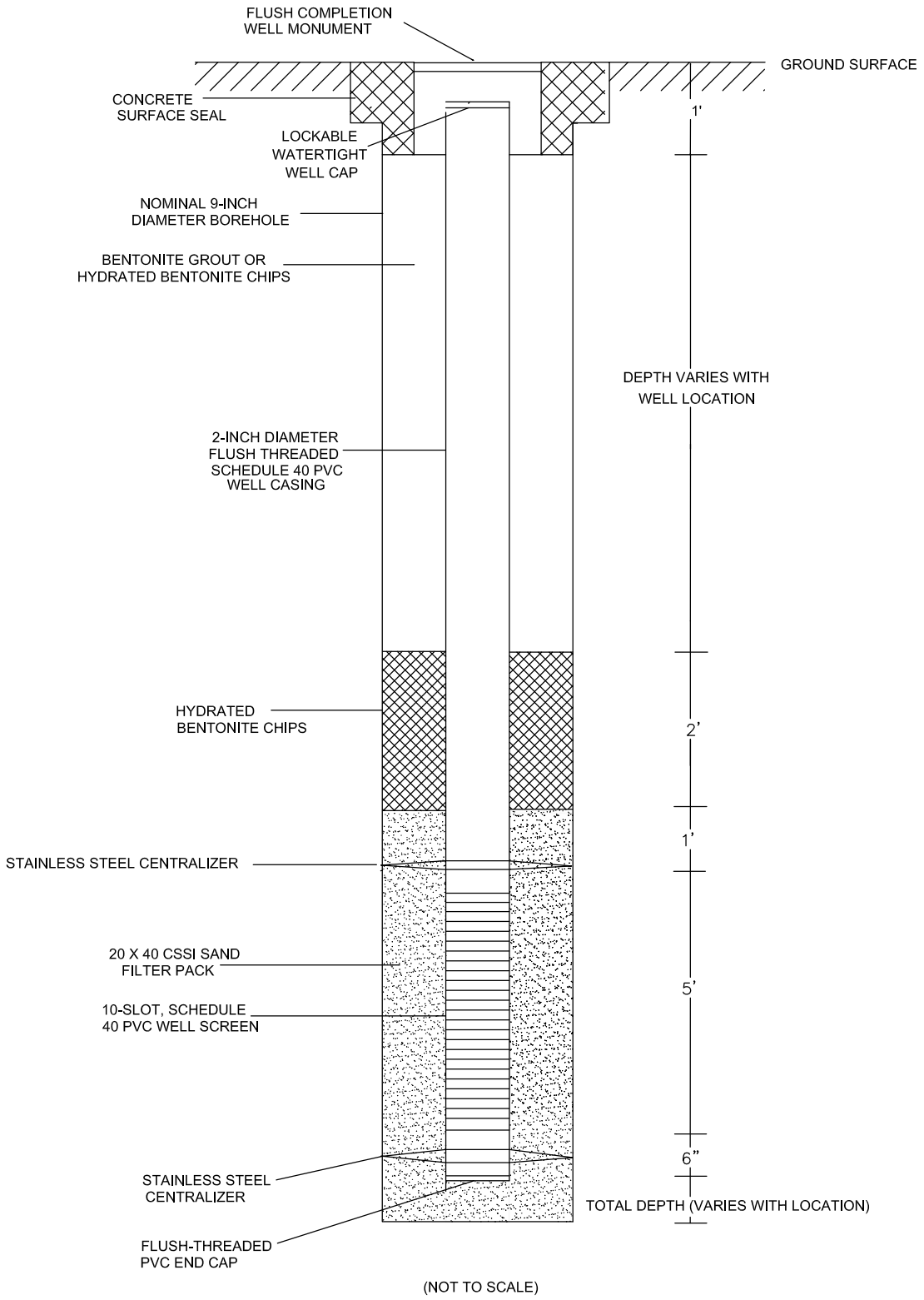

K:\CAD\Projects\2001\0131646\x004\100\013_1646_004_100_F02.dwg 08/16/2007, 13:16 Layout: FIG_3-1

ENVIRONMENTAL PARTNERS INC

| SHEET | DRAWN BY | REVIEWED BY | DATE |
|---|---|---|---|
| 1 of 1 | TJN | DCK | 8/16/07 |

Data Gaps Investigation Work Plan
North Area
Boeing Plant 2
Seattle/Tukwila, Washington

Figure 3-1
Generalized Shallow Monitoring Well Construction Drawing




ENVIRONMENTAL PARTNERS INC

| SHEET | DRAWN BY | REVIEWED BY | DATE |
|---|---|---|---|
| 1 of 1 | TJN | DCK | 04/02/08 |

Data Gaps Investigation Work Plan
2-66 Area
Boeing Plant 2
Seattle/Tukwila, Washington

Figure 3-2
Generalized Deeper Monitoring Well Construction Drawing

K:\CAD\Projects\2001\0131646\x004\100\r1\013_1646_004_100_F02_r1.dwg 03/31/2008, 09:46 Layout: FIG_3-2

**Boeing Plant 2**
**Seattle/Tukwila, Washington**

# Uplands Corrective Measures
# Volume VIIa: North Area

# Data Gap Investigation Work Plan

# Attachment A
# Groundwater Constituents of Concern

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# Table of Contents

**A1.0 Groundwater Constituents of Concern A-1**

A1.1 IDENTIFICATION OF COCS ..... A-1

A1.2 SPATIAL DISTRIBUTION OF COCS ..... A-1

A1.3 DATA TABLES ..... A-1

# List of Tables

Table A-1 Screening Levels for Constituents of Concern in Site-wide Groundwater

Table A-2 Constituents of Concern Detected in Groundwater

Table A-3 Explanation of Data Qualifiers

# List of Maps

Vinyl Chloride Concentrations in A-Level Groundwater

TPH-Oil Concentrations in A-Level Groundwater

# List of Data Tables

North Area – Vinyl Chloride Maximum Concentrations in Groundwater

North Area – TPH Oil Maximum Concentrations in Groundwater

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# A1.0 Groundwater Constituents of Concern

This attachment includes groundwater data information for the North Area of Boeing Plant 2 (Plant 2). This information was used to prepare Section 2, Data Gap Analysis, of this Data Gap Investigation Work Plan and includes: tables summarizing site-wide and North Area groundwater COCs, maps showing the distribution of COCs in the different groundwater zones of the North Area, and data tables for each groundwater COC.

## A1.1 IDENTIFICATION OF COCS

Table A-1 summarizes the screening levels for the site-wide groundwater COCs. All accepted groundwater data including any qualified data compiled since 1986 were used to prepare the table. A COC was identified when laboratory analysis of a sample resulted in a concentration greater than the screening level at least once in any groundwater zone at the site. Table A-1 also includes the risk calculation for the groundwater-to-air and groundwater-to-surface water pathways. As discussed in detail in Volume II, screening levels for groundwater are the same as risk calculation results. At the time of this submittal, background metal concentrations for Plant 2 have not been determined, so a blank column is included in the table as a placeholder. Background metals concentrations will be used to revise screening levels when the values are available later in the CMS process. Because no risk information is available, the TPH screening level was established according to the Model Toxics Control Act (MTCA) Method A.

Table A-2 presents the current groundwater COCs for the North Area. COCs were identified by the same method as described above for Table A-1. All accepted groundwater data, including any qualified data compiled from the North Area since 1989 collected under the agreed order, were used to prepare the table.

## A1.2 SPATIAL DISTRIBUTION OF COCS

Included in this attachment are maps showing the spatial distribution of each COC in Level A groundwater of the North Area. The accepted maximum concentration of each COC was used to generate the maps. If a constituent was never detected at a particular location, then the reporting limit and date for the most recent non-detects is presented along with the number of times the constituent was sampled at that location. All maps are oriented according to “plant” north.

## A1.3 DATA TABLES

The data tables show all of the accepted maximum concentrations for each groundwater COC and the three soil COCs mentioned above. The data tables include data from the A level groundwater regardless of the frequency of detection. The B and C levels of the aquifer have not been sampled to date.

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**Boeing Plant 2**
**Seattle/Tukwila, Washington**

# Uplands Corrective Measures
# Volume VIIa: North Area

# Data Gap Investigation Work Plan

# Attachment A
# Tables

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**Table A-1 Screening Levels for Constituents of Concern in Site-wide Groundwater**
**North Area**
**Boeing Plant 2**

| CAS Number | Constituent of Concern | Maximum Detect (µg/l) | Laboratory RL (µg/l) | Air Screening Level (µg/l) | Lowest Air Screening Level (µg/l) | Surface Water Screening Level (µg/l) | Lowest Surface Water Screening Level (µg/l) |
|---|---|---|---|---|---|---|---|
| **Metals and Cyanide** | | | | | | | |
| 7440-38-2 | Arsenic | 1.30E+02 | 2.00E-01 | - - | - - | ***1.94E-02*** | ***2.00E-01*** |
| 7440-43-9 | Cadmium | 1.89E+02 | 2.00E+00 | - - | - - | ***7.35E+00*** | ***7.35E+00*** |
| 7440-50-8 | Copper | 1.35E+02 | 5.00E-01 | - - | - - | ***3.10E+00*** | ***3.10E+00*** |
| 7439-92-1 | Lead | 1.20E+01 | 1.00E+00 | - - | - - | ***8.10E+00*** | ***8.10E+00*** |
| 7439-96-5 | Manganese | 7.61E+03 | 1.00E+00 | - - | - - | ***1.00E+02*** | ***1.00E+02*** |
| 7439-97-6 | Mercury | 3.60E+00 | 2.50E-02 | 4.64E+02 | 4.64E+02 | ***2.50E-02*** | ***2.50E-02*** |
| 7440-02-0 | Nickel (soluble salts) | 3.40E+02 | 5.00E-01 | - - | - - | ***8.20E+00*** | ***8.20E+00*** |
| 7782-49-2 | Selenium | 3.00E+02 | 5.00E+01 | - - | - - | ***7.10E+01*** | ***7.10E+01*** |
| 7440-22-4 | Silver | 7.60E+01 | 5.00E-01 | - - | - - | ***1.90E+00*** | ***1.90E+00*** |
| 7440-28-0 | Thallium (soluble salts) | 7.00E+01 | 2.00E-01 | - - | - - | ***4.70E-01*** | ***4.70E-01*** |
| 7440-66-6 | Zinc | 1.21E+04 | 6.00E+00 | - - | - - | ***8.10E+01*** | ***8.10E+01*** |
| 57-12-5 | Cyanide | 5.80E+02 | 5.00E+00 | - - | - - | ***1.00E+00*** | ***5.00E+00*** |
| **Semivolatile Organic Compounds (SVOCs) and Polychlorinated Biphenyls (PCBs)** | | | | | | | |
| 56-55-3 | Benzo(a)anthracene | 3.30E+00 | 1.00E-01 | - - | - - | ***5.86E-03*** | ***1.00E-01*** |
| 205-99-2 | Benzo(b)fluoranthene | 8.50E-01 | 1.00E-01 | - - | - - | ***5.86E-03*** | ***1.00E-01*** |
| 207-08-9 | Benzo(k)fluoranthene | 2.80E-01 | 1.00E-01 | - - | - - | ***5.86E-03*** | ***1.00E-01*** |
| 50-32-8 | Benzo(a)pyrene | 1.50E+00 | 1.00E-01 | - - | - - | ***5.86E-03*** | ***1.00E-01*** |
| 218-01-9 | Chrysene | 6.20E+00 | 1.00E-01 | - - | - - | ***5.86E-03*** | ***1.00E-01*** |
| 53-70-3 | Dibenz(a,h)anthracene | 1.90E-01 | 1.00E-01 | - - | - - | ***5.86E-03*** | ***1.00E-01*** |
| 105-67-9 | 2,4-Dimethylphenol | 5.20E+02 | 3.00E+00 | - - | - - | ***2.01E+02*** | ***2.01E+02*** |
| 117-81-7 | bis(2-Ethylhexyl)phthalate | 1.30E+01 | 3.00E+00 | - - | - - | ***7.05E-01*** | ***3.00E+00*** |
| 193-39-5 | Indeno(1,2,3-cd)pyrene | 2.90E-01 | 1.00E-01 | - - | - - | ***5.86E-03*** | ***1.00E-01*** |
| - | Aroclor 1016/1242 | 1.10E-01 | 1.00E-02 | - - | - - | ***6.40E-05*** | ***1.00E-02*** |
| 11097-69-1 | Aroclor 1254 | 1.90E+00 | 1.00E-02 | - - | - - | ***6.40E-05*** | ***1.00E-02*** |
| 11097-69-1 | Aroclor 1260 | 8.90E+00 | 1.00E-02 | - - | - - | ***6.40E-05*** | ***1.00E-02*** |
| - | Total PCBs | 8.90E+00 | 1.00E-02 | - - | - - | ***6.40E-05*** | ***1.00E-02*** |
| **Volatile Organic Compounds (VOCs)** | | | | | | | |
| 71-43-2 | Benzene | 6.20E+03 | 2.00E-01 | ***3.83E+03*** | ***3.83E+03*** | ***4.48E+00*** | ***4.48E+00*** |
| 56-23-5 | Carbon Tetrachloride | 2.20E+00 | 2.00E-01 | 4.08E+02 | 4.08E+02 | ***5.26E-01*** | ***5.26E-01*** |
| 74-87-3 | Chloromethane | 4.80E+01 | 2.00E-01 | 8.02E+03 | 8.02E+03 | ***2.63E+01*** | ***2.63E+01*** |

**Table A-1 Screening Levels for Constituents of Concern in Site-wide Groundwater**
**North Area**
**Boeing Plant 2**

| CAS Number | Constituent of Concern | Maximum Detect (µg/l) | Laboratory RL (µg/l) | Air Screening Level (µg/l) | Lowest Air Screening Level (µg/l) | Surface Water Screening Level (µg/l) | Lowest Surface Water Screening Level (µg/l) |
|---|---|---|---|---|---|---|---|
| **VOCs continued** | | | | | | | |
| 107-06-2 | 1,2-Dichloroethane | 2.30E+01 | 2.00E-01 | 4.91E+03 | 4.91E+03 | ***1.17E+01*** | ***1.17E+01*** |
| 75-35-4 | 1,1-Dichloroethene | 5.00E+02 | 2.00E-01 | ***1.23E+02*** | ***1.23E+02*** | ***3.82E-01*** | ***3.82E-01*** |
| 156-59-2 | cis-1,2-Dichloroethene | 4.60E+05 | 2.00E-01 | ***1.51E+04*** | ***1.51E+04*** | ***1.13E+03*** | ***1.13E+03*** |
| 100-41-4 | Ethylbenzene | 2.30E+03 | 2.00E-01 | noc | noc | ***2.10E+03*** | ***2.10E+03*** |
| 75-09-2 | Methylene Chloride | 5.10E+02 | 3.00E-01 | 1.32E+05 | 1.32E+05 | ***1.90E+02*** | ***1.90E+02*** |
| 127-18-4 | Tetrachloroethene | 3.60E+01 | 2.00E-01 | 1.88E+03 | 1.88E+03 | ***8.22E-01*** | ***8.22E-01*** |
| 79-00-5 | 1,1,2-Trichloroethane | 4.40E+02 | 2.00E-01 | 9.40E+03 | 9.40E+03 | ***5.00E+00*** | ***5.00E+00*** |
| 79-01-6 | Trichloroethene | 5.70E+05 | 2.00E-01 | ***1.58E+02*** | ***1.58E+02*** | ***3.02E-01*** | ***3.02E-01*** |
| 75-01-4 | Vinyl Chloride | 9.80E+04 | 2.00E-01 | ***5.94E+02*** | ***5.94E+02*** | ***7.31E-01*** | ***7.31E-01*** |
| **Total Petroleum Hydrocarbons (TPH)** | | | | | | | |
| - | TPH-D | 1.10E+04 | 5.00E+02 | ***5.00E+02*** | | | |
| - | TPH-G | 6.50E+04 | 2.50E+02 | ***8.00E+02*** | | | |
| - | TPH-O (Motor Oil) | 3.00E+03 | 5.00E+02 | ***5.00E+02*** | | | |
| - | TPH-O (Oil and Grease) | 1.20E+04 | 5.00E+02 | ***5.00E+02*** | | | |

Notes

The screening level for used for evaluating and identfying COCs is the lower value between the lowest air screening value and the lowest surface water screening value.

All maximum detections for metals represent dissolved metals.

Screening levels adjust risk calculations up to RL where applicable.

**Bolded** — **Bolded** risk based and screening level concentrations are below maximum detect.

[a] — Lowest groundwater concentration protective of indoor air, outdoor air, and trenching.

[b] — Lowest groundwater concentration protective of human ingestion of aquatic organisms and protection of aquatic organisms.

RL — Reporting Limit as detailed in Analytical Resources Inc. Laboratory Quality Assurance Plan, Version 11-022, dated 5/17/04 (generally equivalent to the practical quantitation limit in a clean matrix).

TPH — Total Petroleum Hydrocarbons

- - — Not calculated.

noc — Not of concern. No groundwater concentration is able to produce an unacceptable air concentration.

No predicted air concentration can exceed the indoor air screening level. (Boeing Plant 2 Uplands CMS Vol.II Att. C)

**Table A-2: Constituents of Concern Detected in Groundwater**
**North Area**
**Boeing Plant 2**

| CAS Number | Constituent of Concern | Maximum Detect (µg/l) | Samples Analyzed | Detects | Samples above Air Screening Level | Samples above Surface Water Screening Level |
|---|---|---|---|---|---|---|
| **Volatile Organic Compounds (VOCs)** | | | | | | |
| 75-01-4 | Vinyl Chloride | 2 | 9 | 1 | 0 | 1 |
| **Petroleum Hydrocarbons (TPH)** | | | | | | |
| | TPH - Oil and Grease | 12000 | 9 | 4 | 4 | |

Notes:

Sample population is defined as groundwater samples collected from within the North Area, with obvious duplicates not included.

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**Table A-3 Explanation of Data Qualifiers**
**North Area**
**Boeing Plant 2**

| Data Qualifier | Explanation |
|---|---|
| **Data Qualifiers Used by the Contract Laboratory – Analytical Resources, Inc.** | |
| U | The compound was analyzed for, but not detected at the reported concentration. |
| J | Indicates an estimated concentration when a value is less than the calculated reporting limit. |
| D | Indicates the surrogate/spike(s) was not detected, due to dilution of extract. |
| NR | Indicates the surrogate recovery cannot be reported due to matrix interference. |
| E | Indicates a value above the linear range of the detector, sample dilution is required. |
| S | Indicates no value reported due to saturation of the detector, sample dilution required. |
| NA | Indicates compound was not analyzed for. |
| M | Indicates an estimated value of analyte found and confirmed by the analyst but with a low spectral match (GC-MS). |
| B | Indicates possible/probable blank contamination. Flagged when the analyte is detected in the blank as well as in the sample. |
| Y | Indicates raised reporting limit due to background interference or to activity in the instrument. Compound is still not detected at or above the raised level. |
| C | Indicates a probably detection that cannot be confirmed due to matrix interferences. |
| P | Indicates a high RPD between detected concentrations for dual column GC analyses without obvious interference. |
| **Data Validation Qualifiers for Organic Analyses** | |
| U | The analyte was analyzed for, but was not detected above the reported sample quantitation limit. |
| J | The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample. |
| N | The analysis indicates the presence of an analyte for which there is presumptive evidence to make a “tentative identification”. |
| NJ | The analysis indicates the presence of an analyte that has been “tentatively identified” and the associated numerical value represents its approximate concentration. |
| UJ | The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample. |
| R | The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified. |

**Table A-3 Explanation of Data Qualifiers**
**North Area**
**Boeing Plant 2**

| Data Qualifier | Explanation |
|---|---|
| **Data Validation Qualifiers for Inorganic Analyses** | |
| U | The compound was analyzed for, but was not detected above the reported sample quantitation limit. |
| J | The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample. |
| J+ | The result is an estimated quantity, but the result may be biased high. |
| J- | The result is an estimated quantity, but the result may be biased low. |
| R | The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified. |
| UJ | The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample. |

**Boeing Plant 2**
**Seattle/Tukwila, Washington**

# Uplands Corrective Measures
# Volume VIa: North Area

# Data Gap Investigation Work Plan

# Attachment A
# Maps

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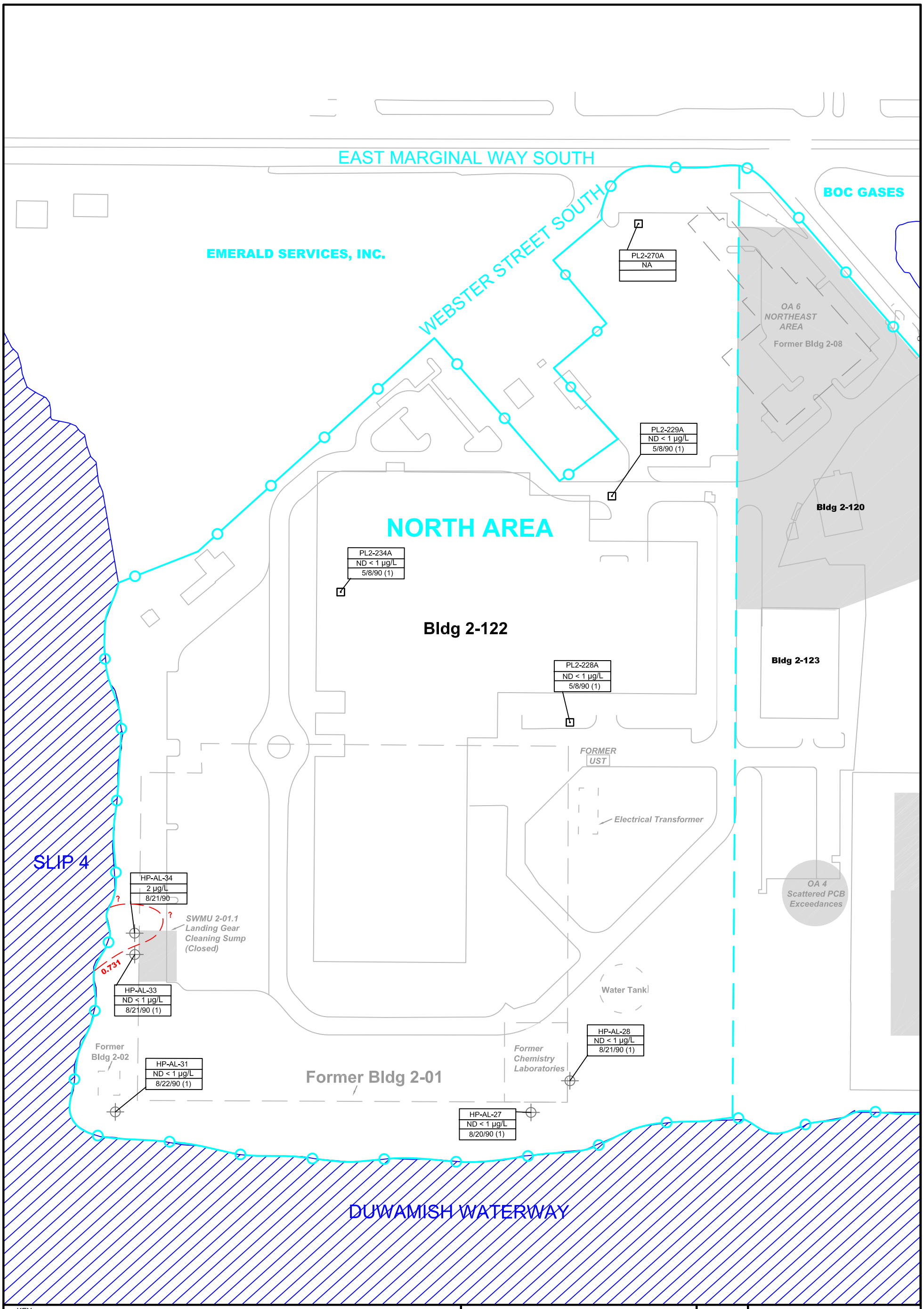



KEY:

- WELL LOCATION
- PROBE LOCATION
- AREA BOUNDARY
- PROPERTY BOUNDARY
- ISOCONCENTRATION LINE
- ONSITE BUILDING AND ROAD STRUCTURE
- FORMER BUILDING OUTLINE
- NA = NOT ANALYZED

| | |
|---|---|
| PL2-005A | WELL/PROBE NAME |
| 7.02 µg/L | MAXIMUM DETECTION OR NON-DETECT WITH DETECTION LIMIT |
| 4/25/04 (2) | DATE (NUMBER OF NON-DETECTS) |

DRAFT CMS VOLUME 2
SCREENING LEVEL (2004) = 0.731 µg/L

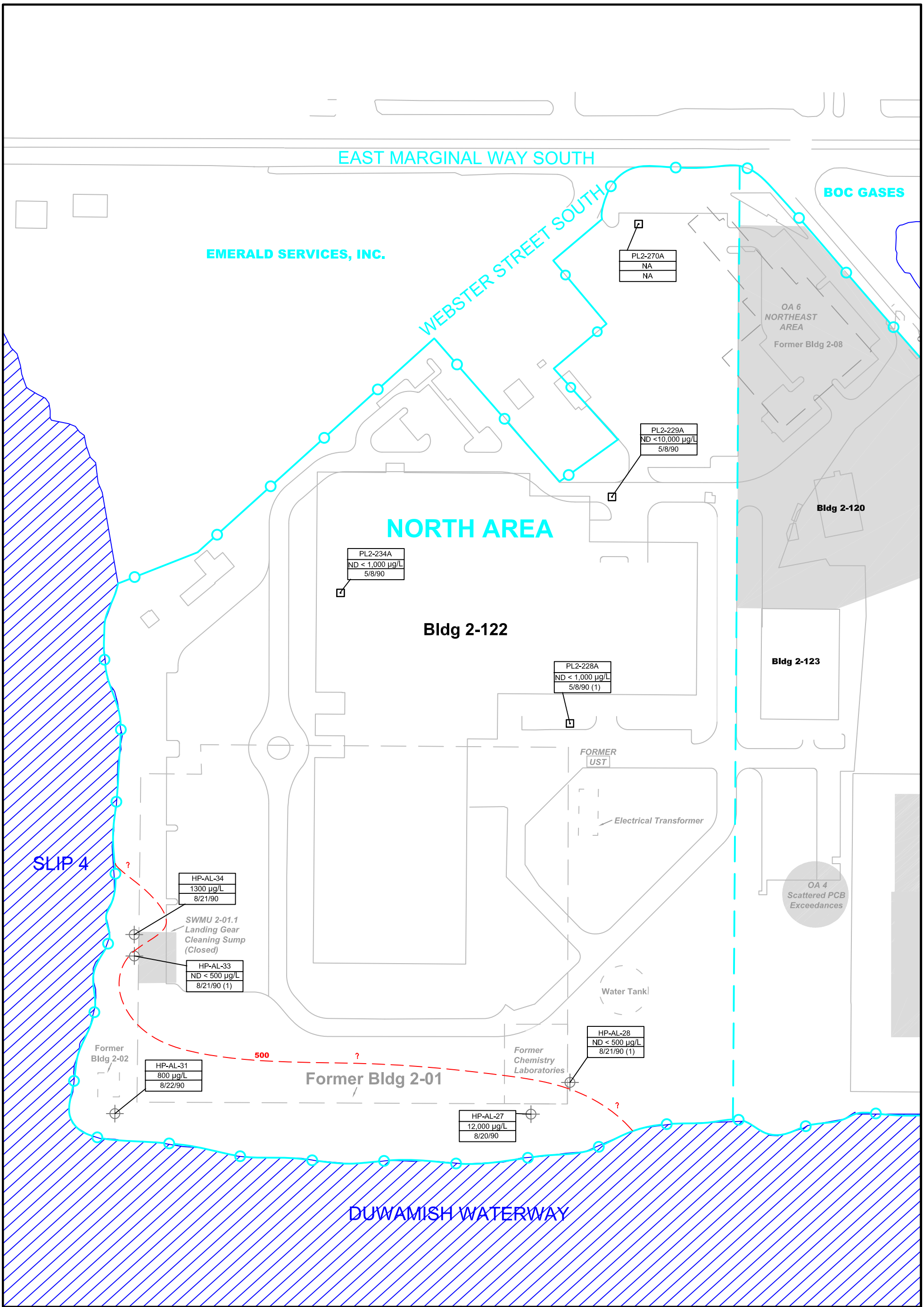
0 30' 60' 120'
SCALE: 1" = 120'

ENVIRONMENTAL PARTNERS INC
295 NE Gilman Boulevard, Suite 201
Issaquah, Washington 98027

**BOEING PLANT 2**
**NORTH AREA**
**VINYL CHLORIDE CONCENTRATIONS**
**IN A-LEVEL GROUNDWATER**

| | |
|---|---|
| PROJECT | BOEING PLANT 2 |
| PREPARED FOR | THE BOEING COMPANY |
| LOCATION | 7725 EAST MARGINAL WAY SEATTLE/TUKWILA, WASHINGTON |

| SHEET | DRAWN BY | REVIEWED BY | DATE |
|---|---|---|---|
| 1 of 1 | MMH | DCK | 08/17/07 |




KEY:

N

0 30' 60' 120'

SCALE: 1" = 120'

- WELL LOCATION
- PROBE LOCATION
- AREA BOUNDARY
- PROPERTY BOUNDARY
- ISOCONCENTRATION LINE
- ONSITE BUILDING AND ROAD STRUCTURE
- FORMER BUILDING OUTLINE

NA = NOT ANALYZED

| | |
|---|---|
| PL2-005A | WELL/PROBE NAME |
| 7.02 µg/L | MAXIMUM DETECTION OR NON-DETECT WITH DETECTION LIMIT |
| 4/25/04 (2) | DATE (NUMBER OF NON-DETECTS) |

DRAFT CMS VOLUME 2
SCREENING LEVEL (2004) = 500 µg/L

ENVIRONMENTAL PARTNERS INC
295 NE Gilman Boulevard, Suite 201
Issaquah, Washington 98027

**BOEING PLANT 2**
**NORTH AREA**
**TPH - OIL CONCENTRATIONS**
**IN A-LEVEL GROUNDWATER**

| | | | |
|---|---|---|---|
| PROJECT | BOEING PLANT 2 | | |
| PREPARED FOR | THE BOEING COMPANY | | |
| LOCATION | 7725 EAST MARGINAL WAY SEATTLE/TUKWILA, WASHINGTON | | |
| SHEET 1 of 1 | DRAWN BY MMH | REVIEWED BY DCK | DATE 08/17/07 |

**Boeing Plant 2**
**Seattle/Tukwila, Washington**

# Uplands Corrective Measures
# Volume VIIa: North Area

# Data Gap Investigation Work Plan

# Attachment A
# Data Tables

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## North Area - Vinyl Chloride Maximum Concentrations in Groundwater
## Boeing Plant 2
**Draft CMS Screening Level (2004) = 0.731 µg/L**

| Well or Probe Location | Maximum Concentration Date | Maximum Concentration or Detection Limit (µg/L) | Most Recent Non-Detect Date | Not Analyzed or Not Detected | Number of Non-Detects |
|---|---|---|---|---|---|
| **A-Level** | | | | | |
| HP-AL-27 | - - | 1 U | 08/20/90 | ND | 1 |
| HP-AL-28 | - - | 1 U | 08/21/90 | ND | 1 |
| HP-AL-31 | - - | 1 U | 08/22/90 | ND | 1 |
| HP-AL-33 | - - | 1 U | 08/21/90 | ND | 1 |
| HP-AL-34 | 08/21/90 | 2 | - - | - - | - - |
| PL2-228A | - - | 1 U | 05/08/90 | ND | 1 |
| PL2-229A | - - | 1 U | 05/10/90 | ND | 2 |
| PL2-234A | - - | 1 U | 05/08/90 | ND | 1 |
| PL2-270A | - - | - - | - - | N/A | - - |

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## North Area - TPH Oil Maximum Concentrations in Groundwater
## Boeing Plant 2
**Draft CMS Screening Level (2004) = 500 µg/L**

| Well or Probe Location | Maximum Concentration Date | Maximum Concentration or Detection Limit (µg/L) | Most Recent Non-Detect Date | Not Analyzed or Not Detected | Number of Non-Detects |
|---|---|---|---|---|---|
| **A-Level** | | | | | |
| HP-AL-27 | 08/20/90 | 12000 | - - | - - | - - |
| HP-AL-28 | - - | 500 U | 08/21/90 | ND | 1 |
| HP-AL-31 | 08/22/90 | 800 | - - | - - | - - |
| HP-AL-33 | | 500 U | 08/21/90 | ND | 1 |
| HP-AL-34 | 08/21/90 | 1300 | - - | - - | - - |
| PL2-228A | - - | 1000 U | 05/08/90 | ND | 1 |
| PL2-229A | - - | 10000 U | 05/10/90 | ND | 1 |
| PL2-234A | - - | 1000 U | 05/08/90 | ND | 1 |
| PL2-270A | - - | - - | - - | N/A | - - |

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**Boeing Plant 2**
**Seattle/Tukwila, Washington**

# Uplands Corrective Measures
# Volume VIIa: North Area

# Data Gap Investigation Work Plan

# Attachment B
# Soil Constituents of Concern

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Table B-2 Constituents of Concern Detected in Soil

Table B-3 Explanation of Data Qualifiers

# List of Maps

Arsenic in Soil, North Area: Depth 0 - 1 Ft.

Arsenic in Soil, North Area: Depth 1 - 6 Ft.

Arsenic in Soil, North Area: Depth 6 - 12 Ft.

Cadmium in Soil, North Area: Depth 0 - 1 Ft.

Cadmium in Soil, North Area: Depth 1 - 6 Ft.

Cadmium in Soil, North Area: Depth 6 - 12 Ft.

Copper in Soil, North Area: Depth 0 - 1 Ft.

Copper in Soil, North Area: Depth 1 - 6 Ft.

Copper in Soil, North Area: Depth 6 - 12 Ft.

Mercury in Soil, North Area: Depth 0 - 1 Ft.

Mercury in Soil, North Area: Depth 1 - 6 Ft.

Mercury in Soil, North Area: Depth 6 - 12 Ft.

Zinc in Soil, North Area: Depth 0 - 1 Ft.

Zinc in Soil, North Area: Depth 1 - 6 Ft.

Zinc in Soil, North Area: Depth 6 - 12 Ft.

Benzo(a)anthracene in Soil, North Area: Depth 0 - 1 Ft.

Benzo(a)anthracene in Soil, North Area: Depth 1 - 6 Ft.

Benzo(a)anthracene in Soil, North Area: Depth 6 - 12 Ft.

Benzo(a)pyrene in Soil, North Area: Depth 0 - 1 Ft.
Benzo(a)pyrene in Soil, North Area: Depth 1 - 6 Ft.
Benzo(a)pyrene in Soil, North Area: Depth 6 - 12 Ft.
Benzo(b)fluoranthene in Soil, North Area: Depth 0 - 1 Ft.
Benzo(b)fluoranthene in Soil, North Area: Depth 1 - 6 Ft.
Benzo(b)fluoranthene in Soil, North Area: Depth 6 - 12 Ft.
Benzo(k)fluoranthene in Soil, North Area: Depth 0 - 1 Ft.
Benzo(k)fluoranthene in Soil, North Area: Depth 1 - 6 Ft.
Benzo(k)fluoranthene in Soil, North Area: Depth 6 - 12 Ft.
Chrysene in Soil, North Area: Depth 0 - 1 Ft.
Chrysene in Soil, North Area: Depth 1 - 6 Ft.
Chrysene in Soil, North Area: Depth 6 - 12 Ft.
Indeno(1,2,3-cd)pyrene in Soil, North Area: Depth 0 - 1 Ft.
Indeno(1,2,3-cd)pyrene in Soil, North Area: Depth 1 - 6 Ft.
Indeno(1,2,3-cd)pyrene in Soil, North Area: Depth 6 - 12 Ft.
Total PCBs in Soil, North Area: Depth 0 - 1 Ft.
Total PCBs in Soil, North Area: Depth 1 - 6 Ft.
Total PCBs in Soil, North Area: Depth 6 - 12 Ft.
Trichloroethene in Soil, North Area: Depth 0 - 1 Ft.
Trichloroethene in Soil, North Area: Depth 1 - 6 Ft.
Trichloroethene in Soil, North Area: Depth 6 - 12 Ft.

## List of Data Tables

Arsenic Concentrations in Soil
Cadmium Concentrations in Soil
Copper Concentrations in Soil
Mercury Concentrations in Soil
Zinc Concentrations in Soil
Benzo(a)anthracene Concentrations in Soil
Benzo(a)pyrene Concentrations in Soil
Benzo(b)fluoranthene Concentrations in Soil

Benzo(k)fluoranthene Concentrations in Soil

Chrysene Concentrations in Soil

Indeno(1,2,3-cd)pyrene Concentrations in Soil

Aroclor 1242 Concentrations in Soil

Aroclor 1248 Concentrations in Soil

Aroclor 1254 Concentrations in Soil

Trichloroethene Concentrations in Soil

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# B1.0 Soil Constituents of Concern

This attachment includes soil data information for the North Area of Boeing Plant 2 (Plant 2). This information was used to prepare Section 2, Data Gap Analysis, of this Data Gap Investigation Work Plan and includes: tables summarizing site-wide and North Area soil COCs, maps showing the distribution of COCs in the North Area, and data tables for each soil COC.

## B1.1 IDENTIFICATION OF COCS

Table B-1 summarizes the screening levels for the site-wide soil COCs. All accepted soil data including any qualified data compiled since 1985 were used to prepare the table with two exceptions:

1. Soil data below 12 feet (generally below the water table) were excluded.
2. Soil data from soil that was removed from the site as a result of interim actions were excluded.

A COC was identified when laboratory analysis of a sample resulted in a concentration greater than the screening level at least once in any soil sample from the site. Table B-1 also includes the risk calculation in soil for the direct, air, and surface water exposure pathways. As discussed in detail in Volume II, screening levels for soil are the same as risk calculations. Because no risk information is available, the direct contact pathway screening level for TPH and lead were established according to MTCA Method A. Background soil concentrations are based on *Natural Background in Soil Metals Concentrations in Washington State* (Ecology Pub #94-115).

Table B-2 presents the current groundwater COCs for the North Area. COCs were identified by the same method as described above for Table B-1. All accepted soil data, including any qualified data compiled from the North Area since 1989, were used to prepare the table.

## B1.2 SPATIAL DISTRIBUTION OF COCS

Included in this attachment are maps showing the spatial distribution of each COC in soil at the North Area.

Maps showing the spatial distribution of each COC in soil (at three different depth intervals) in the North are included in this attachment. The maps show the spatial distribution of each COC at three depth intervals: 0 to 1 foot, 1 to 6 feet, and 6 to 12 feet below ground surface. The accepted maximum concentration of each COC for each interval was used to generate the maps. If a constituent was never detected at a particular location, then the reporting limit for the non-detect is presented, with the exception of Total PCBs, where only the sum of all detected aroclors is shown.

## B1.3 DATA TABLES

The data tables show all of the accepted maximum concentrations each soil COC. The data tables include data from all soil intervals, regardless of the frequency of detection.

**Boeing Plant 2**
**Seattle/Tukwila, Washington**

# Uplands Corrective Measures
# Volume VIIa: North Area

# Data Gap Investigation Work Plan

# Attachment B
# Tables

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**Table B-1 Screening Levels for Constituents of Concern in Site-wide Soils**

| CAS Number | Constituent of Concern | Maximum Detected | Soil Units | Laboratory RL | Puget Sound Basin Natural Background Concentration[a] | Direct Contact Risk Calculation[b] | Direct Contact Screening Level | Air Risk Calculation[c] | Air Screening Level | Surface Water Risk Calculation[d] | Surface Water Screening Level |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metals and Cyanide** | | | | | | | | | | | |
| 7440-36-0 | Antimony | 9.90E+02 | mg/kg | 5.00E+00 | - - | ***5.33E+02*** | ***5.33E+02*** | - - | - - | ***4.64E+02*** | ***4.64E+02*** |
| 7440-38-2 | Arsenic | 7.60E+01 | mg/kg | 5.00E+00 | 7.30E+00 | ***3.33E+01*** | ***3.33E+01*** | 3.22E+04 | 3.22E+04 | ***1.13E-02*** | ***5.00E+00*** |
| 7440-43-9 | Cadmium | 3.70E+03 | mg/kg | 2.00E-01 | 7.70E-01 | ***6.67E+02*** | ***6.67E+02*** | 7.70E+04 | 7.70E+04 | ***1.21E+00*** | ***1.21E+00*** |
| 18540-29-9 | Chromium (VI) | 1.30E+03 | mg/kg | 2.00E-01 | - - | 4.00E+03 | 4.00E+03 | 1.06E+04 | 1.06E+04 | ***1.92E+01*** | ***1.92E+01*** |
| 7440-50-8 | Copper | 2.81E+04 | mg/kg | 2.00E-01 | 3.64E+01 | 4.93E+04 | 4.93E+04 | - - | - - | ***1.38E+00*** | ***1.38E+00*** |
| 7439-92-1 | Lead | 1.82E+04 | mg/kg | 2.00E+00 | 1.68E+01 | ***1.00E+03*** | ***1.00E+03*** | - - | - - | ***1.62E+03*** | ***1.62E+03*** |
| 7439-96-5 | Manganese | 4.01E+03 | mg/kg | 1.00E-01 | 1.146E+03 | 1.87E+05 | 1.87E+05 | - - | - - | ***1.30E+02*** | ***1.30E+02*** |
| 7439-97-6 | Mercury | 3.00E+01 | mg/kg | 5.00E-02 | 7.00E-02 | 4.19E+01 | 4.19E+01 | ***6.13E+00*** | ***6.13E+00*** | ***2.61E-02*** | ***5.00E-02*** |
| 7440-02-0 | Nickel (soluble salts) | 1.77E+03 | mg/kg | 1.00E+00 | 4.78E+01 | 2.67E+04 | 2.67E+04 | - - | - - | ***1.07E+01*** | ***1.07E+01*** |
| 7782-49-2 | Selenium | 9.00E+00 | mg/kg | 5.00E+00 | - - | 6.67E+03 | 6.67E+03 | - - | - - | ***7.38E+00*** | ***7.38E+00*** |
| 7440-22-4 | Silver | 2.74E+02 | mg/kg | 3.00E-01 | - - | 6.67E+03 | 6.67E+03 | - - | - - | ***3.23E-01*** | ***3.23E-01*** |
| 7440-28-0 | Thallium (soluble salts) | 5.60E+01 | mg/kg | 2.00E-01 | - - | 8.64E+01 | 8.64E+01 | - - | - - | ***6.69E-01*** | ***6.69E-01*** |
| 7440-66-6 | Zinc | 2.60E+04 | mg/kg | 6.00E-01 | 8.51E+01 | 4.00E+05 | 4.00E+05 | - - | - - | ***1.01E+02*** | ***1.01E+02*** |
| 57-12-5 | Cyanide | 4.60E+03 | mg/kg | 1.00E-01 | - - | 2.67E+04 | 2.67E+04 | - - | - - | ***2.02E-01*** | ***2.02E-01*** |
| **Semivolatile Organic Compounds (SVOCs) and Polychlorinated Biphenyls (PCBs)** | | | | | | | | | | | |
| 56-55-3 | Benzo(a)anthracene | 2.00E+05 | µg/kg | 6.70E+00 | - - | ***3.42E+03*** | ***3.42E+03*** | - - | - - | ***4.19E+01*** | ***4.19E+01*** |
| 205-99-2 | Benzo(b)fluoranthene | 1.00E+05 | µg/kg | 6.70E+00 | - - | ***3.42E+03*** | ***3.42E+03*** | - - | - - | ***1.44E+02*** | ***1.44E+02*** |
| 207-08-9 | Benzo(k)fluoranthene | 1.60E+05 | µg/kg | 6.70E+00 | - - | ***3.42E+03*** | ***3.42E+03*** | - - | - - | ***1.44E+02*** | ***1.44E+02*** |
| 50-32-8 | Benzo(a)pyrene | 2.10E+05 | µg/kg | 6.70E+00 | - - | ***3.42E+03*** | ***3.42E+03*** | 7.95E+07 | 7.95E+07 | ***1.13E+02*** | ***1.13E+02*** |
| 218-01-9 | Chrysene | 2.40E+05 | µg/kg | 6.70E+00 | - - | ***3.42E+03*** | ***3.42E+03*** | - - | - - | ***4.66E+01*** | ***4.66E+01*** |
| 53-70-3 | Dibenz(a,h)anthracene | 3.30E+04 | µg/kg | 6.70E+00 | - - | ***3.42E+03*** | ***3.42E+03*** | - - | - - | ***2.10E+02*** | ***2.10E+02*** |
| 105-67-9 | 2,4-Dimethylphenol | 6.80E+01 | µg/kg | 2.00E+02 | - - | 1.33E+07 | 1.33E+07 | - - | - - | 2.24E+03 | 2.24E+03 |
| 131-11-3 | Dimethylphthalate | ND | µg/kg | 6.70E+01 | ***- -*** | ***6.67E+08*** | ***6.67E+08*** | ***- -*** | ***- -*** | ***1.69E+05*** | ***1.69E+05*** |
| 117-81-7 | bis(2-Ethylhexyl)phthalate | 3.30E+05 | µg/kg | 6.70E+01 | - - | 1.79E+06 | 1.79E+06 | - - | - - | ***1.57E+03*** | ***1.57E+03*** |
| 206-44-0 | Fluoranthene | 4.10E+05 | µg/kg | 6.70E+01 | - - | 2.67E+07 | 2.67E+07 | - - | - - | ***4.40E+04*** | ***4.40E+04*** |
| 193-39-5 | Indeno(1,2,3-cd)pyrene | 8.30E+04 | µg/kg | 6.70E+00 | - - | ***3.42E+03*** | ***3.42E+03*** | - - | - - | ***4.06E+02*** | ***4.06E+02*** |
| 12672-29-6 | Aroclor 1248 | 1.30E+05 | µg/kg | 3.30E+01 | - - | - - | - - | - - | - - | - - | ***3.30E+01*** |
| - | Aroclor 1016/1242 | 9.00E+02 | µg/kg | 3.30E+01 | - - | 4.67E+04 | 4.67E+04 | - - | - - | ***1.38E-01*** | ***3.30E+01*** |
| 11097-69-1 | Aroclor 1254 | 8.10E+04 | µg/kg | 3.30E+01 | - - | ***1.33E+04*** | ***1.33E+04*** | - - | - - | ***1.08E+00*** | ***3.30E+01*** |
| 11096-82-5 | Aroclor 1260 | 6.60E+05 | µg/kg | 3.30E+01 | - - | - - | - - | - - | - - | ***1.05E+00*** | ***3.30E+01*** |
| 37324-23-5 | Aroclor 1262 | 1.60E+03 | µg/kg | 3.30E+01 | - - | - - | - - | - - | - - | - - | ***3.30E+01*** |
| 11100-14-4 | Aroclor 1268 | 2.10E+02 | µg/kg | 3.30E+01 | - - | - - | - - | - - | - - | - - | ***3.30E+01*** |
| - | Total PCBs | 6.60E+05 | µg/kg | 3.30E+01 | - - | - - | - - | - - | - - | ***3.96E-01*** | ***3.30E+01*** |
| **Volatile Organic Compounds (VOCs)** | | | | | | | | | | | |
| 71-43-2 | Benzene | 4.90E+04 | µg/kg | 1.00E+00 | - - | 1.36E+06 | 1.36E+06 | ***5.05E+02*** | ***5.05E+02*** | ***2.53E+01*** | ***2.53E+01*** |
| 104-51-8 | n-Butylbenzene | 3.70E+04 | µg/kg | 1.00E+00 | - - | - - | - - | ***4.64E+03*** | ***4.64E+03*** | - - | - - |
| 135-98-8 | sec-Butylbenzene | 1.00E+04 | µg/kg | 1.00E+00 | - - | - - | - - | ***7.86E+03*** | ***7.86E+03*** | - - | - - |
| 56-23-5 | Carbon Tetrachloride | 1.50E+01 | µg/kg | 1.00E+00 | - - | 5.73E+05 | 5.73E+05 | 1.93E+02 | 1.93E+02 | ***4.84E+00*** | ***4.84E+00*** |
| 108-90-7 | Chlorobenzene | 1.90E+03 | µg/kg | 1.00E+00 | - - | 2.91E+07 | 2.91E+07 | ***1.85E+03*** | ***1.85E+03*** | 1.40E+04 | 1.40E+04 |
| 67-66-3 | Chloroform | 4.80E+02 | µg/kg | 1.00E+00 | - - | 7.03E+06 | 7.03E+06 | ***2.04E+02*** | ***2.04E+02*** | ***2.98E+02*** | ***2.98E+02*** |
| 75-35-4 | 1,1-Dichloroethene | 1.70E+03 | µg/kg | 1.00E+00 | - - | 1.24E+05 | 1.24E+05 | ***5.80E+01*** | ***5.80E+01*** | ***2.73E+00*** | ***2.73E+00*** |
| 156-59-2 | cis-1,2-Dichloroethene | 7.30E+05 | µg/kg | 1.00E+00 | - - | 7.99E+06 | 7.99E+06 | ***7.94E+02*** | ***7.94E+02*** | ***7.73E+03*** | ***7.73E+03*** |
| 156-60-5 | trans-1,2-Dichloroethene | 7.10E+03 | µg/kg | 1.00E+00 | - - | 1.31E+07 | 1.31E+07 | 8.21E+03 | 8.21E+03 | 5.43E+04 | 5.43E+04 |
| 100-41-4 | Ethylbenzene | 2.60E+05 | µg/kg | 1.00E+00 | - - | 1.45E+08 | 1.45E+08 | noc | noc | ***1.81E+04*** | ***1.81E+04*** |
| 98-82-8 | Isopropylbenzene | 1.80E+04 | µg/kg | 1.00E+00 | - - | 1.45E+08 | 1.45E+08 | noc | noc | - - | - - |
| 75-09-2 | Methylene Chloride | 2.40E+04 | µg/kg | 2.00E+00 | - - | 9.94E+06 | 9.94E+06 | ***1.21E+04*** | ***1.21E+04*** | ***8.28E+02*** | ***8.28E+02*** |
| 91-20-3 | Naphthalene | 5.20E+05 | µg/kg | 5.00E+00 | - - | 1.44E+07 | 1.44E+07 | ***9.82E+04*** | ***9.82E+04*** | ***6.80E+04*** | ***6.80E+04*** |
| 103-65-1 | n-Propylbenzene | 4.20E+04 | µg/kg | 1.00E+00 | - - | - - | - - | ***1.36E+04*** | ***1.36E+04*** | - - | - - |
| 79-34-5 | 1,1,2,2-Tetrachloroethane | 1.70E+02 | µg/kg | 1.00E+00 | - - | 2.73E+05 | 2.73E+05 | 1.39E+03 | 1.39E+03 | ***7.19E+00*** | ***7.19E+00*** |
| 127-18-4 | Tetrachloroethene | 2.00E+04 | µg/kg | 1.00E+00 | - - | 1.07E+06 | 1.07E+06 | ***4.89E+02*** | ***4.89E+02*** | ***8.72E+00*** | ***8.72E+00*** |

**Table B-1 Screening Levels for Constituents of Concern in Site-wide Soils**

| CAS Number | Constituent of Concern | Maximum Detected | Soil Units | Laboratory RL | Puget Sound Basin Natural Background Concentration[a] | Direct Contact Risk Calculation[b] | Direct Contact Screening Level | Air Risk Calculation[c] | Air Screening Level | Surface Water Risk Calculation[d] | Surface Water Screening Level |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **VOCs (cont'd)** | | | | | | | | | | | |
| 108-88-3 | Toluene | 6.50E+05 | µg/kg | 1.00E+00 | - - | 1.34E+08 | 1.34E+08 | noc | noc | ***1.09E+05*** | ***1.09E+05*** |
| 71-55-6 | 1,1,1-Trichloroethane | 1.10E+05 | µg/kg | 1.00E+00 | - - | 4.12E+08 | 4.12E+08 | noc | noc | 1.63E+06 | 1.63E+06 |
| 79-00-5 | 1,1,2-Trichloroethane | 3.30E+03 | µg/kg | 1.00E+00 | - - | 9.57E+05 | 9.57E+05 | ***1.31E+03*** | ***1.31E+03*** | ***2.78E+01*** | ***2.78E+01*** |
| 79-01-6 | Trichloroethene | 1.10E+07 | µg/kg | 1.00E+00 | - - | ***1.36E+05*** | ***1.36E+05*** | ***3.60E+01*** | ***3.60E+01*** | ***2.00E+00*** | ***2.00E+00*** |
| 95-63-6 | 1,2,4-Trimethylbenzene | 3.20E+05 | µg/kg | 1.00E+00 | - - | 7.27E+07 | 7.27E+07 | ***1.01E+04*** | ***1.01E+04*** | - - | - - |
| 108-67-8 | 1,3,5-Trimethylbenzene | 1.20E+05 | µg/kg | 1.00E+00 | - - | 7.27E+07 | 7.27E+07 | noc | noc | - - | - - |
| 75-01-4 | Vinyl Chloride | 1.80E+04 | µg/kg | 1.00E+00 | - - | 4.97E+04 | 4.97E+04 | ***3.31E+02*** | ***3.31E+02*** | ***4.59E+00*** | ***4.59E+00*** |
| **Total Petroleum Hydrocarbons (TPH)** | | | | | | | | | | | |
| - | TPH - Diesel Range | 1.10E+05 | mg/kg | 5.00E+00 | - - | ***2.00E+03*** | | | | | |
| - | TPH - Gasoline Range | 2.50E+04 | mg/kg | 5.00E+00 | - - | ***3.00E+01*** | | | | | |
| - | TPH - Mineral Spirits | 4.10E+03 | mg/kg | 5.00E+00 | - - | ***2.00E+03*** | | | | | |
| - | TPH - Motor Oil Range | 2.00E+04 | mg/kg | 1.00E+01 | - - | ***2.00E+03*** | | | | | |

Notes:

| | |
|---|---|
| | Screening levels adjust risk calculations up to the reporting limit (RL) where applicable. |
| **Bolded** | **Bolded** risk based and screening level concentrations are below maximum detect. |
| a | Source: Ecology, 1994. |
| b | Lowest soil concentration protective of dermal contact, ingestion and trenching. |
| c | Lowest soil concentration protective of indoor and outdoor air (inclusive of fugitive dust). |
| d | Lowest soil concentration protective of human ingestion of aquatic organisms and protection of aquatic organisms. |
| * | Constituent not listed. |
| - - | Not calculated. |
| RL | Reporting Limit as detailed in Analytical Resources Inc. Laboratory Quality Assurance Plan, Version 11-022, dated 5/17/04 (generally equivalent to the practical quantitation limit in a clean matrix). |
| TPH | Total Petroleum Hydrocarbon. |
| noc | Not of concern. No soil concentration is able to produce an unacceptable air concentration. No predicted air concentration can exceed the indoor air screening level. (Boeing Plant 2 Uplands CMS Vol.II Att. C) |

**Table B-2: Constituents of Concern Detected in Soil**
**North Area**
**Boeing Plant 2**

| CAS Number | Constituent of Concern | Soil Units | Maximum Detected | Samples Analyzed | Detects | Samples Above Direct Contact Screening Level | Samples Above Air Screening Level | Samples Above Surface Water Screening Level | Samples above Puget Sound Basin Natural Background Concentration |
|---|---|---|---|---|---|---|---|---|---|
| **Metals and Cyanide** | | | | | | | | | |
| 7440-38-2 | Arsenic | mg/kg | 15 | 56 | 52 | 0 | 0 | -- | 10 |
| 7440-43-9 | Cadmium | mg/kg | 2.9 | 56 | 4 | 0 | 0 | 1 | -- |
| 7440-50-8 | Copper | mg/kg | 310 | 56 | 56 | 0 | -- | -- | 2 |
| 7439-97-6 | Mercury | mg/kg | 0.2 | 41 | 7 | 0 | 0 | -- | 3 |
| 7440-66-6 | Zinc | mg/kg | 220 | 56 | 56 | 0 | -- | 1 | -- |
| **Semivolatile Organic Compounds (SVOCs) and Polychlorinated Biphenyls (PCBs)** | | | | | | | | | |
| 56-55-3 | Benzo(a)anthracene | µg/kg | 3500 | 42 | 3 | 1 | -- | 3 | -- |
| 50-32-8 | Benzo(a)pyrene | µg/kg | 1700 | 42 | 2 | 0 | 0 | 1 | -- |
| 205-99-2 | Benzo(b)fluoranthene | µg/kg | 3100 | 42 | 2 | 0 | -- | 1 | -- |
| 207-08-9 | Benzo(k)fluoranthene | µg/kg | 3100 | 42 | 2 | 0 | -- | 1 | -- |
| 218-01-9 | Chrysene | µg/kg | 2900 | 42 | 8 | 0 | -- | 6 | -- |
| 193-39-5 | Indeno(1,2,3-cd)pyrene | µg/kg | 450 | 42 | 1 | 0 | -- | 1 | -- |
| 53469-21-9 | Aroclor 1242 | µg/kg | 38 | 42 | 1 | 0 | -- | 1 | -- |
| 12672-29-6 | Aroclor 1248 | µg/kg | 40 | 57 | 1 | -- | -- | 1 | -- |
| 11097-69-1 | Aroclor 1254 | µg/kg | 76 | 57 | 3 | 0 | -- | 3 | -- |
| 1336-36-3 | Total PCB | µg/kg | 114 | 57 | 3 | -- | -- | 3 | -- |
| **Volatile Organic Compounds (VOCs)** | | | | | | | | | |
| 79-01-6 | Trichloroethene | µg/kg | 9 | 70 | 1 | 0 | 0 | 1 | -- |

Note:

Sample population is defined as soil samples collected from within the North Area for which coordinates of sample station are known.

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**Table B-3 Explanation of Data Qualifiers**
**North Area**
**Boeing Plant 2**

| Data Qualifier | Explanation |
|---|---|
| **Data Qualifiers Used by the Contract Laboratory – Analytical Resources, Inc.** | |
| U | The compound was analyzed for, but not detected at the reported concentration. |
| J | Indicates an estimated concentration when a value is less than the calculated reporting limit. |
| D | Indicates the surrogate/spike(s) was not detected, due to dilution of extract. |
| NR | Indicates the surrogate recovery cannot be reported due to matrix interference. |
| E | Indicates a value above the linear range of the detector, sample dilution is required. |
| S | Indicates no value reported due to saturation of the detector, sample dilution required. |
| NA | Indicates compound was not analyzed for. |
| M | Indicates an estimated value of analyte found and confirmed by the analyst but with a low spectral match (GC-MS). |
| B | Indicates possible/probable blank contamination. Flagged when the analyte is detected in the blank as well as in the sample. |
| Y | Indicates raised reporting limit due to background interference or to activity in the instrument. Compound is still not detected at or above the raised level. |
| C | Indicates a probably detection that cannot be confirmed due to matrix interferences. |
| P | Indicates a high RPD between detected concentrations for dual column GC analyses without obvious interference. |
| **Data Validation Qualifiers for Organic Analyses** | |
| U | The analyte was analyzed for, but was not detected above the reported sample quantitation limit. |
| J | The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample. |
| N | The analysis indicates the presence of an analyte for which there is presumptive evidence to make a “tentative identification”. |
| NJ | The analysis indicates the presence of an analyte that has been “tentatively identified” and the associated numerical value represents its approximate concentration. |
| UJ | The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample. |
| R | The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified. |

**Table B-3 Explanation of Data Qualifiers**
**North Area**
**Boeing Plant 2**

| Data Qualifier | Explanation |
|---|---|
| **Data Validation Qualifiers for Inorganic Analyses** | |
| U | The compound was analyzed for, but was not detected above the reported sample quantitation limit. |
| J | The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample. |
| J+ | The result is an estimated quantity, but the result may be biased high. |
| J- | The result is an estimated quantity, but the result may be biased low. |
| R | The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified. |
| UJ | The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample. |

**Boeing Plant 2**
**Seattle/Tukwila, Washington**

# Uplands Corrective Measures
# Volume VIIa: North Area

# Data Gap Investigation Work Plan

# Attachment B
# Maps

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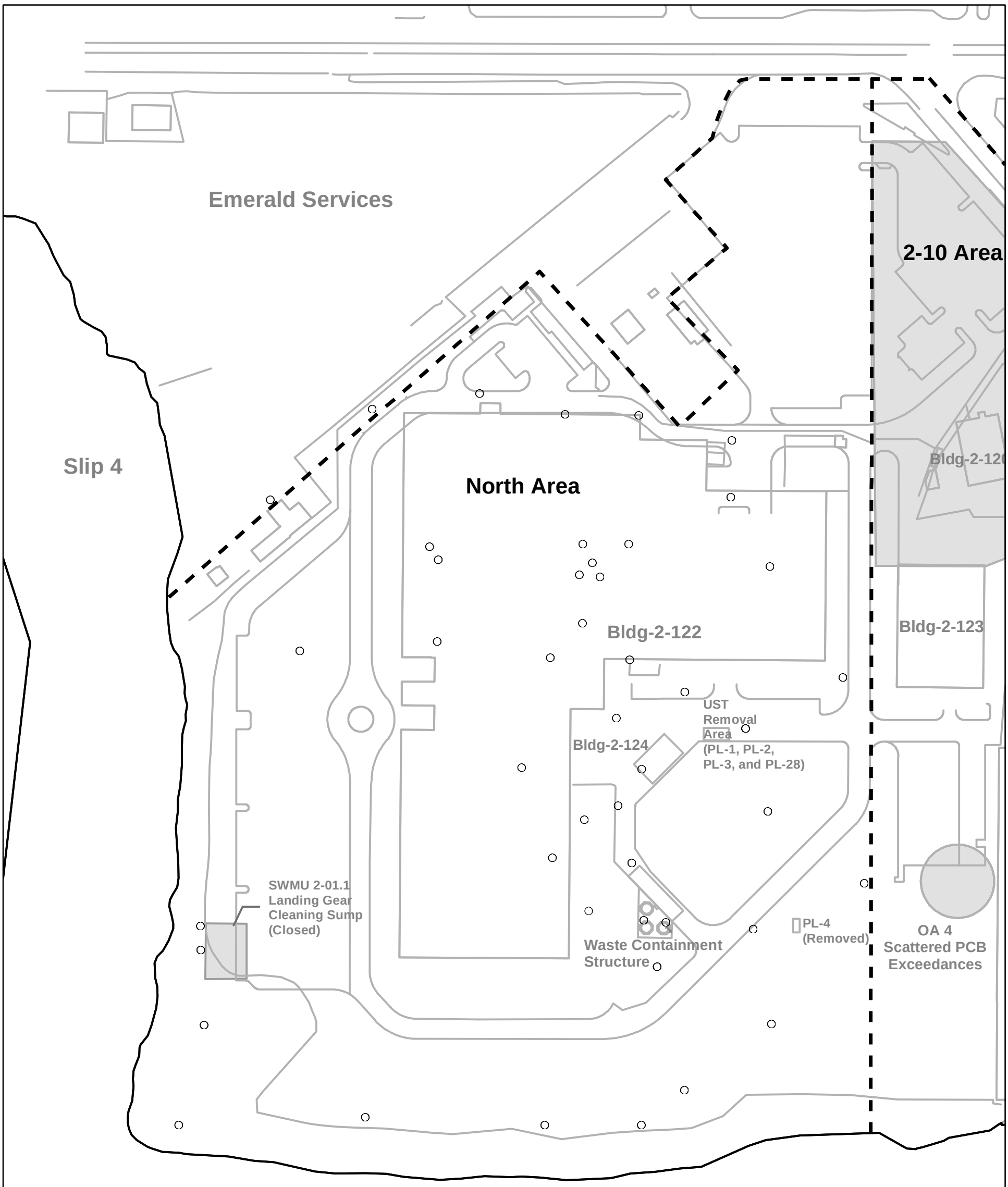



**Soil Screening Level = 7.3 mg/kg**
**Proposed Media Cleanup Level (PMCL) = 7.3 mg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

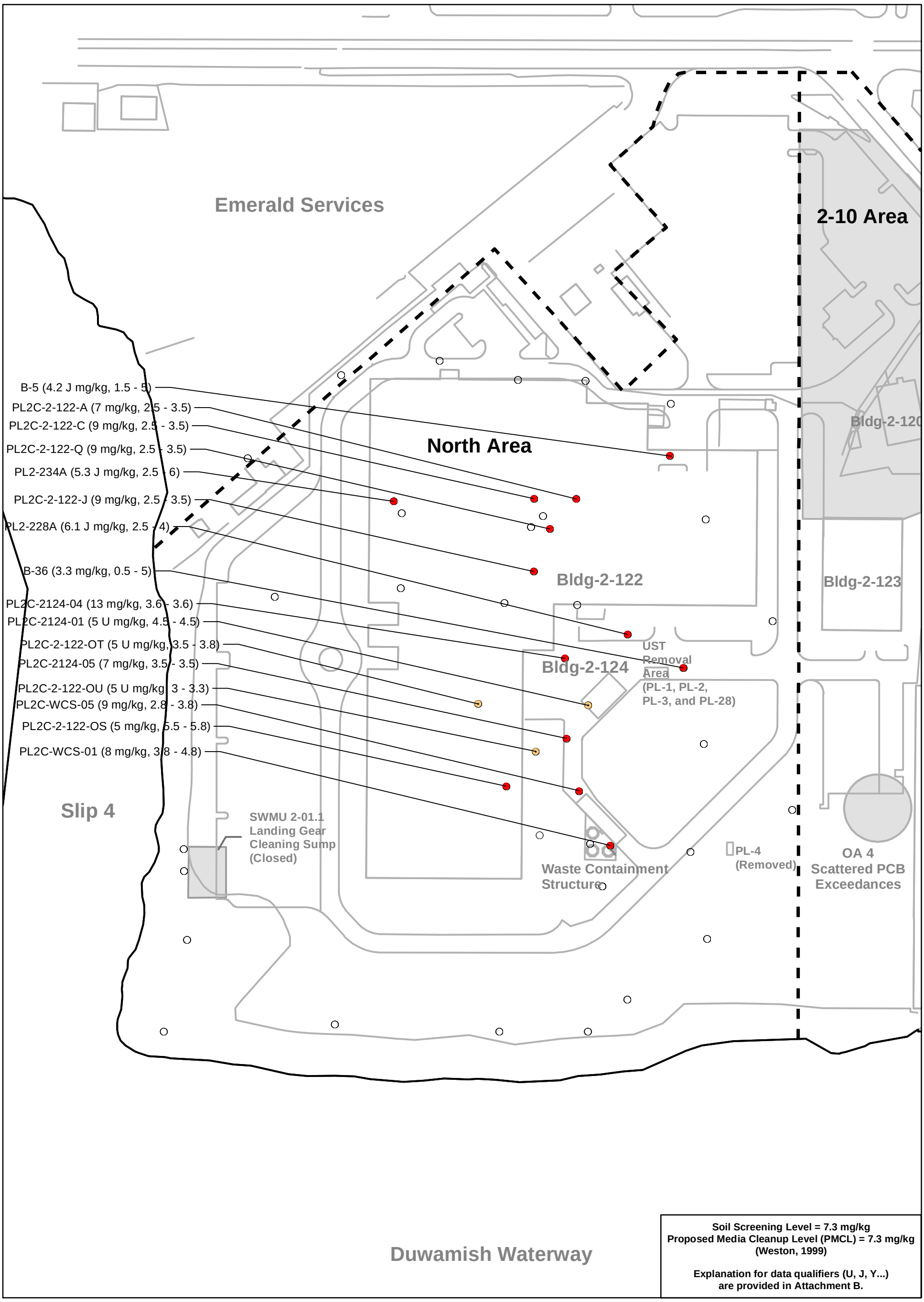
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
ARSENIC IN SOIL: DEPTH 0 - 1 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 1 |
|---|---|---|---|

0131646004100_ARSENICNY1.mxd | 01/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 7.3 mg/kg**
**Proposed Media Cleanup Level (PMCL) = 7.3 mg/kg (Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...) are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

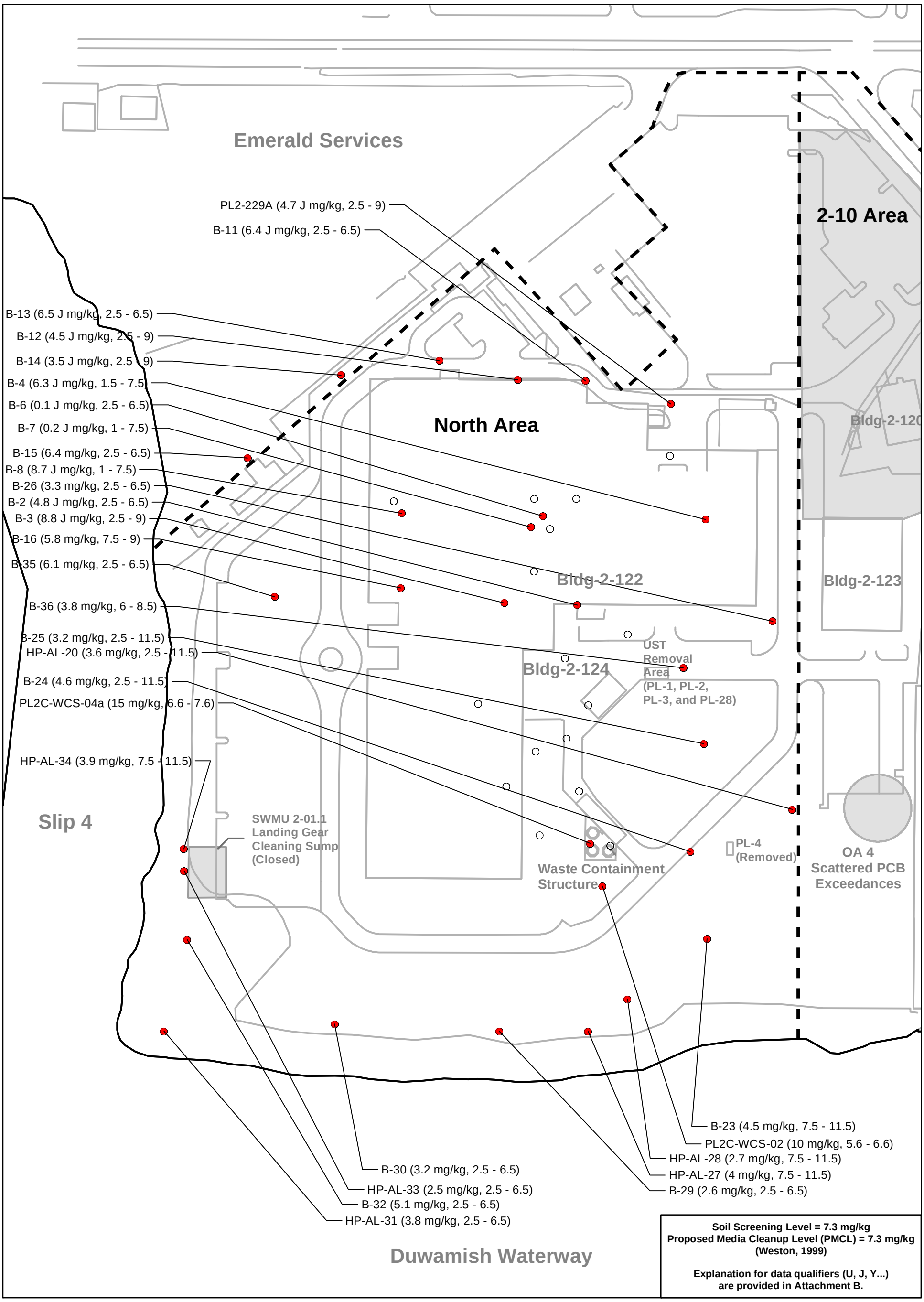
EPI, Golder Associates Inc., Weston Solutions, Inc.

NORTH AREA
ARSENIC IN SOIL: DEPTH 1 - 6 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 2 |
|---|---|---|---|

0131646004100_ARSENICNY2.mxd | 10/05/2007 | TBROUSSEAU

**Golder Associates**




**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

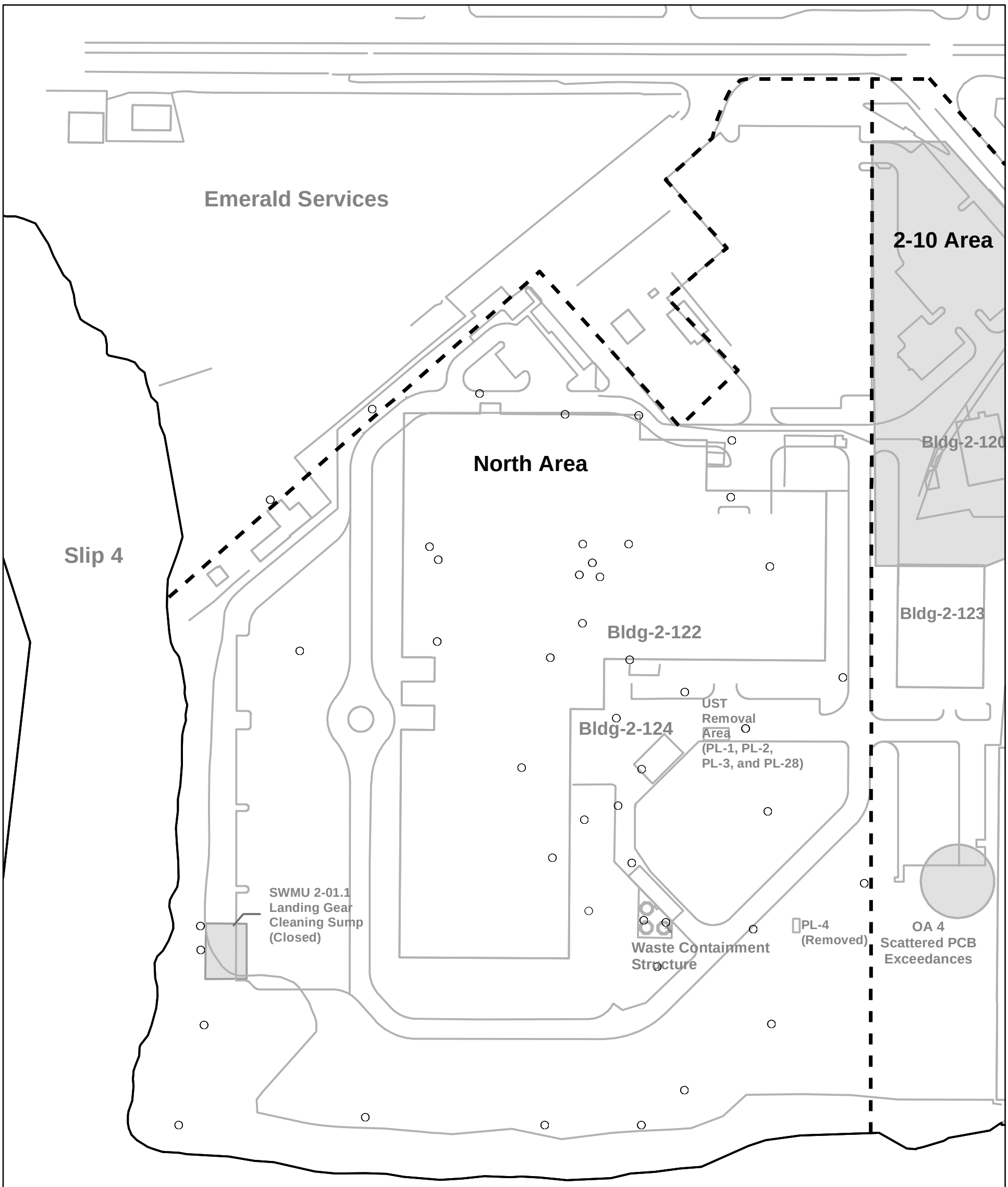
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
ARSENIC IN SOIL: DEPTH 6 - 12 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 3 |
|---|---|---|---|

0131646004100_ARSENICNY3.mxd | 10/05/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 1.21 mg/kg**
**Proposed Media Cleanup Level (PMCL) = 1.28 mg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

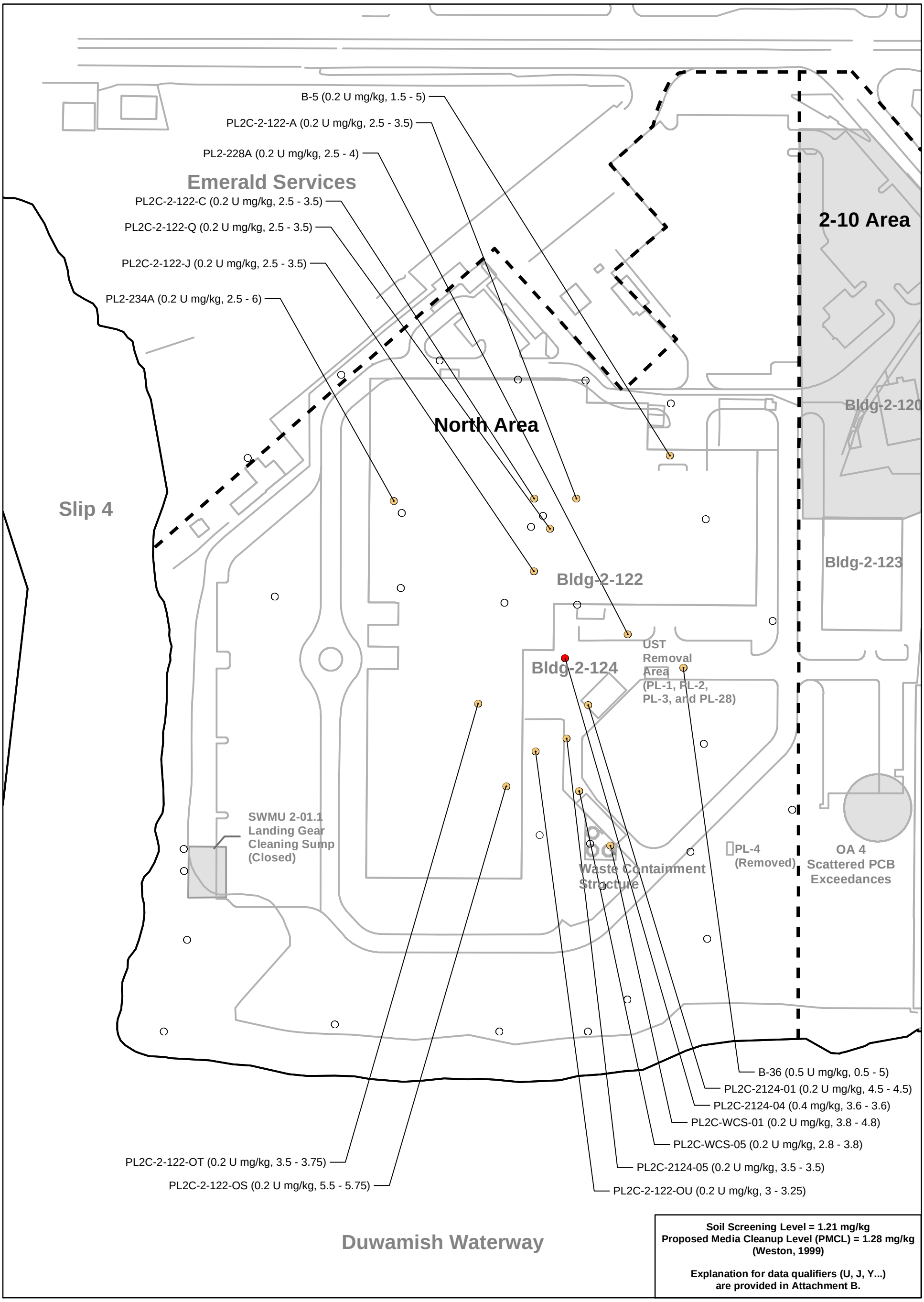
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
CADMIUM IN SOIL: DEPTH 0 - 1 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 1 |
|---|---|---|---|

0131646004100_CADMIUMNY1.mxd | 10/12/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 1.21 mg/kg**
**Proposed Media Cleanup Level (PMCL) = 1.28 mg/kg (Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...) are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

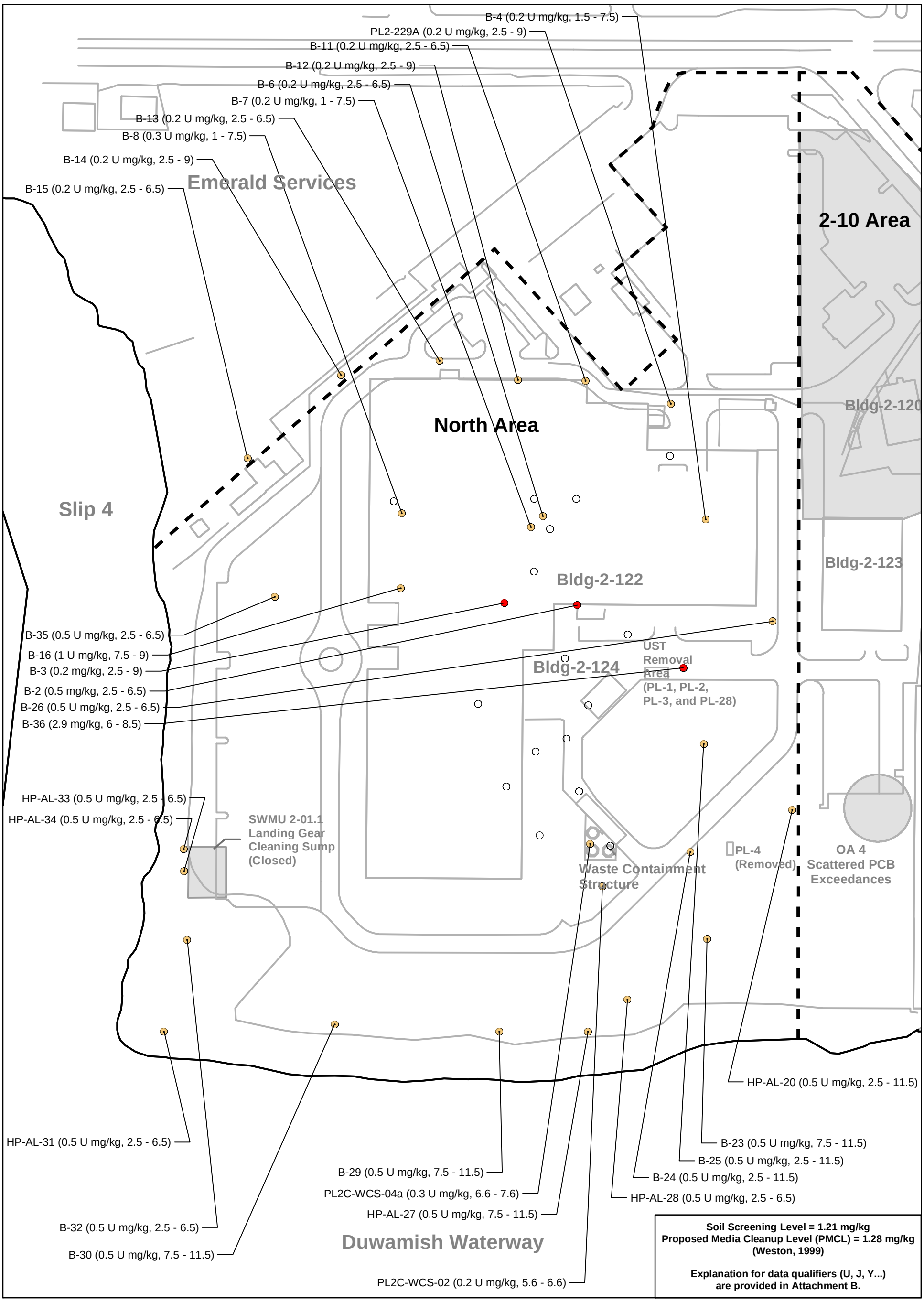
EPI, Golder Associates Inc., Weston Solutions, Inc.

NORTH AREA
CADMIUM IN SOIL: DEPTH 1 - 6 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 2 |
|---|---|---|---|

0131646004100_CADMIUMNY2.mxd | 10/05/2007 | TBROUSSEAU

**Golder Associates**




**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

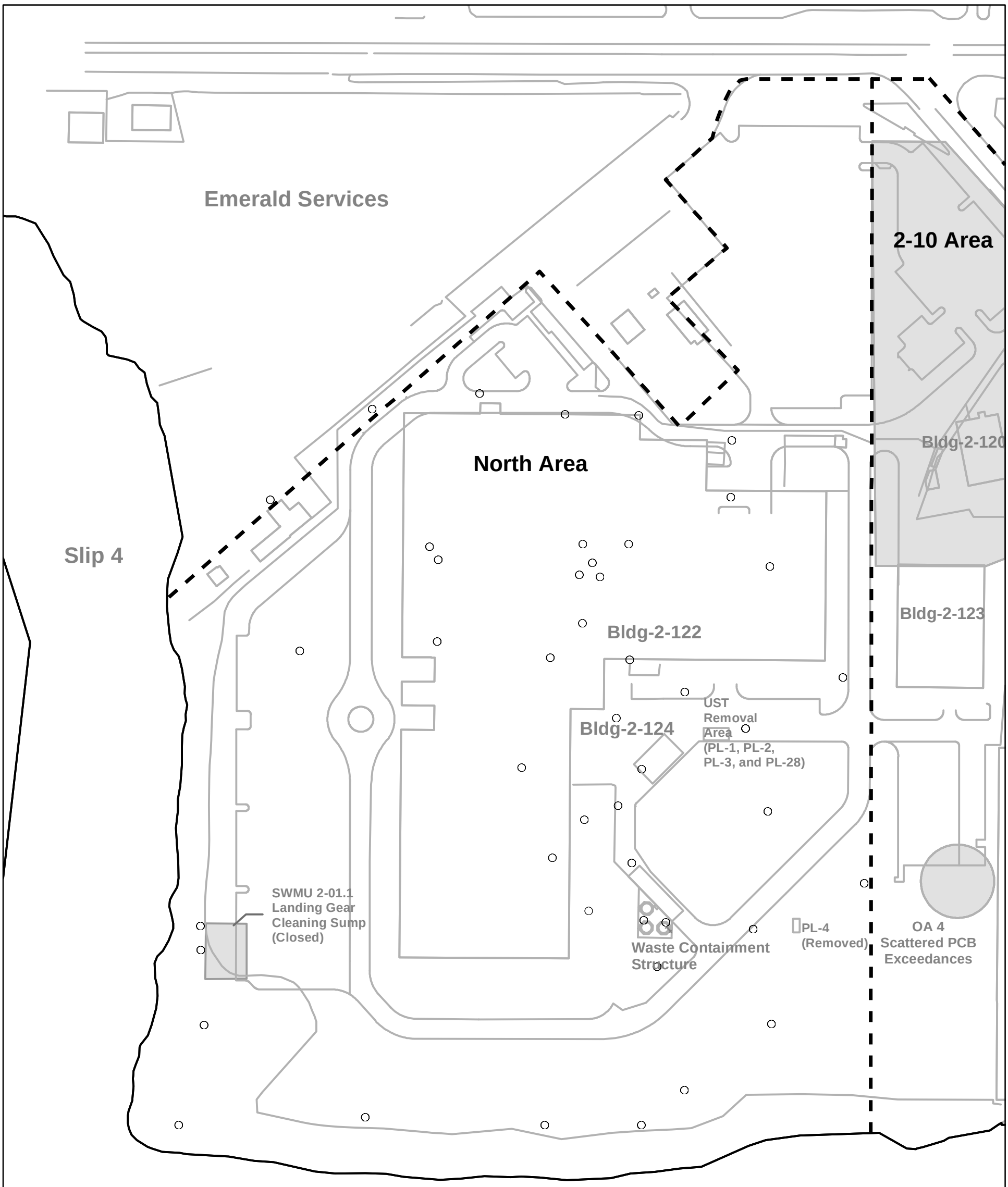
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
CADMIUM IN SOIL: DEPTH 6 - 12 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 3 |
|---|---|---|---|

0131646003200_CADMIUMNY3.mxd | 06/15/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 36.4 mg/kg**
**Proposed Media Cleanup Level (PMCL) = 36.4 mg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

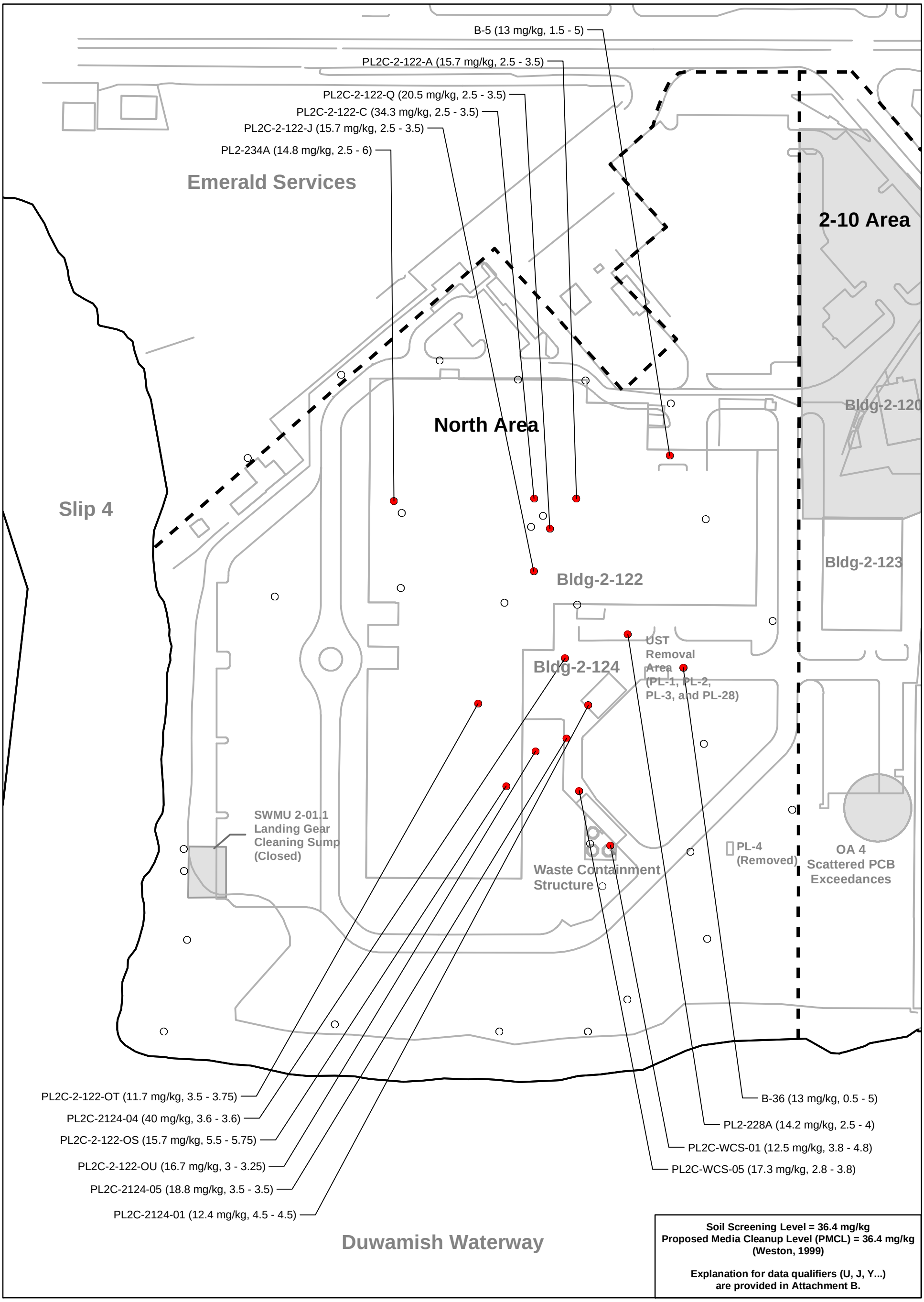
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
COPPER IN SOIL: DEPTH 0 - 1 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 1 |
|---|---|---|---|

0131646004100_COPPERNY1.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 36.4 mg/kg**
**Proposed Media Cleanup Level (PMCL) = 36.4 mg/kg (Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...) are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

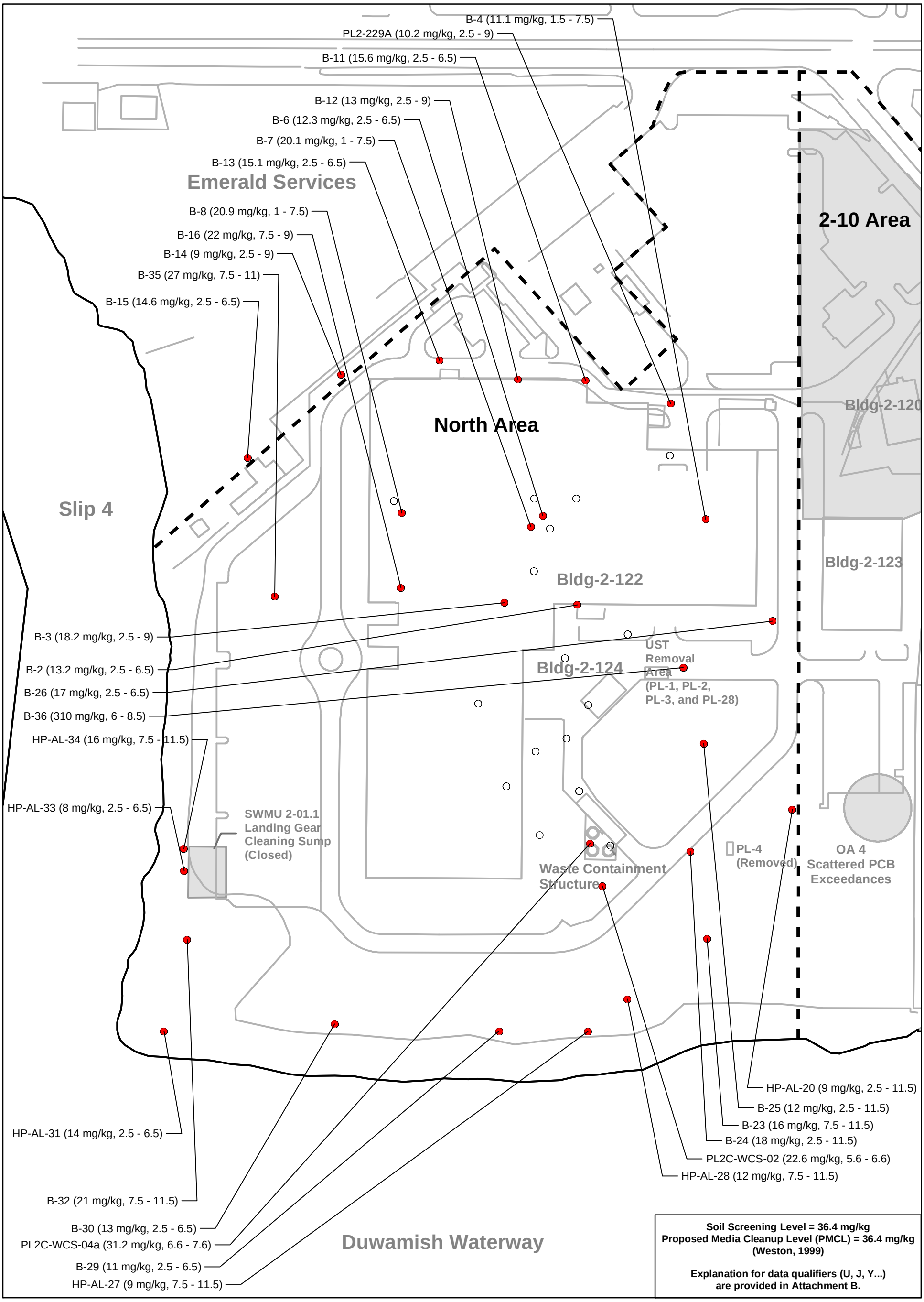
EPI, Golder Associates Inc., Weston Solutions, Inc.

NORTH AREA
COPPER IN SOIL: DEPTH 1 - 6 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 2 |
|---|---|---|---|

0131646004100_COPPERNY2.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120

Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA

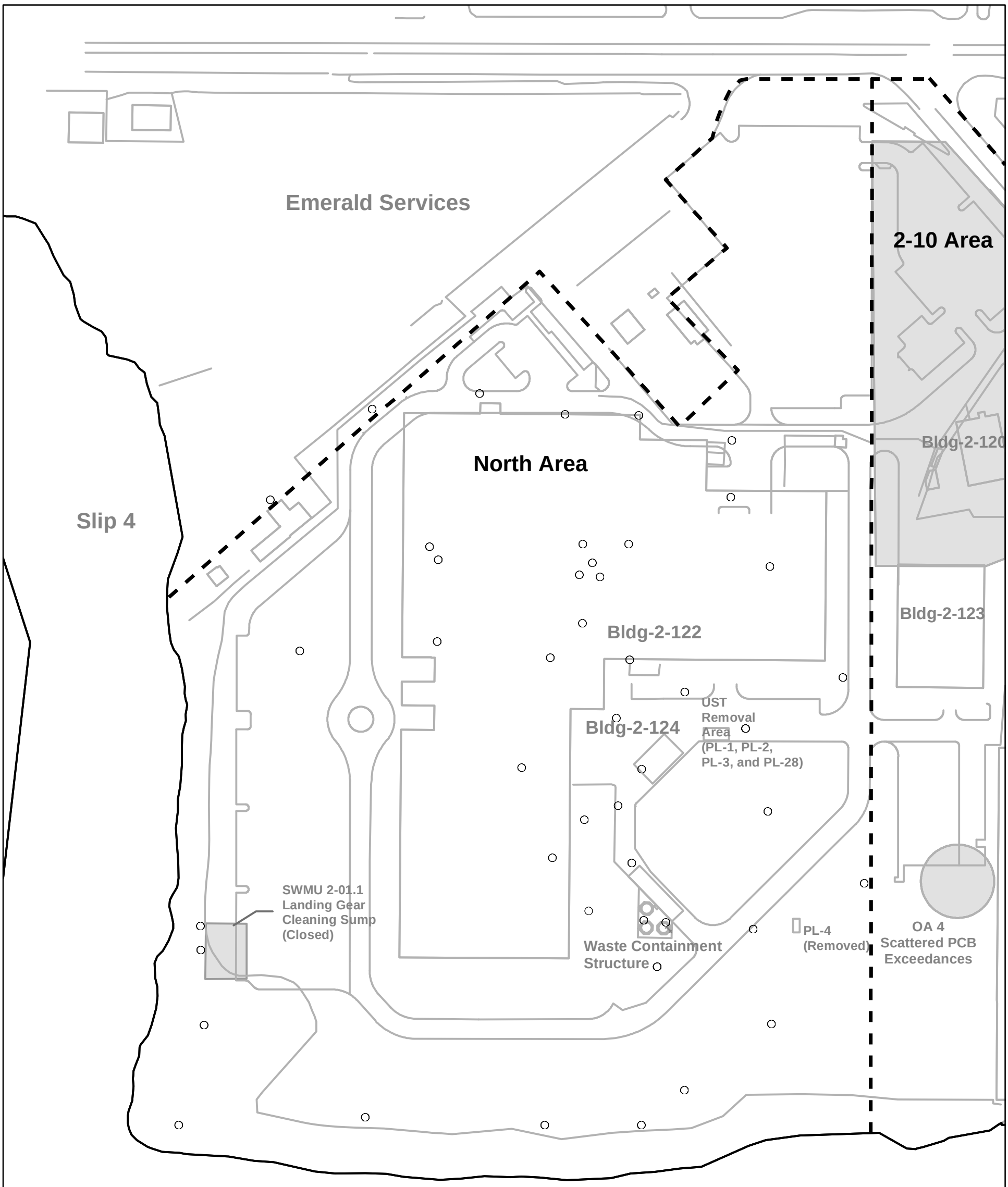
COPPER IN SOIL: DEPTH 6 - 12 FT

**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 3 |
|---|---|---|---|

0131646004100_COPPERNY3.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 0.07 mg/kg**
**Proposed Media Cleanup Level (PMCL) = 0.07 mg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

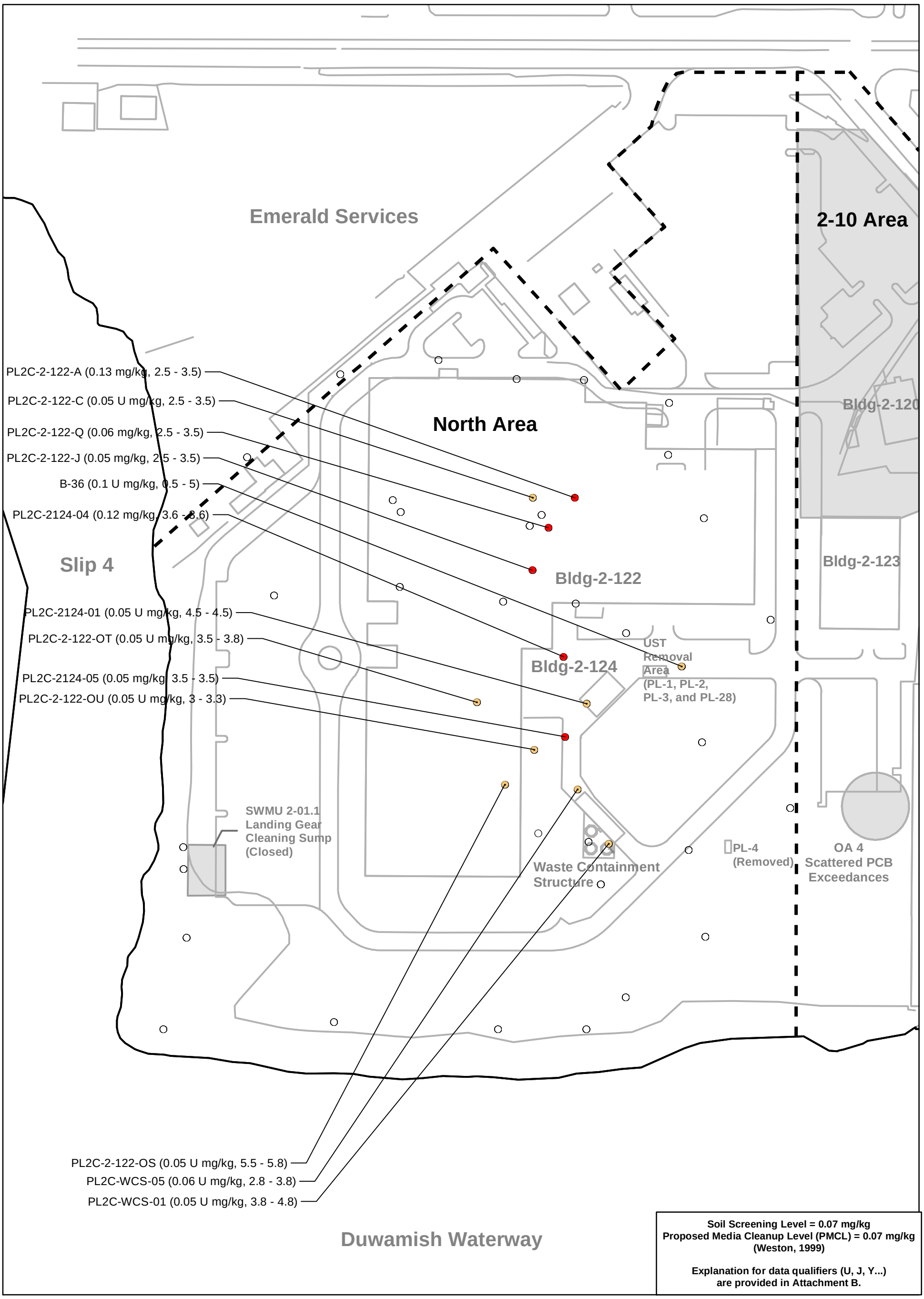
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
MERCURY IN SOIL: DEPTH 0 - 1 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 1 |
|---|---|---|---|

0131646004100_MERCURYNY1.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 0.07 mg/kg**
**Proposed Media Cleanup Level (PMCL) = 0.07 mg/kg (Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...) are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

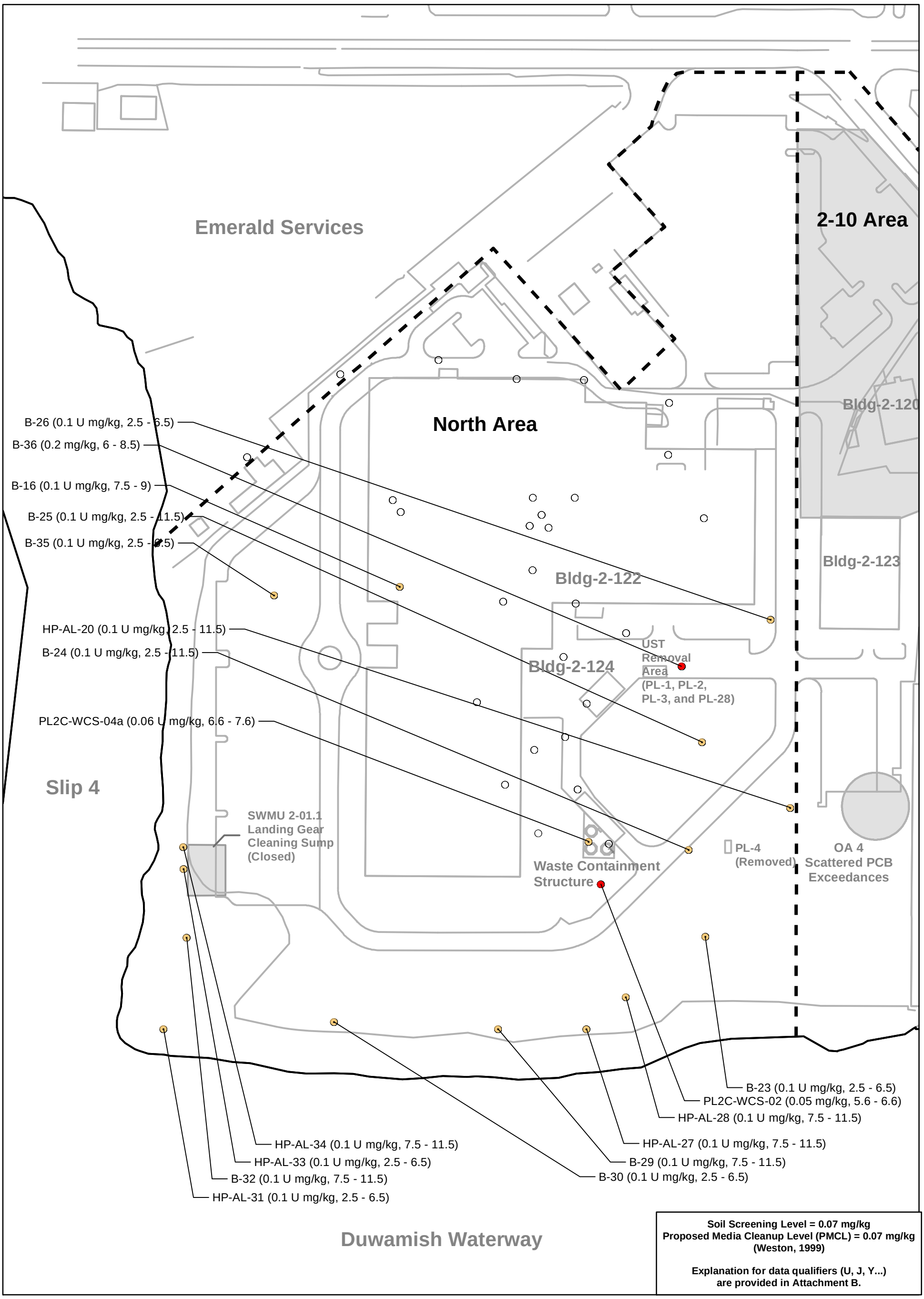
EPI, Golder Associates Inc., Weston Solutions, Inc.

NORTH AREA
MERCURY IN SOIL: DEPTH 1 - 6 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 2 |
|---|---|---|---|

0131646004100_MERCURYNY2.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 0.07 mg/kg**
**Proposed Media Cleanup Level (PMCL) = 0.07 mg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

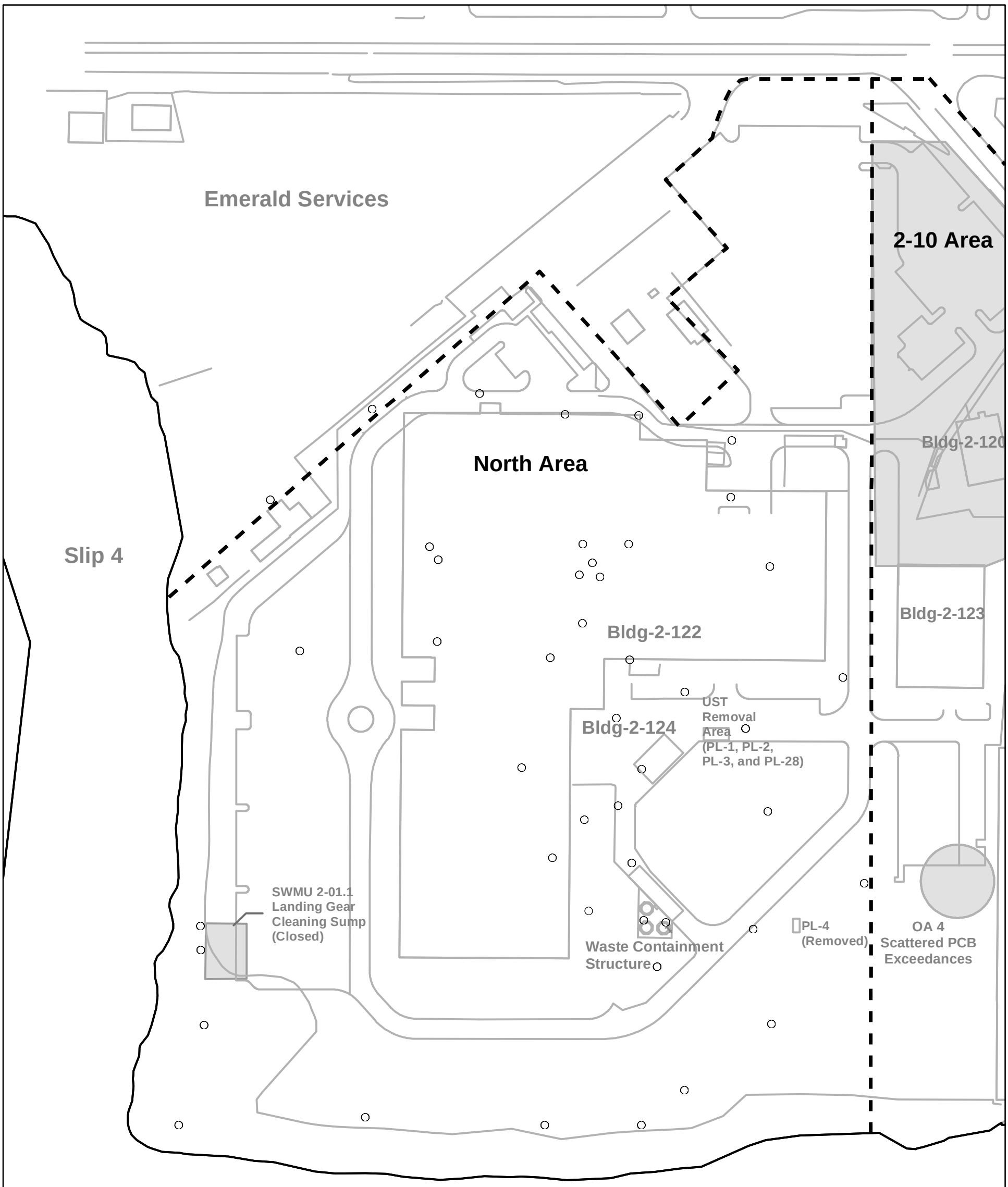
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
MERCURY IN SOIL: DEPTH 6 - 12 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 3 |
|---|---|---|---|

0131646004100_MERCURYNY3.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 101 mg/kg**
**Proposed Media Cleanup Level (PMCL) = 107 mg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

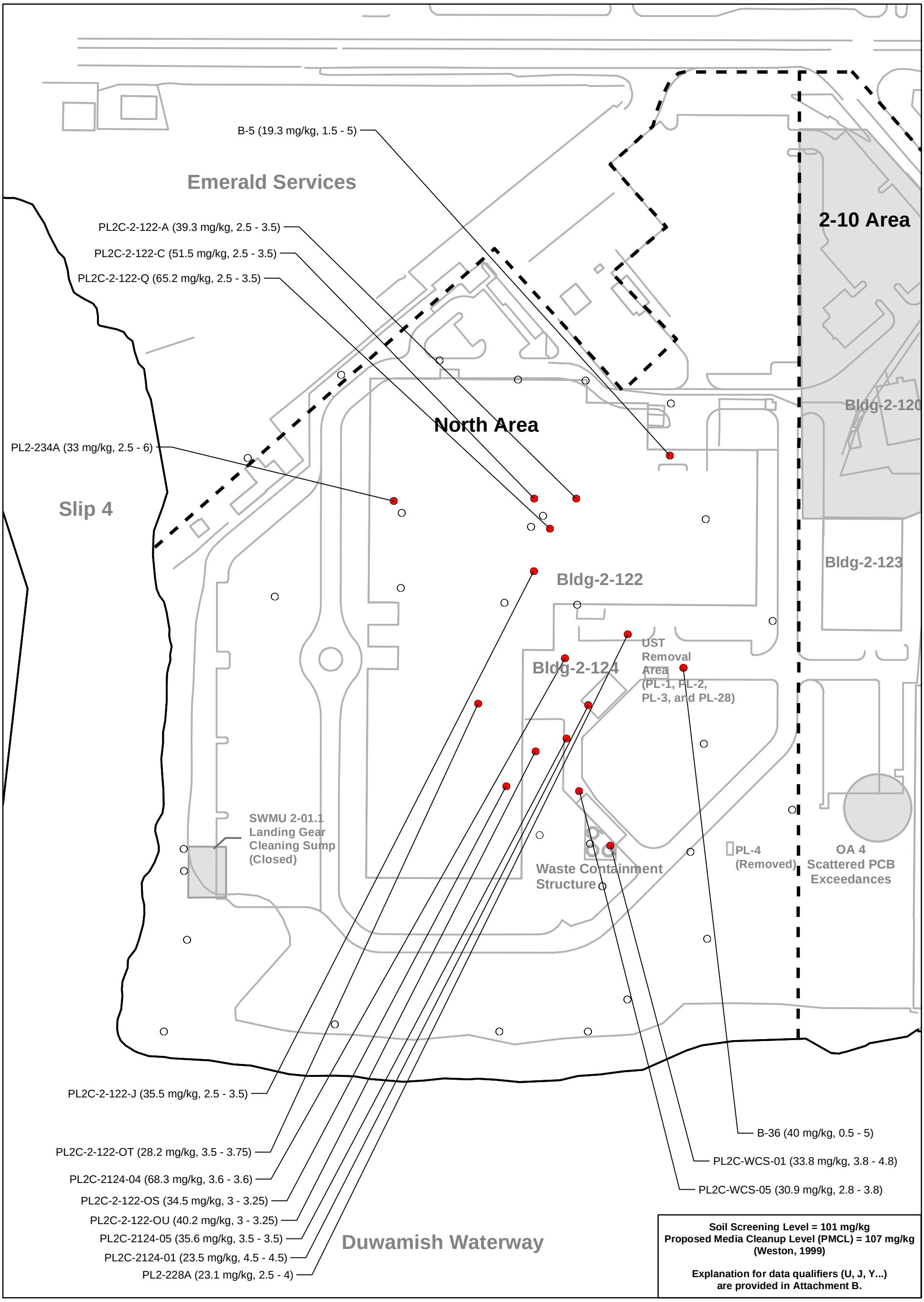
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
ZINC IN SOIL: DEPTH 0 - 1 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 1 |
|---|---|---|---|

0131646004100_ZINCNY1.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 101 mg/kg**
**Proposed Media Cleanup Level (PMCL) = 107 mg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

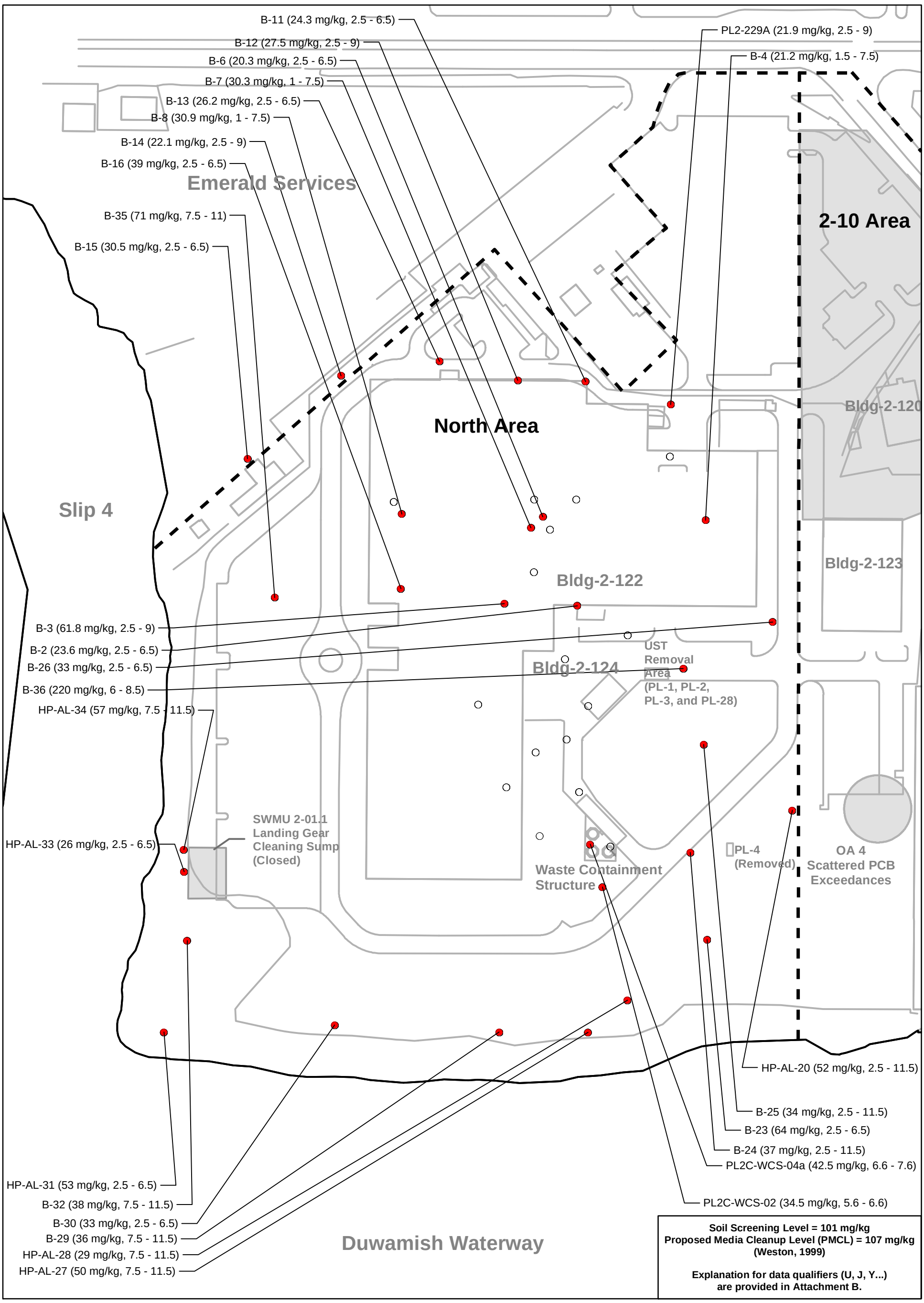
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
ZINC IN SOIL: DEPTH 1 - 6 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 2 |
|---|---|---|---|

0131646004100_ZINCNY2.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**LEGEND**

- Sample location where constituent was detected. (Concentration; mg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

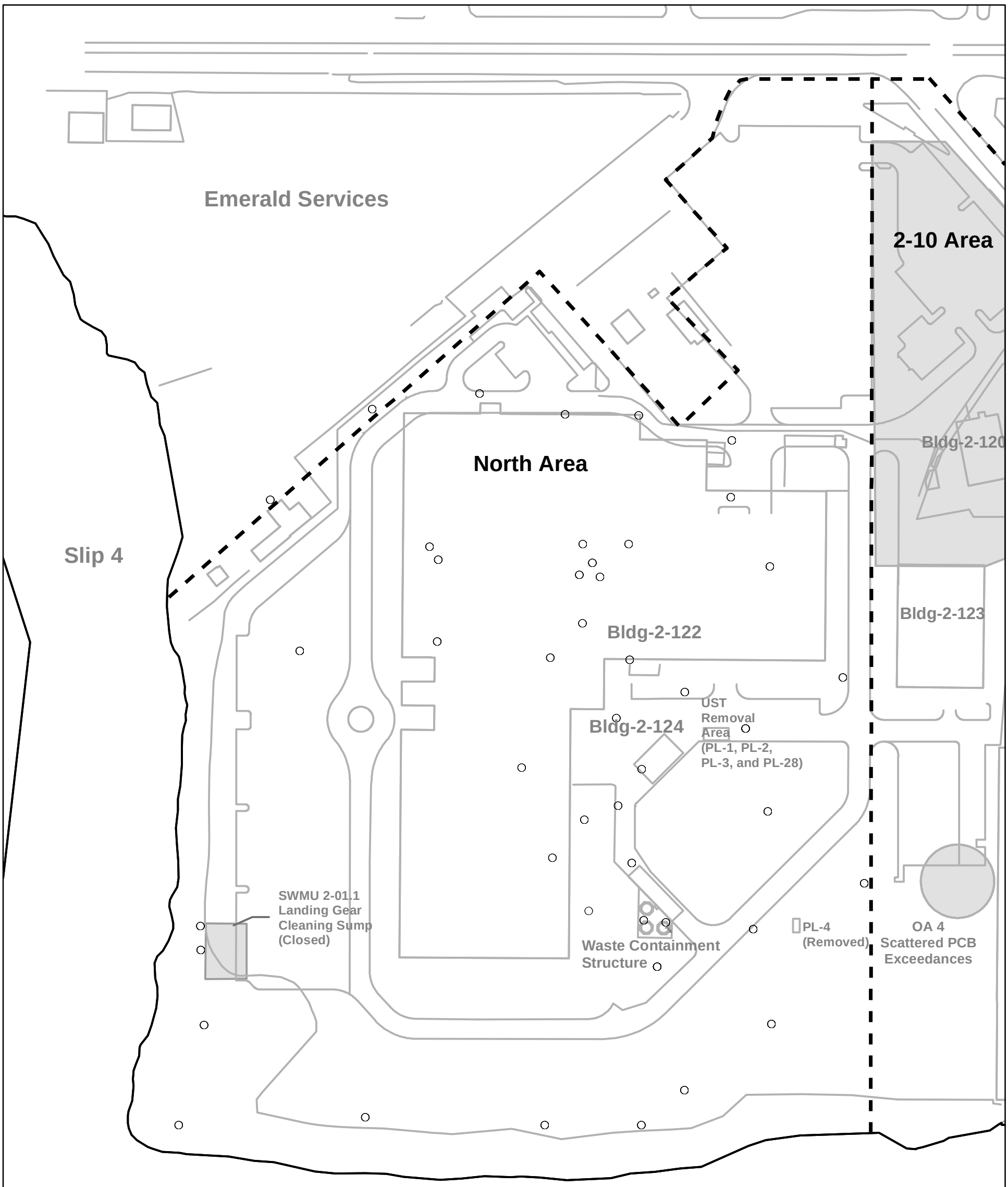
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
ZINC IN SOIL: DEPTH 6 - 12 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 3 |
|---|---|---|---|

0131646004100_ZINCNY3.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 41.9 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 2.9 µg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

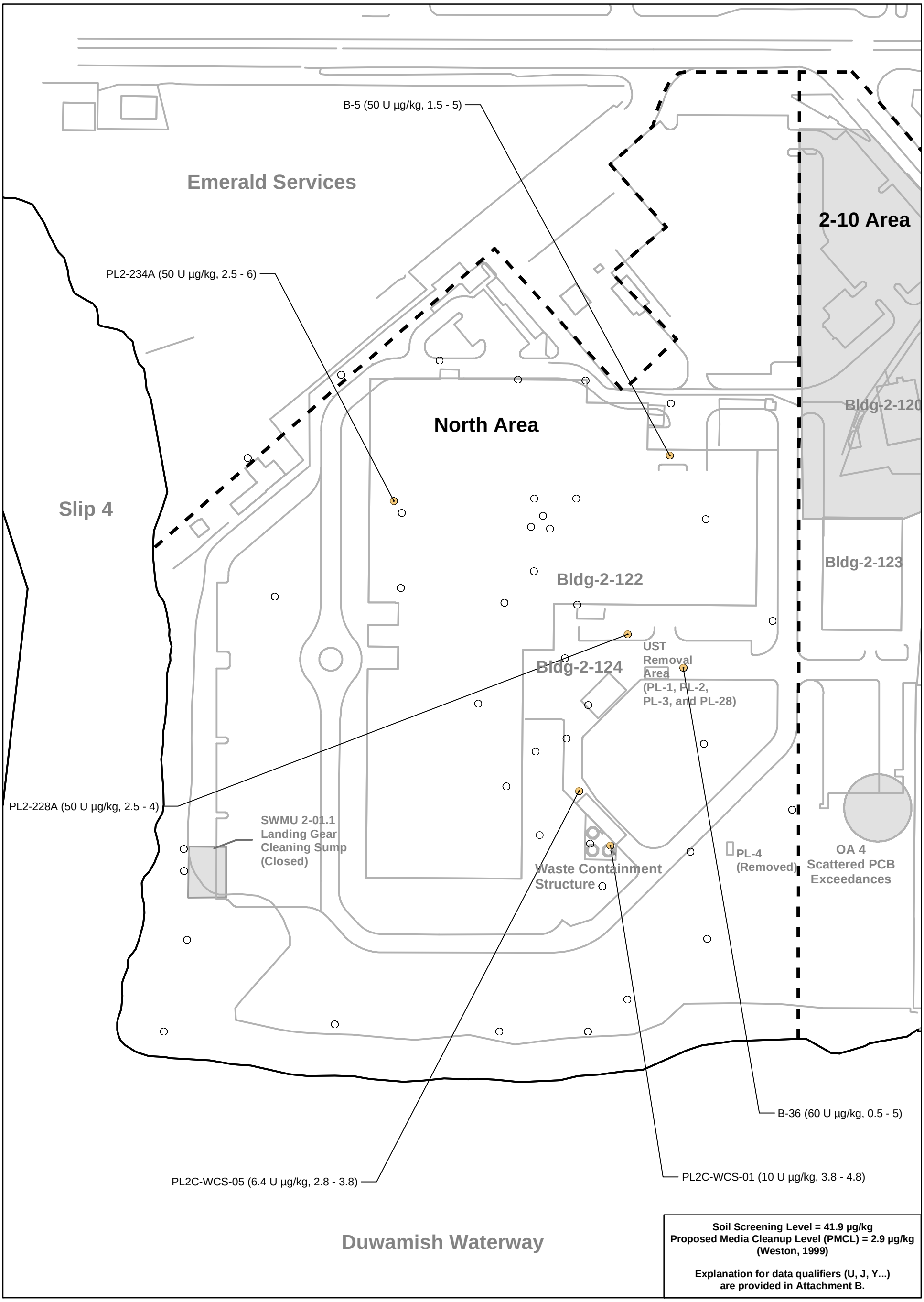
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
BENZO(A)ANTHRACENE IN SOIL: DEPTH 0 - 1 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 1 |
|---|---|---|---|

0131646004100_BENZOAANTHRACENENY1.mxd | 10/05/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 41.9 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 2.9 µg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

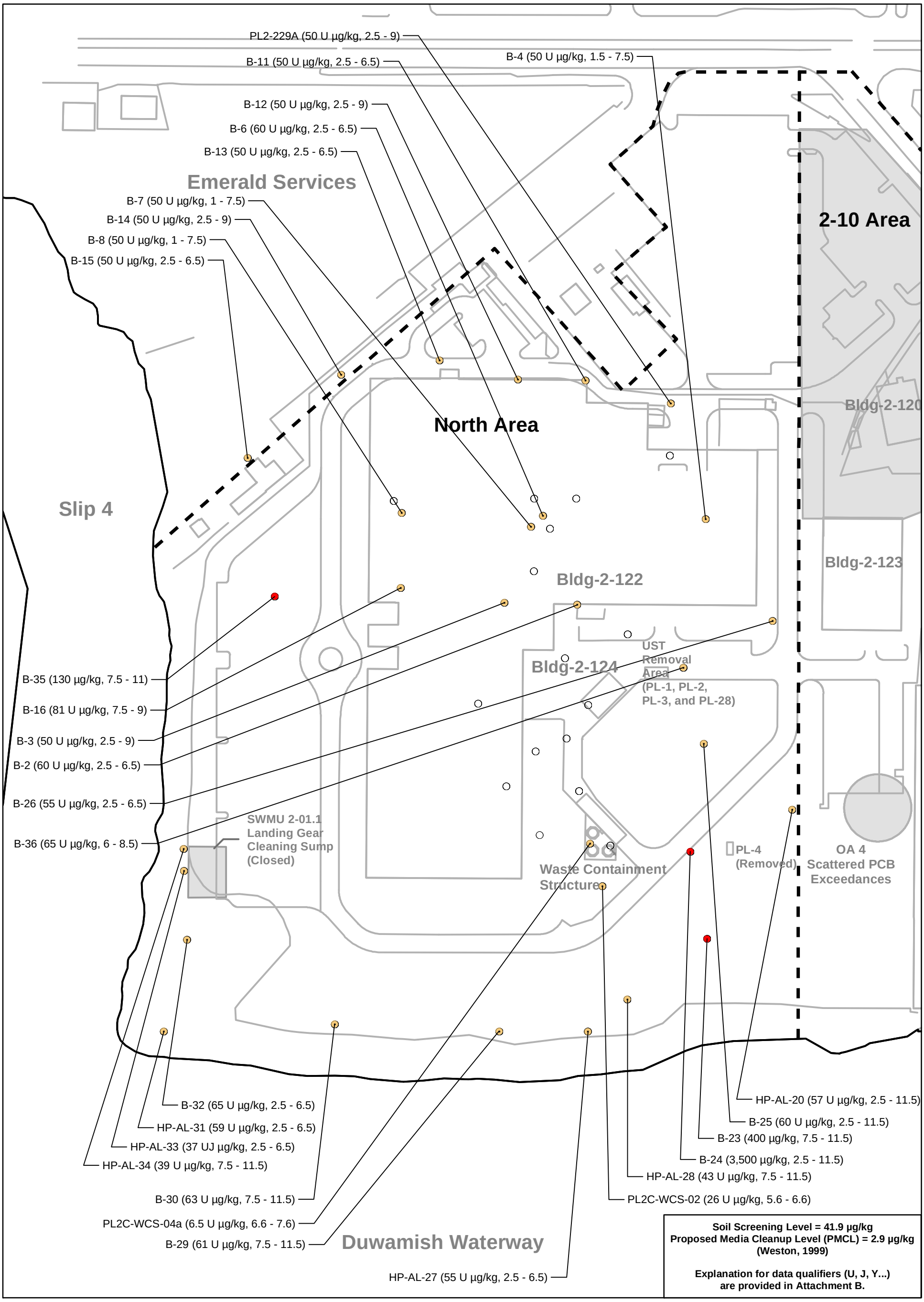
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
BENZO(A)ANTHRACENE IN SOIL: DEPTH 1 - 6 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 2 |
|---|---|---|---|

0131646004100_BENZOAANTHRACENENY2.mxd | 10/12/07 | TBROUSSEAU

**Golder Associates**




**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

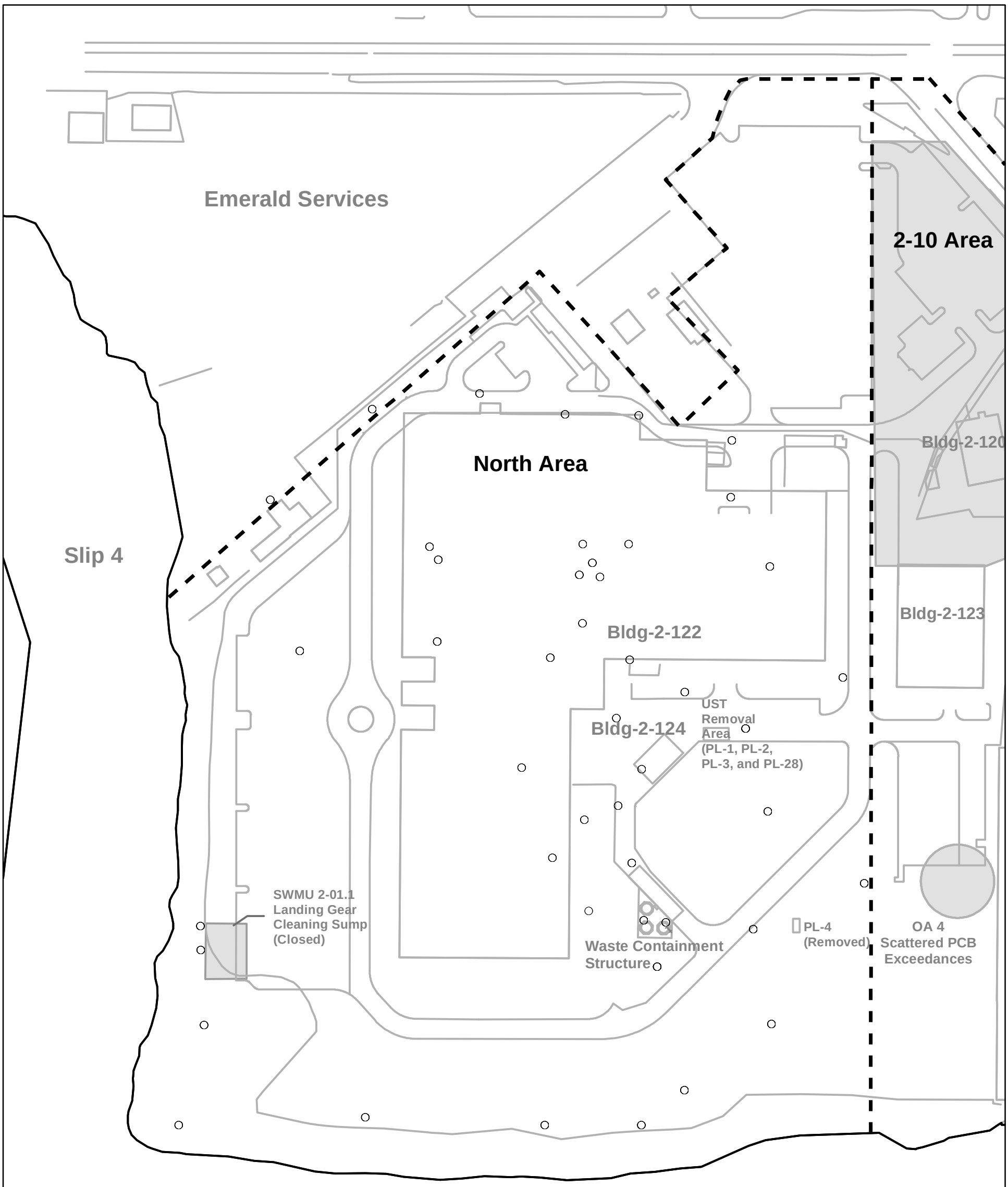
EPI, Golder Associates Inc., Weston Solutions, Inc.

NORTH AREA
BENZO(A)ANTHRACENE IN SOIL: DEPTH 6 - 12 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 3 |
|---|---|---|---|

0131646004100_BENZOAANTHRACENENY3.mxd | 10/12/07 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 113 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 2.9 µg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

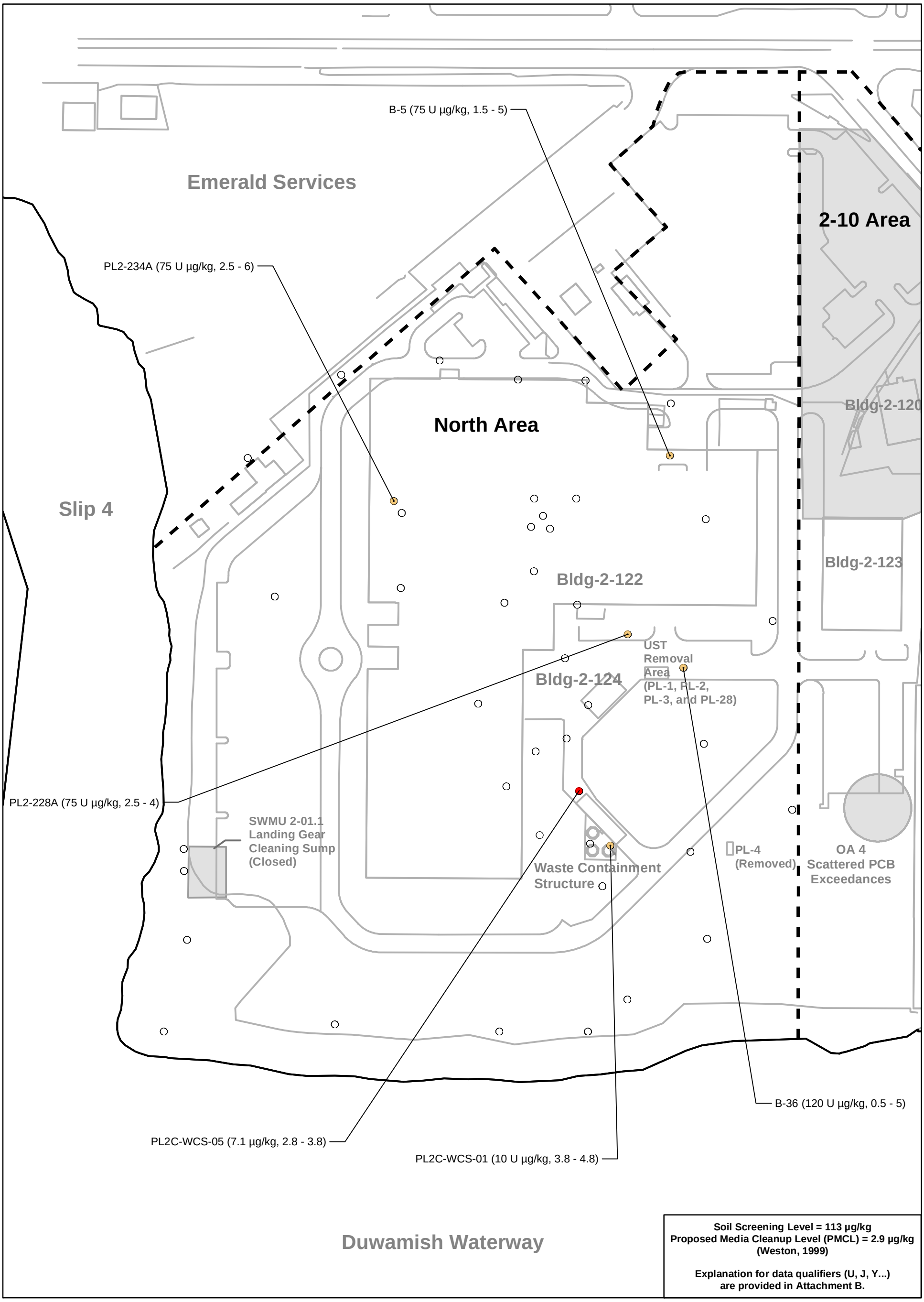
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
BENZO(A)PYRENE IN SOIL: DEPTH 0 - 1 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 1 |
|---|---|---|---|

0131646004100_BENZOAPYRENENY1.mxd | 10/05/07 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 113 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 2.9 µg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

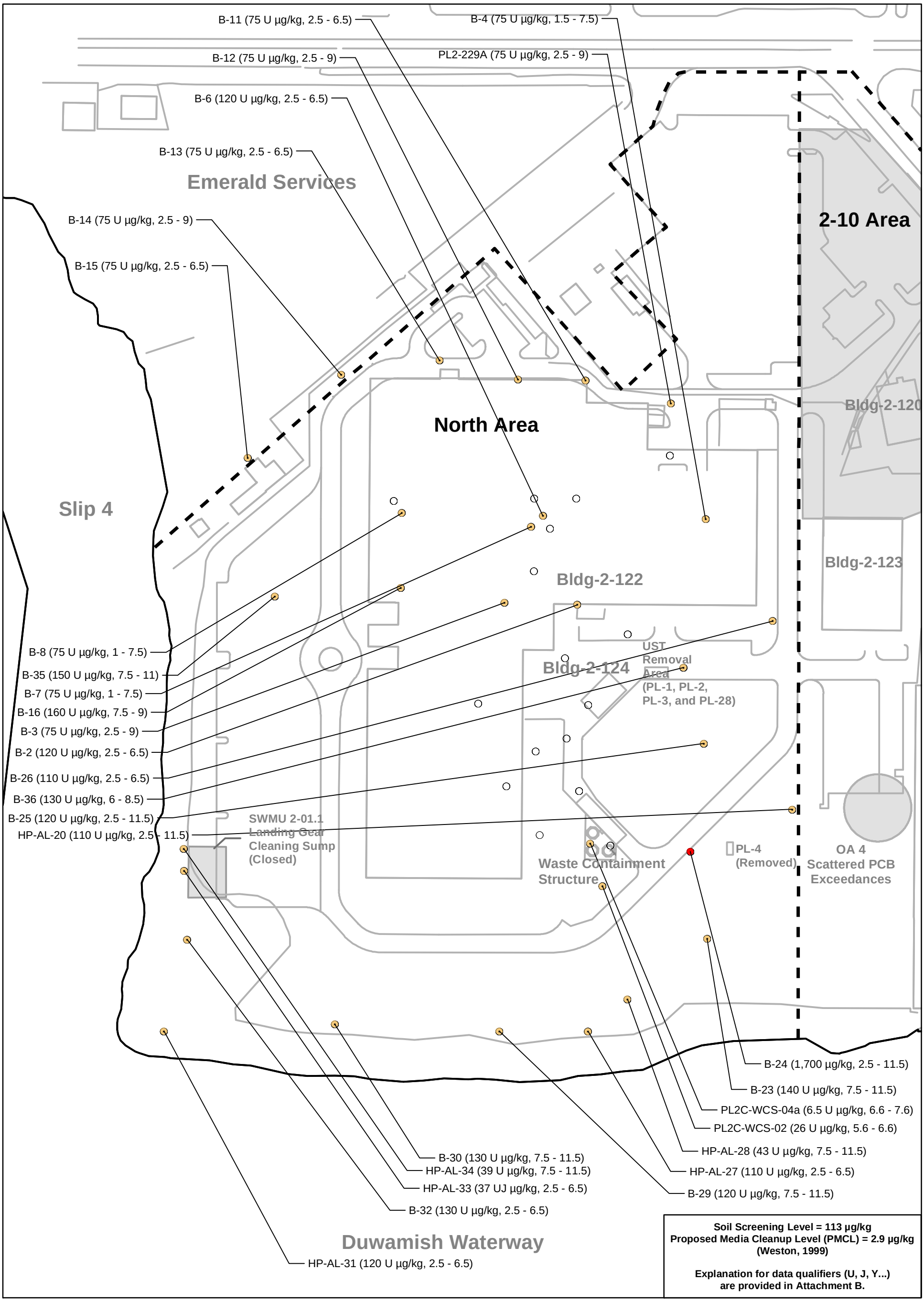
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
BENZO(A)PYRENE IN SOIL: DEPTH 1 - 6 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 2 |
|---|---|---|---|

0131646004100_BENZOAPYRENENY2.mxd | 10/05/2007 | TBROUSSEAU

**Golder Associates**




**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

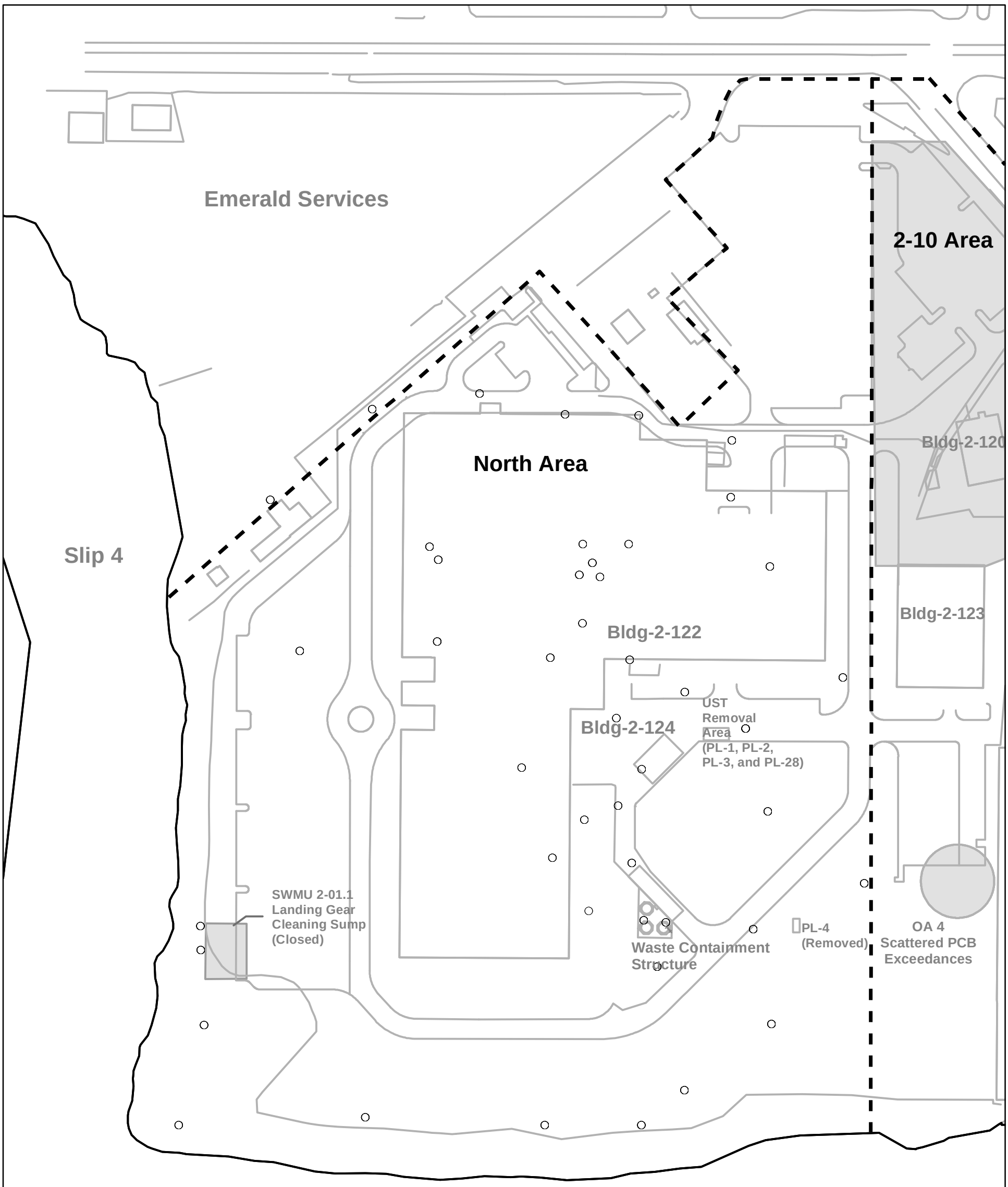
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
BENZO(A)PYRENE IN SOIL: DEPTH 6 - 12 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 3 |
|---|---|---|---|

0131646004100_BENZOAPYRENENY3.mxd | 10/05/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 144 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 2.9 µg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

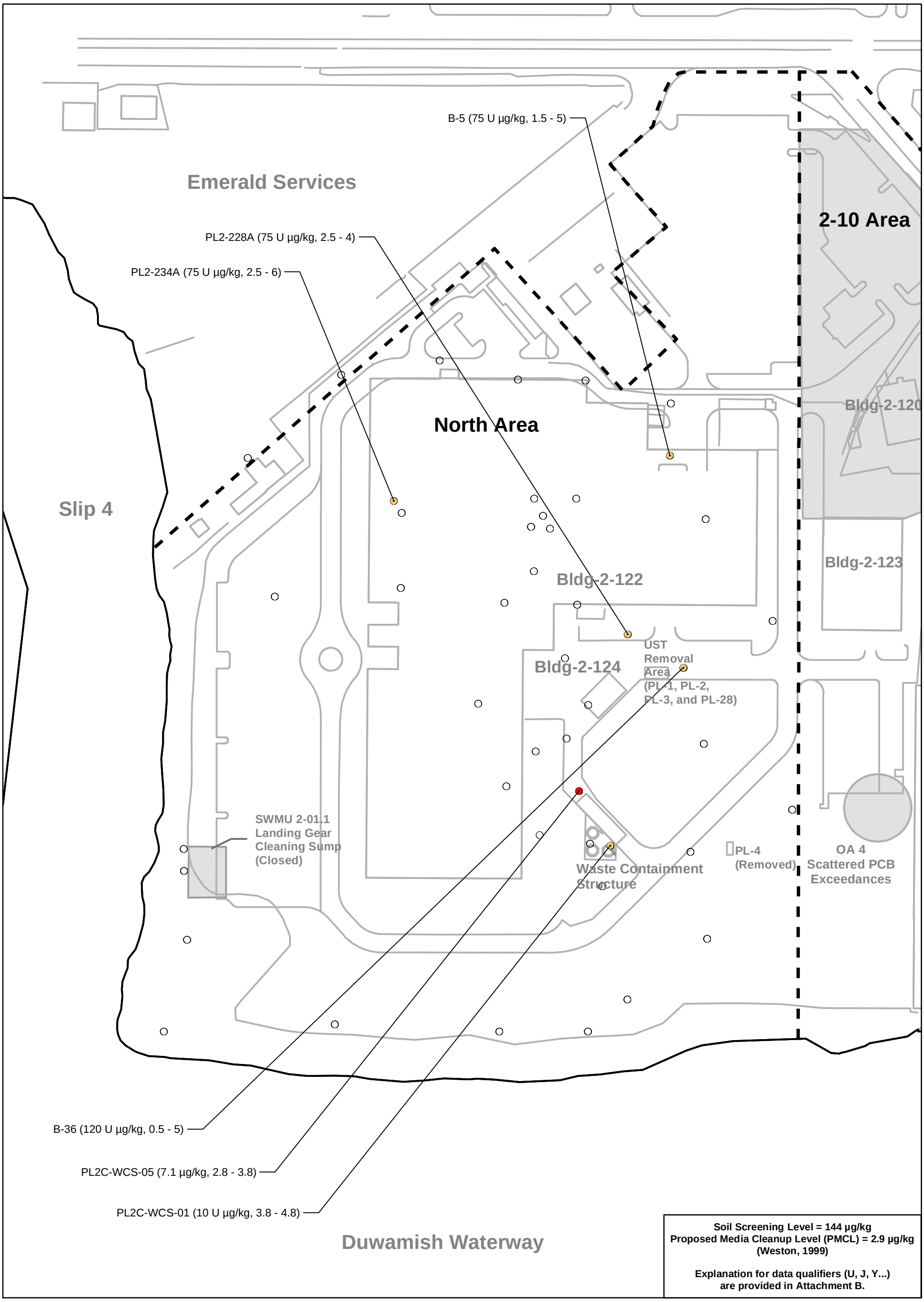
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
BENZO(B)FLUORANTHENE IN SOIL: DEPTH 0 - 1 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 1 |
|---|---|---|---|

0131646004100_BENZOBFLUORANTHENENY1.mxd | 10/05/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 144 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 2.9 µg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

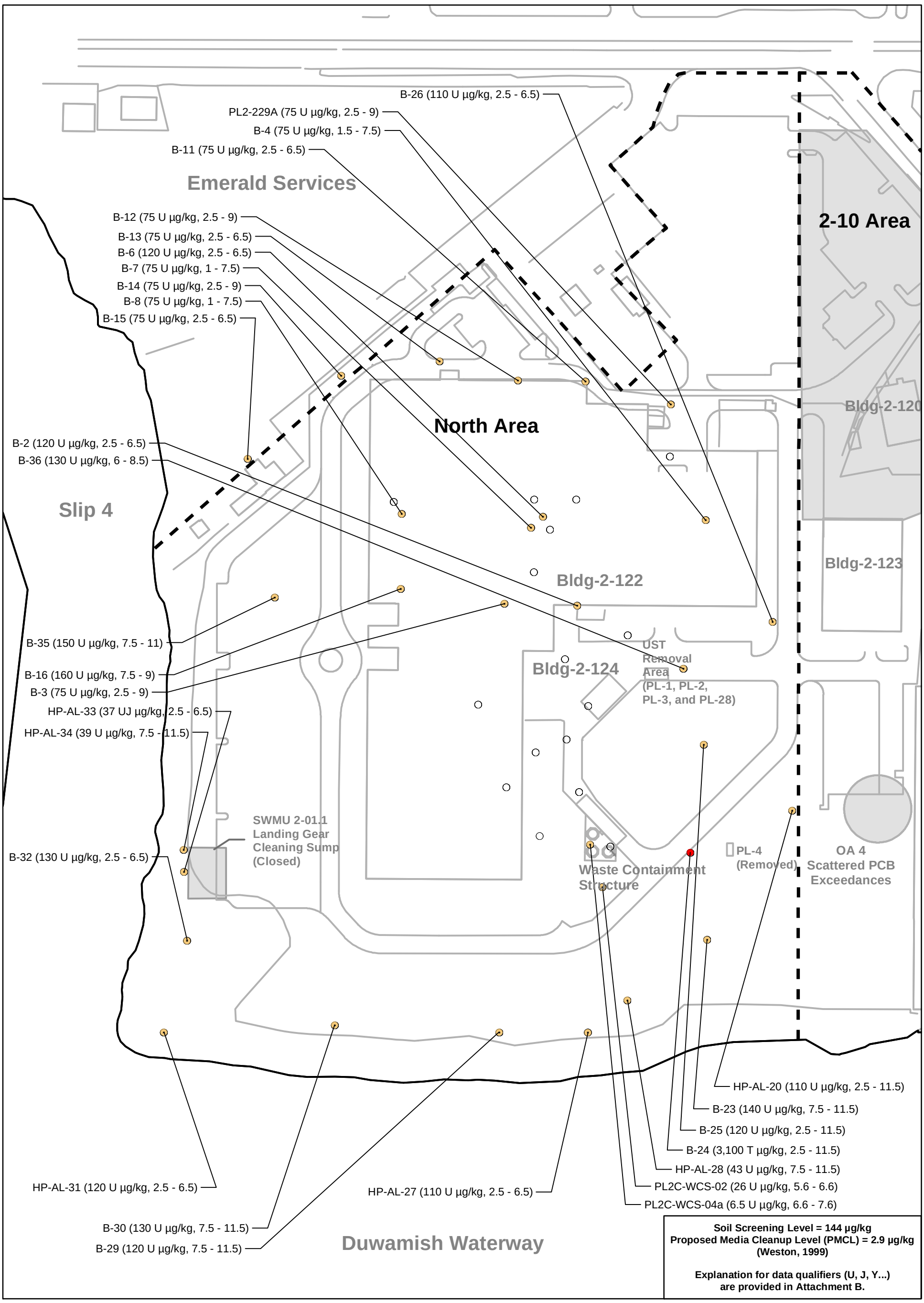
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
BENZO(B)FLUORANTHENE IN SOIL: DEPTH 1 - 6 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 2 |
|---|---|---|---|

0131646004100_BENZOBFLUORANTHENENY2.mxd | 10/05/2007 | TBROUSSEAU

**Golder Associates**




**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

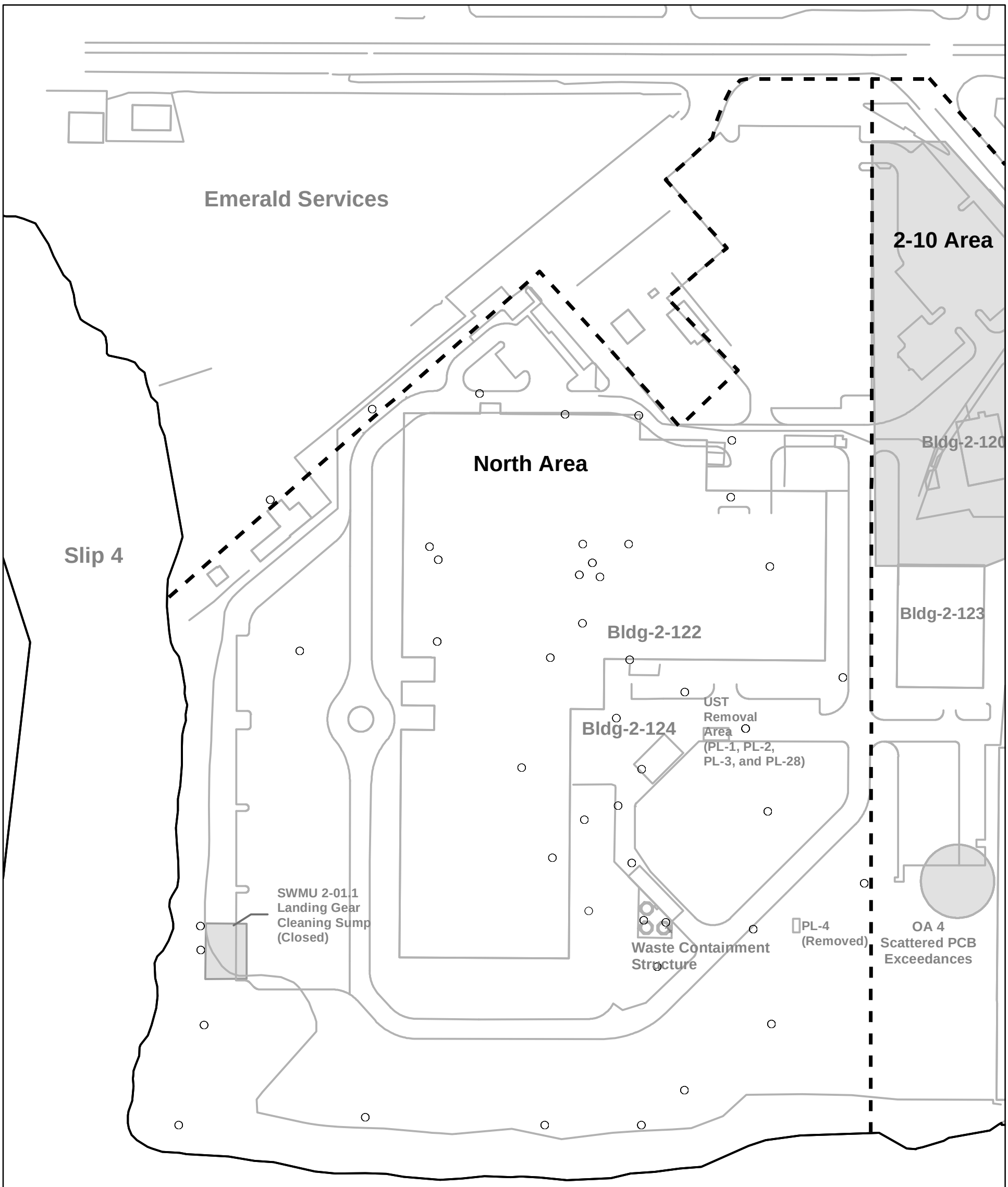
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
BENZO(B)FLUORANTHENE IN SOIL: DEPTH 6 - 12 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 3 |
|---|---|---|---|

0131646004100_BENZOBFLUORANTHENENY3.mxd | 10/05/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 144 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 2.9 µg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

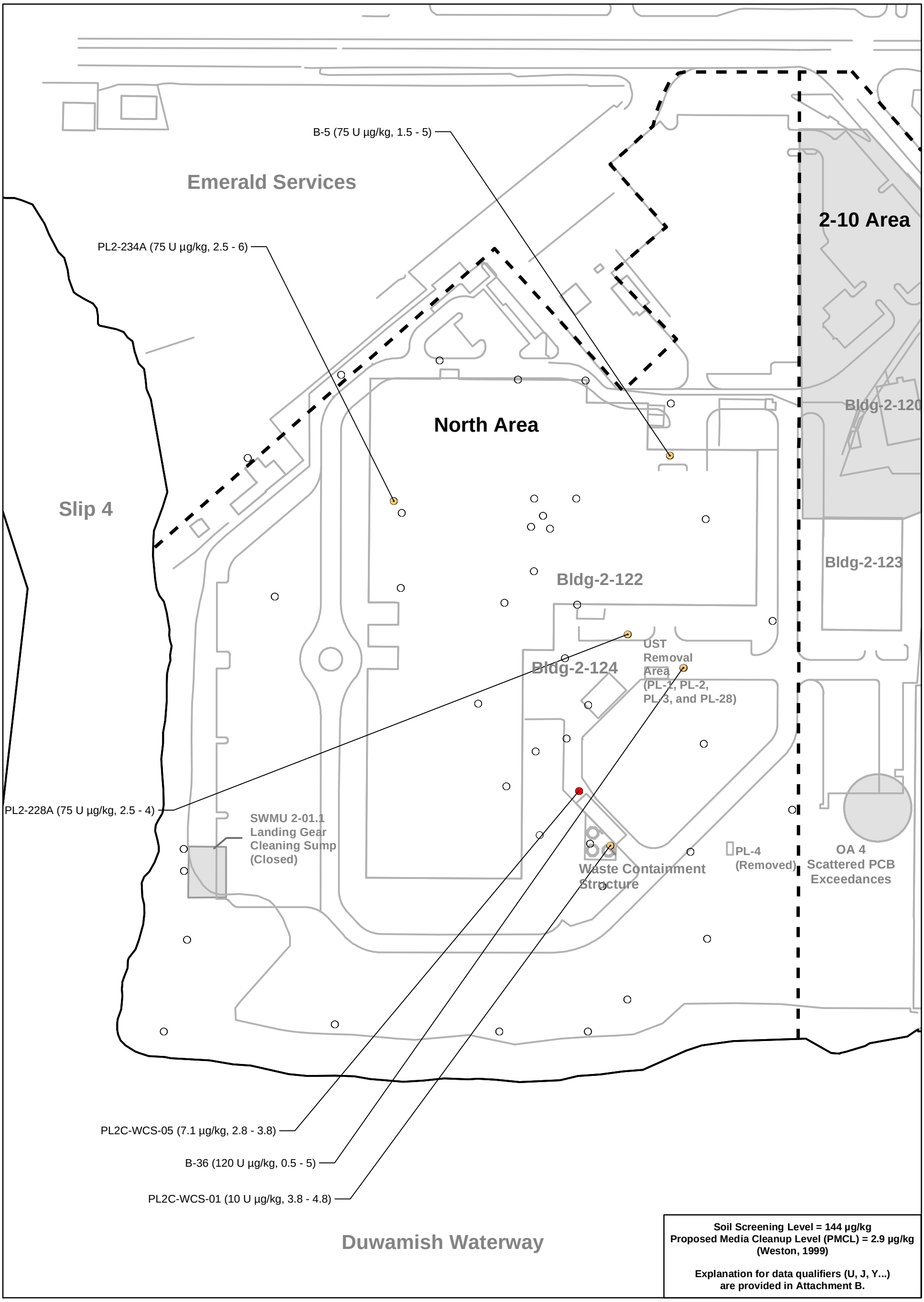
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
BENZO(K)FLUORANTHENE IN SOIL: DEPTH 0 - 1 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 1 |
|---|---|---|---|

0131646004100_BENZOKFLUORANTHENENY1.mxd | 10/05/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 144 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 2.9 µg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

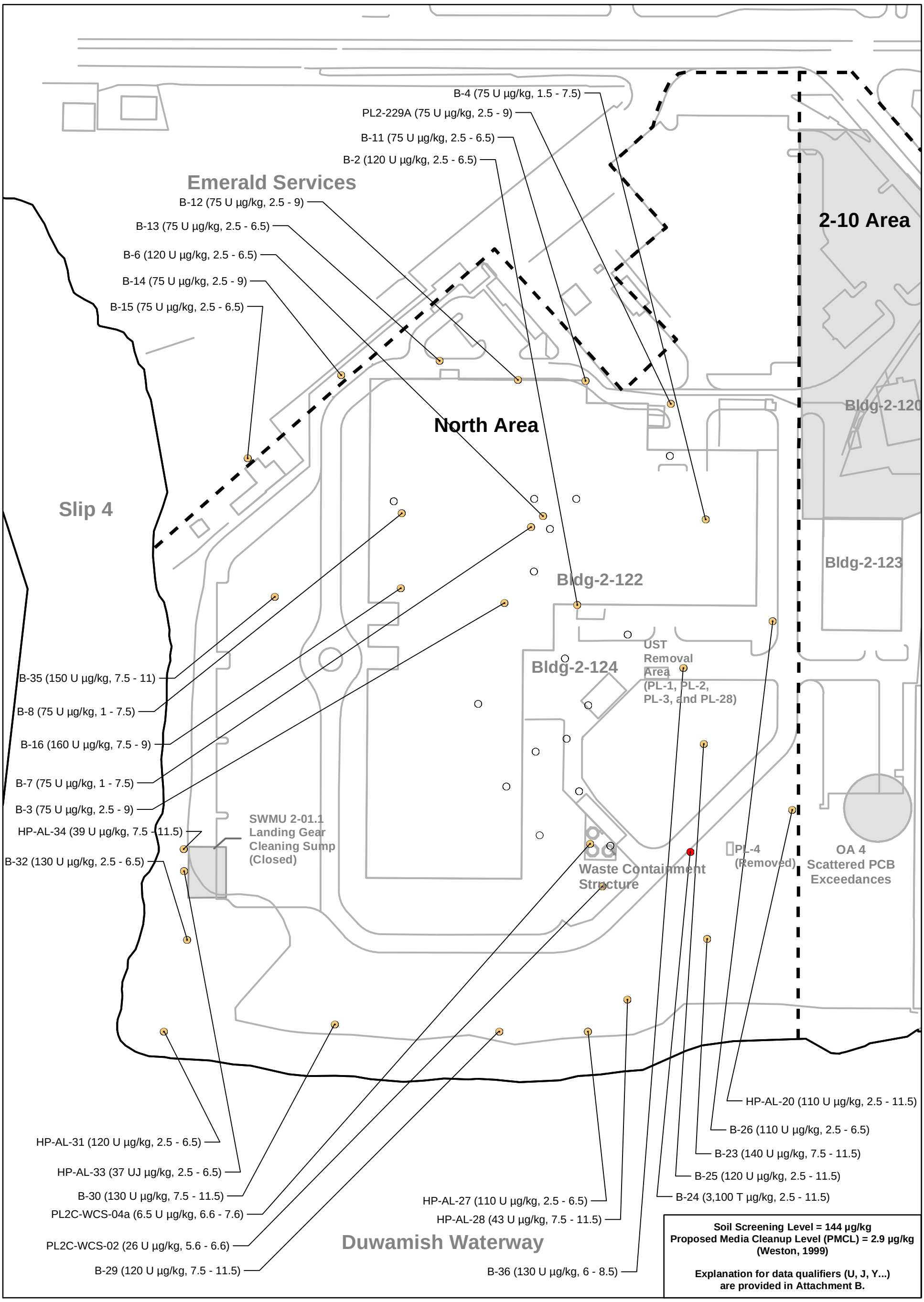
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
BENZO(K)FLUORANTHENE IN SOIL: DEPTH 1 - 6 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 2 |
|---|---|---|---|

0131646004100_BENZOKFLUORANTHENENY2.mxd | 10/05/2007 | TBROUSSEAU

**Golder Associates**




**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

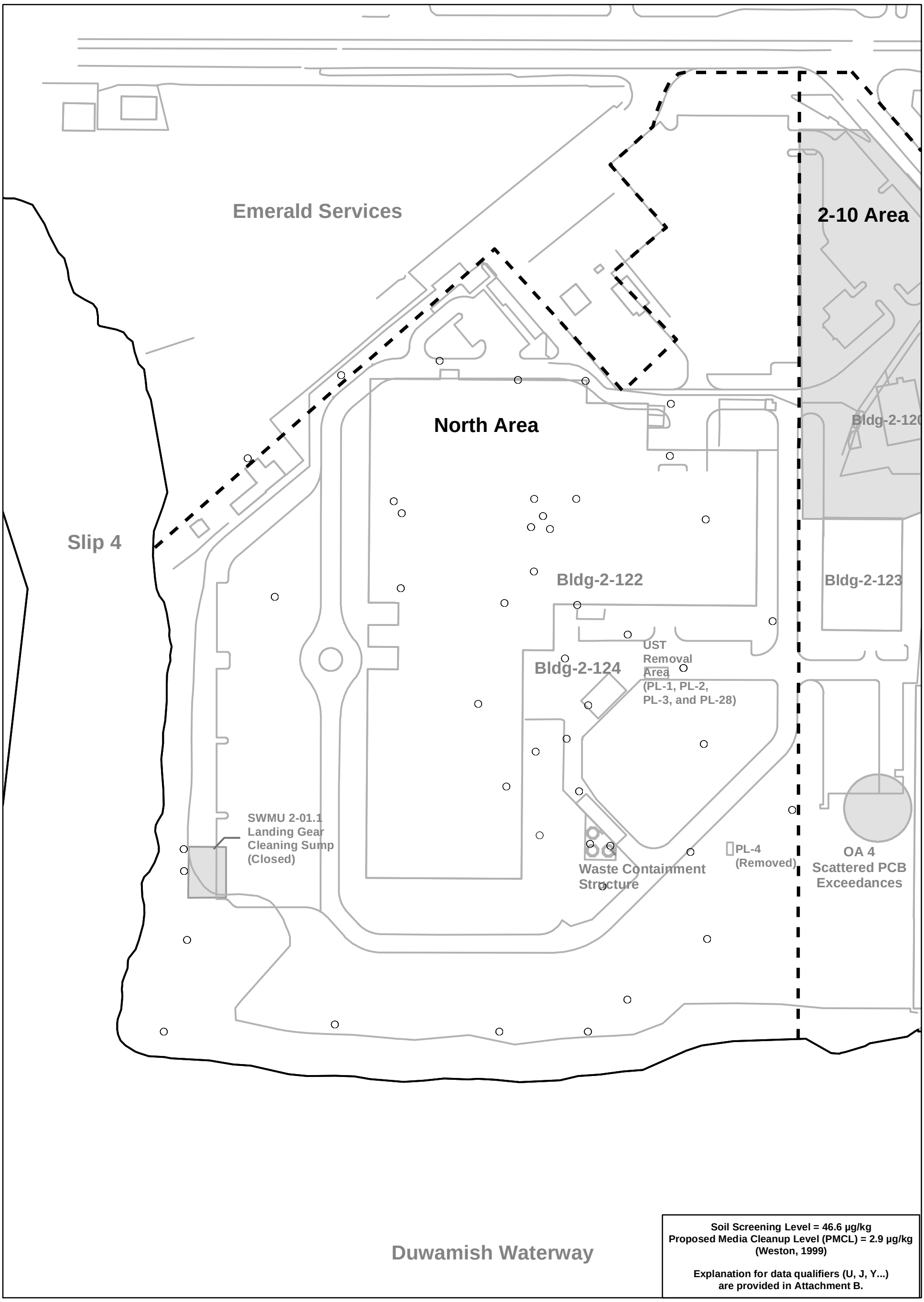
EPI, Golder Associates Inc., Weston Solutions, Inc.

NORTH AREA
BENZO(K)FLUORANTHENE IN SOIL: DEPTH 6 - 12 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 3 |
|---|---|---|---|

0131646004100_BENZOKFLUORANTHENENY3.mxd | 10/05/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 46.6 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 2.9 µg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

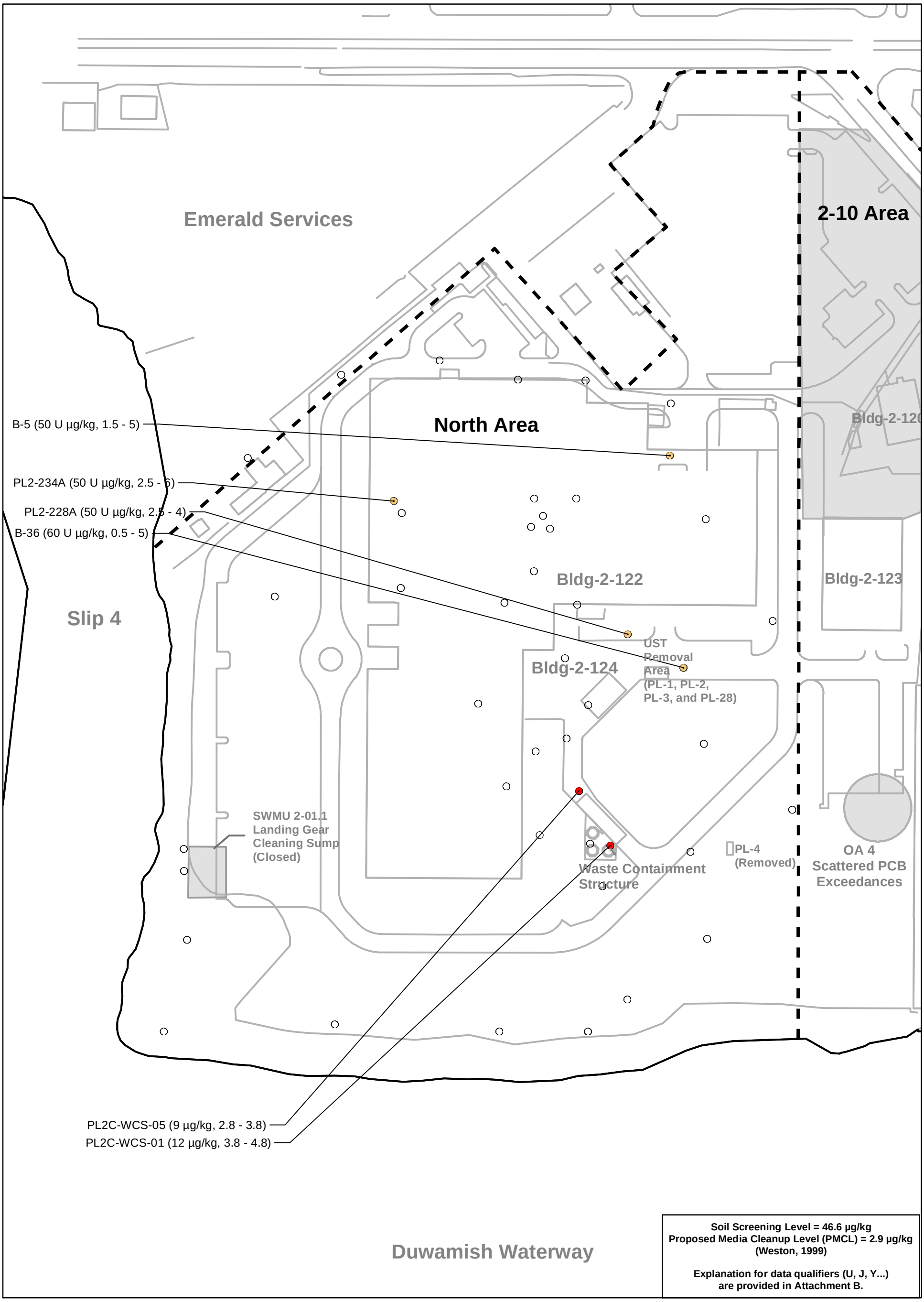
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
CHRYSENE IN SOIL: DEPTH 0 - 1 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 1 |
|---|---|---|---|

0131646004100_CHRYSENENY1.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 46.6 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 2.9 µg/kg (Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...) are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

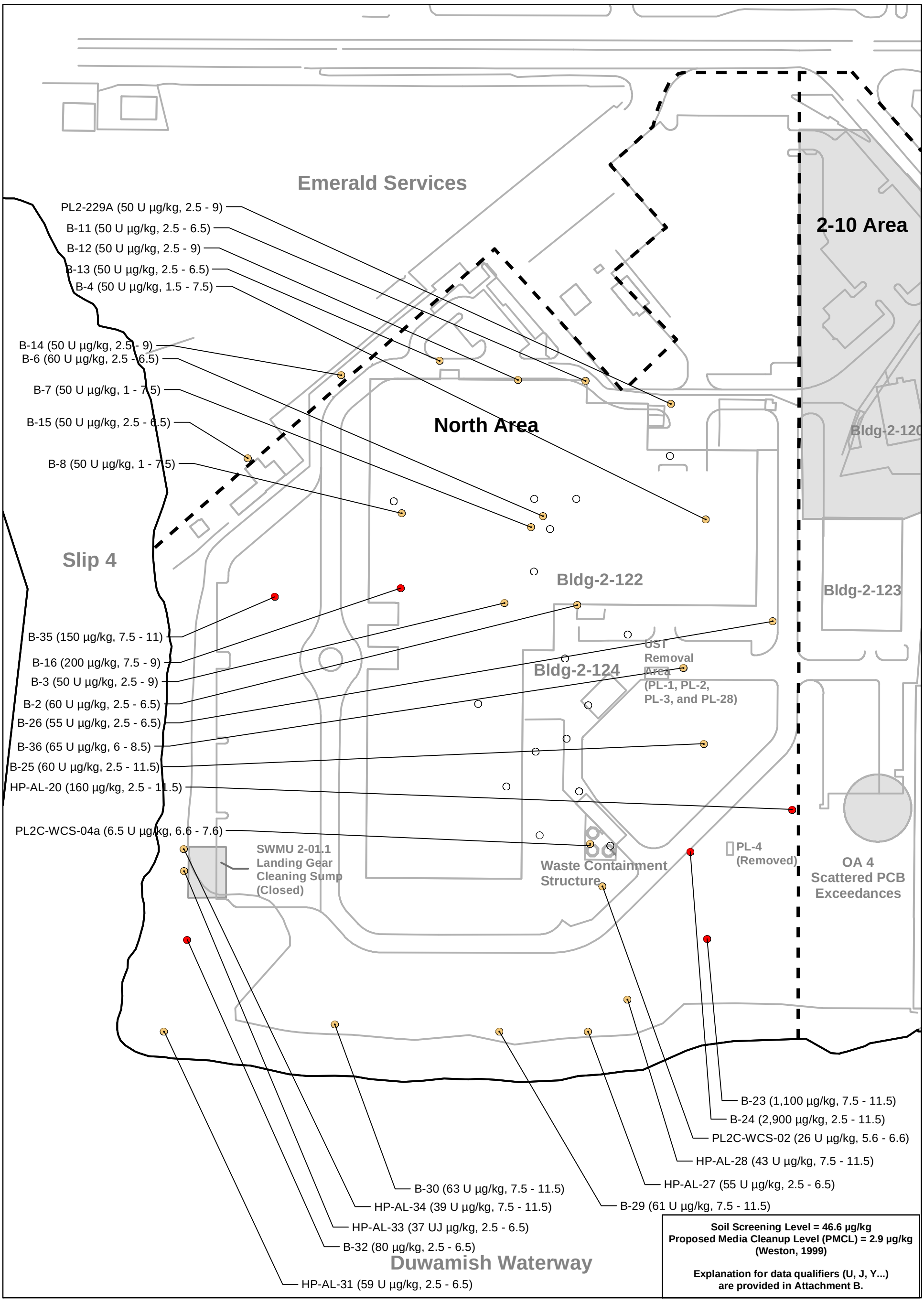
EPI, Golder Associates Inc., Weston Solutions, Inc.

NORTH AREA
CHRYSENE IN SOIL: DEPTH 1 - 6 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 2 |
|---|---|---|---|

0131646004100_CHRYSENENY2.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

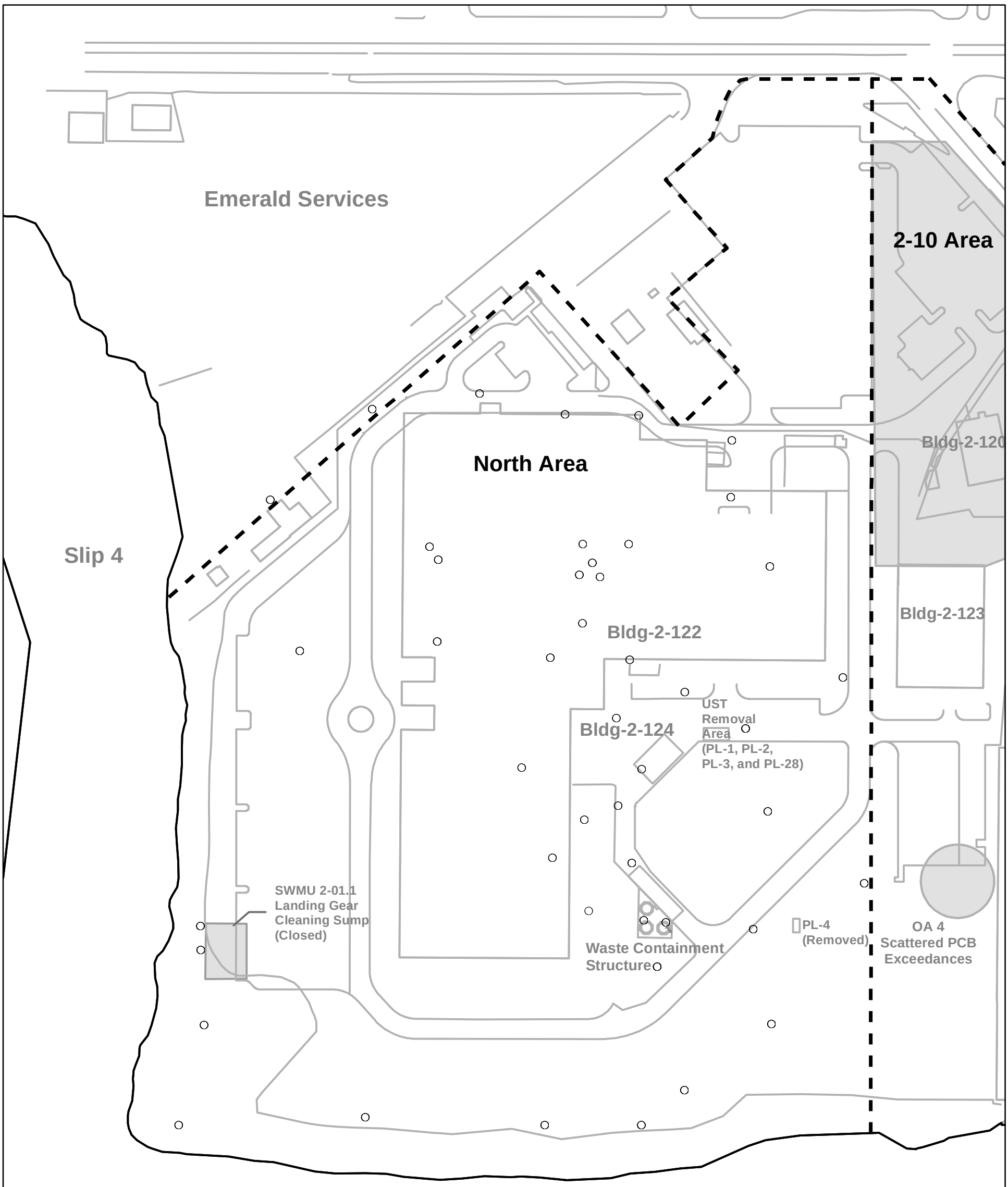
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
CHRYSENE IN SOIL: DEPTH 6 - 12 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 3 |
|---|---|---|---|

0131646004100_CHRYSENENY3.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 406 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 2.9 µg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

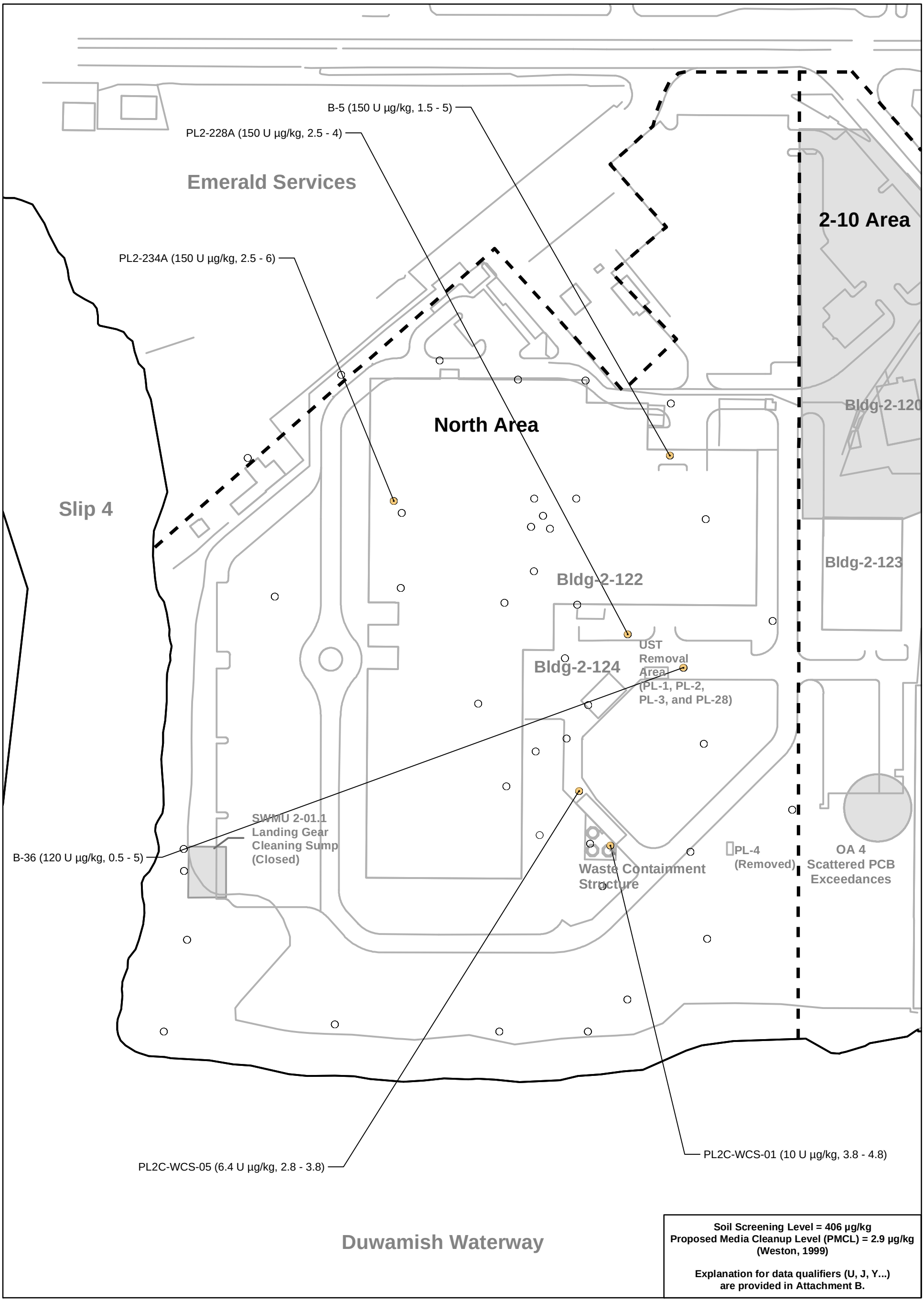
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
INDENO(1,2,3-cd)PYRENE IN SOIL: DEPTH 0 - 1 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 1 |
|---|---|---|---|

0131646004100_INDENOPYRENENY1.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 406 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 2.9 µg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

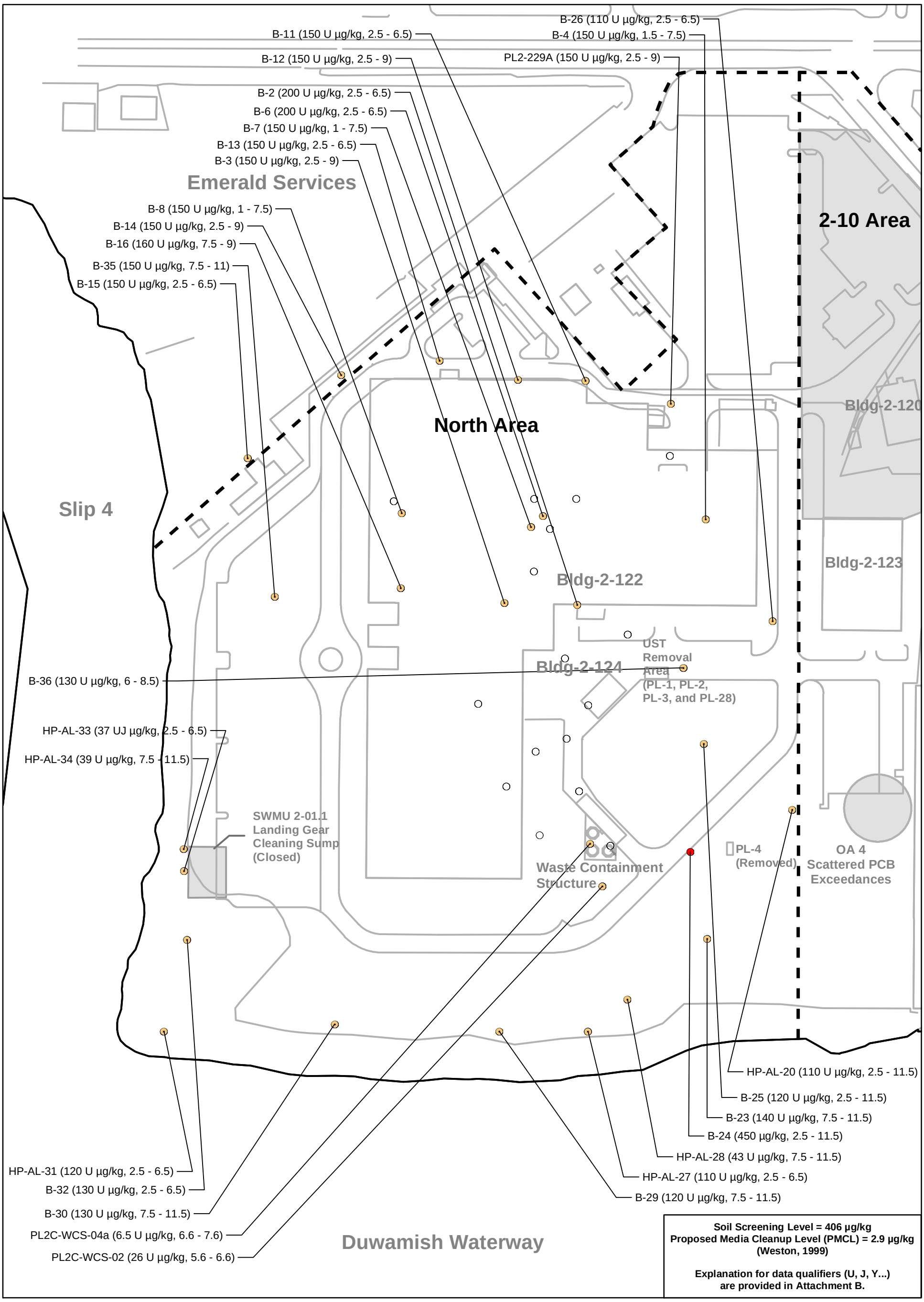
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
INDENO(1,2,3-cd)PYRENE IN SOIL: DEPTH 1 - 6 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 2 |
|---|---|---|---|

0131646004100_INDENOPYRENENY2.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

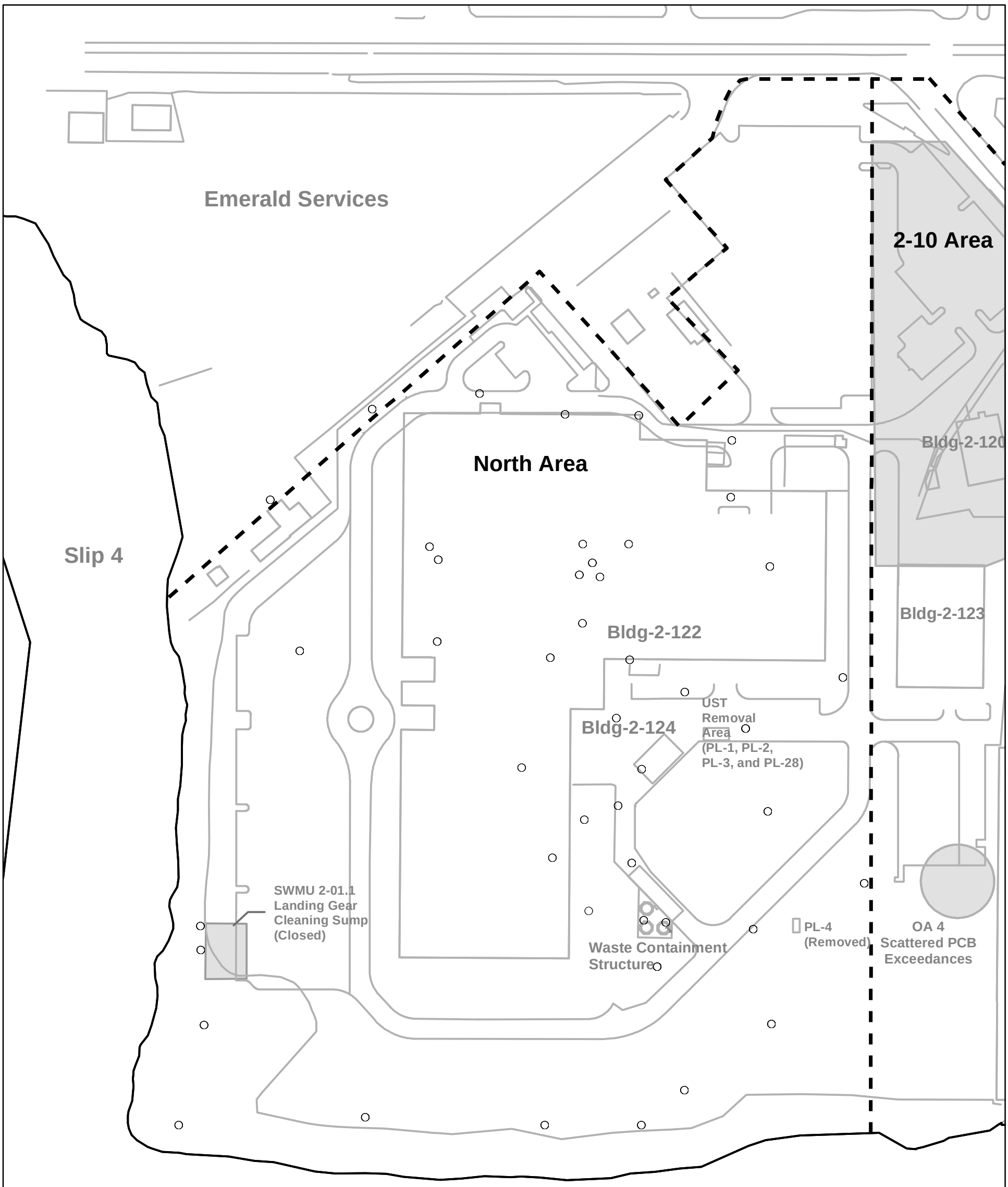
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
INDENO(1,2,3-cd)PYRENE IN SOIL: DEPTH 6 - 12 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 3 |
|---|---|---|---|

0131646004100_INDENOPYRENENY3.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 33 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 33 µg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

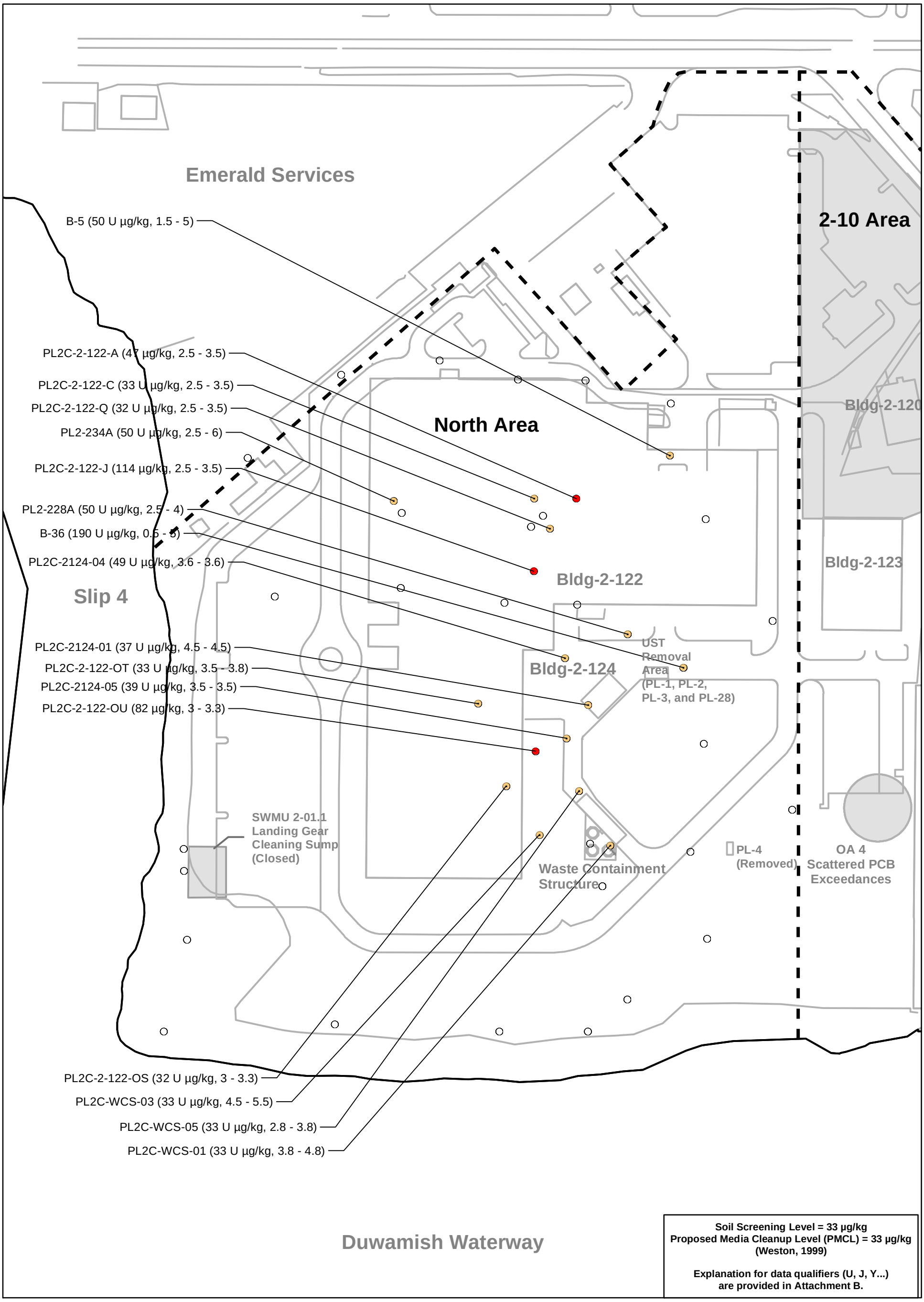
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
TOTAL PCB IN SOIL: DEPTH 0 - 1 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 1 |
|---|---|---|---|

0131646004100_TOTALPCBNY1.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 33 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 33 µg/kg (Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...) are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

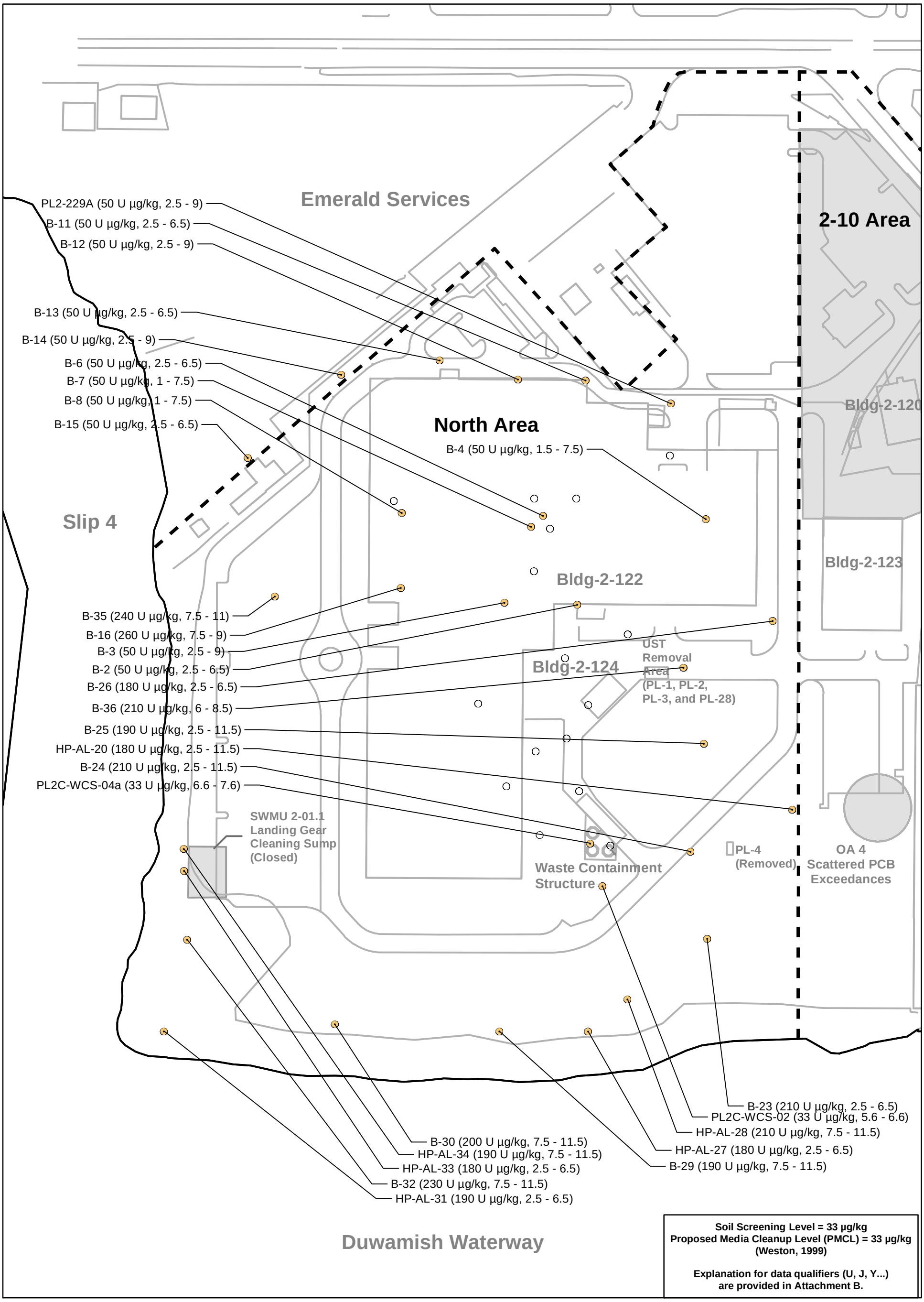
EPI, Golder Associates Inc., Weston Solutions, Inc.

NORTH AREA
TOTAL PCB IN SOIL: DEPTH 1 - 6 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 2 |
|---|---|---|---|

0131646004100_TOTALPCBNY2.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 33 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 33 µg/kg (Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...) are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

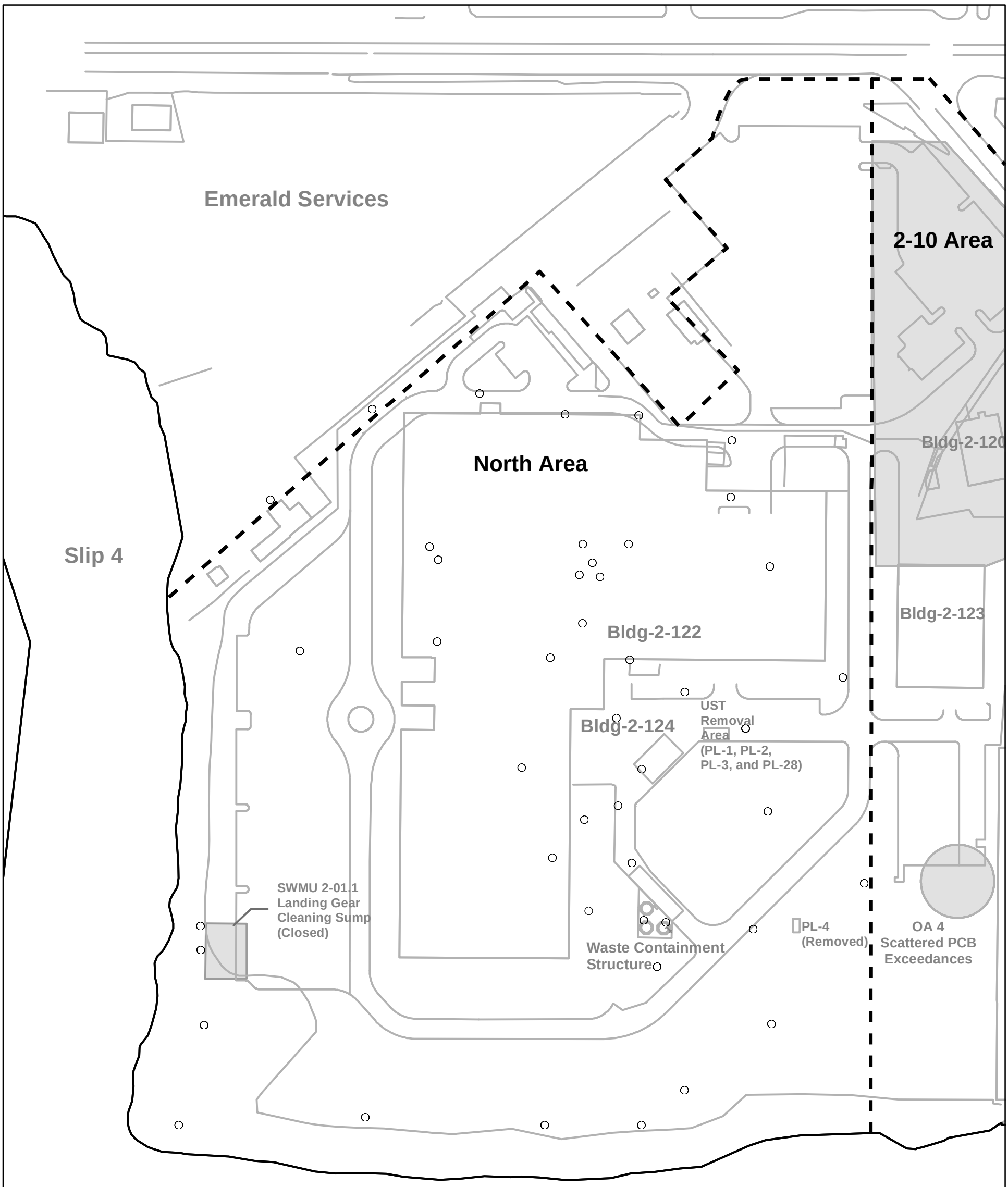
EPI, Golder Associates Inc., Weston Solutions, Inc.

NORTH AREA
TOTAL PCB IN SOIL: DEPTH 6 - 12 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 3 |
|---|---|---|---|

0131646004100_TOTALPCBNY3.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 2 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 5,500 µg/kg**
**(Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...)**
**are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

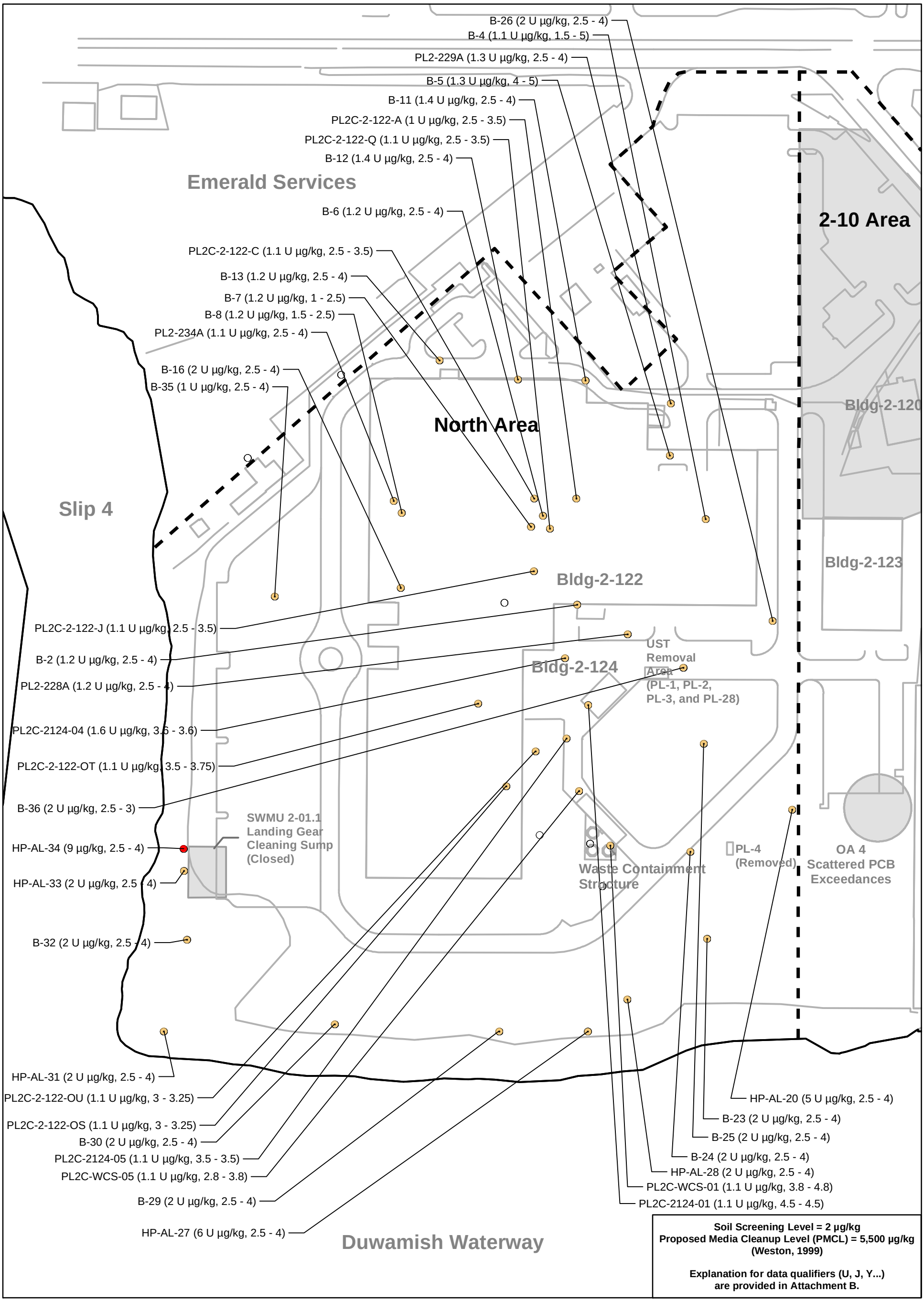
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
TRICHLOROETHENE IN SOIL: DEPTH 0 - 1 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 1 |
|---|---|---|---|

0131646004100_TRICHLOROETHENENY1.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

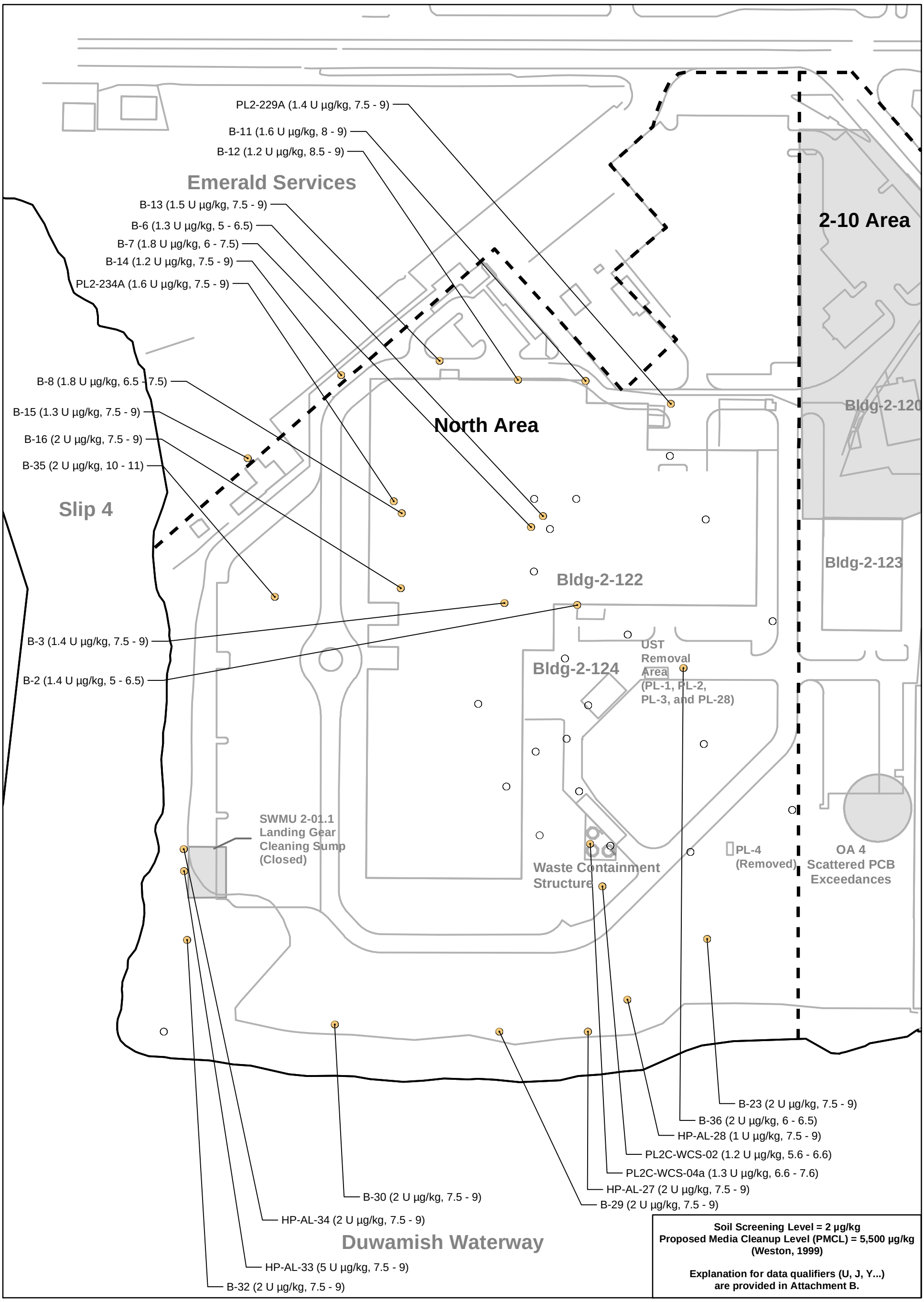
EPI, Golder Associates Inc.,
Weston Solutions, Inc.

NORTH AREA
TRICHLOROETHENE IN SOIL: DEPTH 1 - 6 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 2 |
|---|---|---|---|

0131646004100_TRICHLOROETHENENY2.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**




**Soil Screening Level = 2 µg/kg**
**Proposed Media Cleanup Level (PMCL) = 5,500 µg/kg (Weston, 1999)**

**Explanation for data qualifiers (U, J, Y...) are provided in Attachment B.**

**LEGEND**

- Sample location where constituent was detected. (Concentration; µg/kg, Depth; feet bgs).
- Sample location where constituent was not detected.
- Sample location where constituent was not analyzed.
- Plant 2 Sub-Area Boundary.

0 120
Scale 1" = 120 Feet

Map Projection:
Washington State Plane
North Zone, NAD 83, Feet

EPI, Golder Associates Inc., Weston Solutions, Inc.

NORTH AREA
TRICHLOROETHENE IN SOIL: DEPTH 6 - 12 FT
**BOEING PLANT 2**

| Drawn: TGB | Revision: 0 | Date: April 2008 | Figure: 3 |
|---|---|---|---|

0131646004100_TRICHLOROETHENENY3.mxd | 10/08/2007 | TBROUSSEAU

**Golder Associates**

**Boeing Plant 2**
**Seattle/Tukwila, Washington**

# Uplands Corrective Measures
# Volume VIIa: North Area

# Data Gap Investigation Work Plan

# Attachment B
# Data Tables

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North Area COC Results
Arsenic Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (mg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Arsenic (mg/kg) - 2004 Soil Screening Level = 7.3 mg/kg[3]; PMCL = 7.3 mg/kg[4]** | | | | |
| B-11 | 2.5 - 6.5 | 5/5/1990 | 6.4 | J |
| B-12 | 2.5 - 9 | 5/4/1990 | 4.5 | J |
| B-13 | 2.5 - 6.5 | 5/4/1990 | 6.5 | J |
| B-14 | 2.5 - 9 | 5/5/1990 | 3.5 | J |
| B-15 | 2.5 - 6.5 | 5/5/1990 | 6.4 | |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 3.1 | |
| B-16 | 7.5 - 9 | 8/14/1990 | 5.8 | |
| B-2 | 2.5 - 6.5 | 4/30/1990 | 4.8 | J |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 4.3 | |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 4.5 | |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 4.6 | |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 3.2 | |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 3.3 | |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 2.6 | |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 2.4 | |
| B-3 | 2.5 - 9 | 5/4/1990 | 8.8 | J |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 3.2 | |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 3.2 | |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 5.1 | |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 4.5 | |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 6.1 | |
| B-35 | 7.5 - 11 | 8/14/1990 | 4.5 | |
| B-36 | 0.5 - 5 | 8/23/1990 | 3.3 | |
| B-36 | 6 - 8.5 | 8/23/1990 | 3.8 | |
| B-4 | 1.5 - 7.5 | 5/3/1990 | 6.3 | J |
| B-5 | 1.5 - 5 | 5/3/1990 | 4.2 | J |
| B-6 | 2.5 - 6.5 | 4/30/1990 | 0.1 | J |
| B-7 | 1 - 7.5 | 5/5/1990 | 0.2 | J |
| B-8 | 1 - 7.5 | 5/3/1990 | 8.7 | J |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 3.6 | |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 2.7 | |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 4 | |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 2 | |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 2.7 | |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 3.8 | |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 2.5 | |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 3 | |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 3.9 | |
| PL2-228A | 2.5 - 4 | 5/4/1990 | 6.1 | J |
| PL2-229A | 2.5 - 9 | 5/4/1990 | 4.7 | J |
| PL2-234A | 2.5 - 6 | 5/5/1990 | 5.3 | J |
| PL2C-2-122-A | 2.5 - 3.5 | 10/6/2005 | 7 | |
| PL2C-2-122-C | 2.5 - 3.5 | 10/10/2005 | 9 | |
| PL2C-2-122-J | 2.5 - 3.5 | 10/10/2005 | 9 | |
| PL2C-2-122-OS | 3 - 3.25 | 4/10/2006 | 5 | U |
| PL2C-2-122-OS | 5.5 - 5.75 | 4/10/2006 | 5 | |
| PL2C-2-122-OT | 3.5 - 3.75 | 4/14/2006 | 5 | U |
| PL2C-2-122-OU | 3 - 3.25 | 4/18/2006 | 5 | U |
| PL2C-2-122-Q | 2.5 - 3.5 | 10/11/2005 | 9 | |
| PL2C-2124-01 | 4.5 - 4.5 | 8/3/2005 | 5 | U |
| PL2C-2124-04 | 3.6 - 3.6 | 8/4/2005 | 13 | |
| PL2C-2124-05 | 3.5 - 3.5 | 8/3/2005 | 7 | |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 8 | |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 10 | |

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (mg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Arsenic (mg/kg) - 2004 Soil Screening Level = 7.3 mg/kg[3]; PMCL = 7.3 mg/kg[4]** | | | | |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 15 | |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 9 | |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - Screening level was adjusted in September 2005 to Ecology (1994) calculated Puget Sound Basin natural background concentration.
(4) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (mg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Cadmium (mg/kg) - 2004 Soil Screening Level = 1.21 mg/kg[3]; PMCL = 1.28 mg/kg[4]** | | | | |
| B-11 | 2.5 - 6.5 | 5/5/1990 | 0.2 | U |
| B-12 | 2.5 - 9 | 5/4/1990 | 0.2 | U |
| B-13 | 2.5 - 6.5 | 5/4/1990 | 0.2 | U |
| B-14 | 2.5 - 9 | 5/5/1990 | 0.2 | U |
| B-15 | 2.5 - 6.5 | 5/5/1990 | 0.2 | U |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 0.5 | U |
| B-16 | 7.5 - 9 | 8/14/1990 | 1 | U |
| B-2 | 2.5 - 6.5 | 4/30/1990 | 0.5 | |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 0.5 | U |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 0.5 | U |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 0.5 | U |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 0.5 | U |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 0.5 | U |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 0.5 | U |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 0.5 | U |
| B-3 | 2.5 - 9 | 5/4/1990 | 0.2 | |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 0.5 | U |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 0.5 | U |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 0.5 | U |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 0.5 | U |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 0.5 | U |
| B-35 | 7.5 - 11 | 8/14/1990 | 0.5 | U |
| B-36 | 0.5 - 5 | 8/23/1990 | 0.5 | U |
| B-36 | 6 - 8.5 | 8/23/1990 | 2.9 | |
| B-4 | 1.5 - 7.5 | 5/3/1990 | 0.2 | U |
| B-5 | 1.5 - 5 | 5/3/1990 | 0.2 | U |
| B-6 | 2.5 - 6.5 | 4/30/1990 | 0.2 | U |
| B-7 | 1 - 7.5 | 5/5/1990 | 0.2 | U |
| B-8 | 1 - 7.5 | 5/3/1990 | 0.3 | U |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 0.5 | U |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 0.5 | U |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 0.5 | U |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 0.5 | U |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 0.5 | U |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 0.5 | U |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 0.5 | U |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 0.5 | U |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 0.5 | U |
| PL2-228A | 2.5 - 4 | 5/4/1990 | 0.2 | U |
| PL2-229A | 2.5 - 9 | 5/4/1990 | 0.2 | U |
| PL2-234A | 2.5 - 6 | 5/5/1990 | 0.2 | U |
| PL2C-2-122-A | 2.5 - 3.5 | 10/6/2005 | 0.2 | U |
| PL2C-2-122-C | 2.5 - 3.5 | 10/10/2005 | 0.2 | U |
| PL2C-2-122-J | 2.5 - 3.5 | 10/10/2005 | 0.2 | U |
| PL2C-2-122-OS | 3 - 3.25 | 4/10/2006 | 0.2 | U |
| PL2C-2-122-OS | 5.5 - 5.75 | 4/10/2006 | 0.2 | U |
| PL2C-2-122-OT | 3.5 - 3.75 | 4/14/2006 | 0.2 | U |

North Area COC Results
Cadmium Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (mg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Cadmium (mg/kg) - 2004 Soil Screening Level = 1.21 mg/kg[3]; PMCL = 1.28 mg/kg[4]** | | | | |
| PL2C-2-122-OU | 3 - 3.25 | 4/18/2006 | 0.2 | U |
| PL2C-2-122-Q | 2.5 - 3.5 | 10/11/2005 | 0.2 | U |
| PL2C-2124-01 | 4.5 - 4.5 | 8/3/2005 | 0.2 | U |
| PL2C-2124-04 | 3.6 - 3.6 | 8/4/2005 | 0.4 | |
| PL2C-2124-05 | 3.5 - 3.5 | 8/3/2005 | 0.2 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 0.2 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 0.2 | U |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 0.3 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 0.2 | U |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - Screening level was corrected in July 2005 for an error discovered in the calculations for the protection of surface water screening levels (see Section 2.1).
(4) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (mg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Copper (mg/kg) - 2004 Soil Screening Level = 36.4 mg/kg[3] PMCL = 36.4 mg/kg[4]** | | | | |
| B-11 | 2.5 - 6.5 | 5/5/1990 | 15.6 | |
| B-12 | 2.5 - 9 | 5/4/1990 | 13 | |
| B-13 | 2.5 - 6.5 | 5/4/1990 | 15.1 | |
| B-14 | 2.5 - 9 | 5/5/1990 | 9 | |
| B-15 | 2.5 - 6.5 | 5/5/1990 | 14.6 | |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 13 | |
| B-16 | 7.5 - 9 | 8/14/1990 | 22 | |
| B-2 | 2.5 - 6.5 | 4/30/1990 | 13.2 | |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 15 | |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 16 | |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 18 | |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 12 | |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 17 | |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 11 | |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 11 | |
| B-3 | 2.5 - 9 | 5/4/1990 | 18.2 | |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 13 | |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 9 | |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 12 | |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 21 | |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 18 | |
| B-35 | 7.5 - 11 | 8/14/1990 | 27 | |
| B-36 | 0.5 - 5 | 8/23/1990 | 13 | |
| B-36 | 6 - 8.5 | 8/23/1990 | 310 | |
| B-4 | 1.5 - 7.5 | 5/3/1990 | 11.1 | |
| B-5 | 1.5 - 5 | 5/3/1990 | 13 | |
| B-6 | 2.5 - 6.5 | 4/30/1990 | 12.3 | |
| B-7 | 1 - 7.5 | 5/5/1990 | 20.1 | |
| B-8 | 1 - 7.5 | 5/3/1990 | 20.9 | |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 9 | |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 8 | |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 9 | |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 8 | |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 12 | |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 14 | |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 8 | |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 16 | |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 16 | |
| PL2-228A | 2.5 - 4 | 5/4/1990 | 14.2 | |
| PL2-229A | 2.5 - 9 | 5/4/1990 | 10.2 | |
| PL2-234A | 2.5 - 6 | 5/5/1990 | 14.8 | |
| PL2C-2-122-A | 2.5 - 3.5 | 10/6/2005 | 15.7 | |
| PL2C-2-122-C | 2.5 - 3.5 | 10/10/2005 | 34.3 | |
| PL2C-2-122-J | 2.5 - 3.5 | 10/10/2005 | 15.7 | |
| PL2C-2-122-OS | 3 - 3.25 | 4/10/2006 | 14.1 | |
| PL2C-2-122-OS | 5.5 - 5.75 | 4/10/2006 | 15.7 | |
| PL2C-2-122-OT | 3.5 - 3.75 | 4/14/2006 | 11.7 | |
| PL2C-2-122-OU | 3 - 3.25 | 4/18/2006 | 16.7 | |
| PL2C-2-122-Q | 2.5 - 3.5 | 10/11/2005 | 20.5 | |
| PL2C-2124-01 | 4.5 - 4.5 | 8/3/2005 | 12.4 | |
| PL2C-2124-04 | 3.6 - 3.6 | 8/4/2005 | 40 | |
| PL2C-2124-05 | 3.5 - 3.5 | 8/3/2005 | 18.8 | |

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (mg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Copper (mg/kg) - 2004 Soil Screening Level = 36.4 mg/kg[3] PMCL = 36.4 mg/kg[4]** | | | | |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 12.5 | |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 22.6 | |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 31.2 | |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 17.3 | |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - Screening level was corrected in September 2005 to Ecology (1994) calculated Puget Sound Basin natural background concentration.
(4) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (mg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Mercury (mg/kg) - 2004 Soil Screening Level = 0.07 mg/kg[3]; PMCL = 0.07 mg/kg[4]** | | | | |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 0.1 | U |
| B-16 | 7.5 - 9 | 8/14/1990 | 0.1 | U |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 0.1 | U |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 0.1 | U |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 0.1 | U |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 0.1 | U |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 0.1 | U |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 0.1 | U |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 0.1 | U |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 0.1 | U |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 0.1 | U |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 0.1 | U |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 0.1 | U |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 0.1 | U |
| B-35 | 7.5 - 11 | 8/14/1990 | 0.1 | U |
| B-36 | 0.5 - 5 | 8/23/1990 | 0.1 | U |
| B-36 | 6 - 8.5 | 8/23/1990 | 0.2 | |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 0.1 | U |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 0.1 | U |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 0.1 | U |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 0.1 | U |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 0.1 | U |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 0.1 | U |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 0.1 | U |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 0.1 | U |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 0.1 | U |
| PL2C-2-122-A | 2.5 - 3.5 | 10/6/2005 | 0.13 | |
| PL2C-2-122-C | 2.5 - 3.5 | 10/10/2005 | 0.05 | U |
| PL2C-2-122-J | 2.5 - 3.5 | 10/10/2005 | 0.05 | |
| PL2C-2-122-OS | 3 - 3.25 | 4/10/2006 | 0.04 | U |
| PL2C-2-122-OS | 5.5 - 5.75 | 4/10/2006 | 0.05 | U |
| PL2C-2-122-OT | 3.5 - 3.75 | 4/14/2006 | 0.05 | U |
| PL2C-2-122-OU | 3 - 3.25 | 4/18/2006 | 0.05 | U |
| PL2C-2-122-Q | 2.5 - 3.5 | 10/11/2005 | 0.06 | |
| PL2C-2124-01 | 4.5 - 4.5 | 8/3/2005 | 0.05 | U |
| PL2C-2124-04 | 3.6 - 3.6 | 8/4/2005 | 0.12 | |
| PL2C-2124-05 | 3.5 - 3.5 | 8/3/2005 | 0.05 | |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 0.05 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 0.05 | |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 0.06 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 0.06 | U |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - Screening level was adjusted in September 2005 to Ecology (1994) calculated Puget Sound Basin natural background concentration.
(4) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

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North Area COC Results
Zinc Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (mg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Zinc (mg/kg) - 2004 Soil Screening Level = 101 mg/kg; PMCL = 107 mg/kg[3]** | | | | |
| B-11 | 2.5 - 6.5 | 5/5/1990 | 24.3 | |
| B-12 | 2.5 - 9 | 5/4/1990 | 27.5 | |
| B-13 | 2.5 - 6.5 | 5/4/1990 | 26.2 | |
| B-14 | 2.5 - 9 | 5/5/1990 | 22.1 | |
| B-15 | 2.5 - 6.5 | 5/5/1990 | 30.5 | |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 39 | |
| B-16 | 7.5 - 9 | 8/14/1990 | 34 | |
| B-2 | 2.5 - 6.5 | 4/30/1990 | 23.6 | |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 64 | |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 39 | |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 37 | |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 34 | |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 33 | |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 30 | |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 36 | |
| B-3 | 2.5 - 9 | 5/4/1990 | 61.8 | |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 33 | |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 24 | |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 37 | |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 38 | |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 61 | |
| B-35 | 7.5 - 11 | 8/14/1990 | 71 | |
| B-36 | 0.5 - 5 | 8/23/1990 | 40 | |
| B-36 | 6 - 8.5 | 8/23/1990 | 220 | |
| B-4 | 1.5 - 7.5 | 5/3/1990 | 21.2 | |
| B-5 | 1.5 - 5 | 5/3/1990 | 19.3 | |
| B-6 | 2.5 - 6.5 | 4/30/1990 | 20.3 | |
| B-7 | 1 - 7.5 | 5/5/1990 | 30.3 | |
| B-8 | 1 - 7.5 | 5/3/1990 | 30.9 | |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 52 | |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 25 | |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 50 | |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 27 | |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 29 | |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 53 | |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 26 | |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 37 | |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 57 | |
| PL2-228A | 2.5 - 4 | 5/4/1990 | 23.1 | |
| PL2-229A | 2.5 - 9 | 5/4/1990 | 21.9 | |
| PL2-234A | 2.5 - 6 | 5/5/1990 | 33 | |
| PL2C-2-122-A | 2.5 - 3.5 | 10/6/2005 | 39.3 | |
| PL2C-2-122-C | 2.5 - 3.5 | 10/10/2005 | 51.5 | |
| PL2C-2-122-J | 2.5 - 3.5 | 10/10/2005 | 35.5 | |
| PL2C-2-122-OS | 3 - 3.25 | 4/10/2006 | 34.5 | |
| PL2C-2-122-OS | 5.5 - 5.75 | 4/10/2006 | 34.3 | |
| PL2C-2-122-OT | 3.5 - 3.75 | 4/14/2006 | 28.2 | |

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (mg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Zinc (mg/kg) - 2004 Soil Screening Level = 101 mg/kg; PMCL = 107 mg/kg[3]** | | | | |
| PL2C-2-122-OU | 3 - 3.25 | 4/18/2006 | 40.2 | |
| PL2C-2-122-Q | 2.5 - 3.5 | 10/11/2005 | 65.2 | |
| PL2C-2124-01 | 4.5 - 4.5 | 8/3/2005 | 23.5 | |
| PL2C-2124-04 | 3.6 - 3.6 | 8/4/2005 | 68.3 | |
| PL2C-2124-05 | 3.5 - 3.5 | 8/3/2005 | 35.6 | |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 33.8 | |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 34.5 | |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 42.5 | |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 30.9 | |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

North Area COC Results
Benzo(a)anthracene Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Benzo(a)anthracene (µg/kg) - 2004 Soil Screening Level = 41.9 µg/kg; PMCL = 2.9 µg/kg[3]** | | | | |
| B-11 | 2.5 - 6.5 | 5/5/1990 | 50 | U |
| B-12 | 2.5 - 9 | 5/4/1990 | 50 | U |
| B-13 | 2.5 - 6.5 | 5/4/1990 | 50 | U |
| B-14 | 2.5 - 9 | 5/5/1990 | 50 | U |
| B-15 | 2.5 - 6.5 | 5/5/1990 | 50 | U |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 61 | U |
| B-16 | 7.5 - 9 | 8/14/1990 | 81 | U |
| B-2 | 2.5 - 6.5 | 4/30/1990 | 60 | U |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 56 | UR |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 400 | |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 3500 | |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 60 | U |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 55 | U |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 55 | U |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 61 | U |
| B-3 | 2.5 - 9 | 5/4/1990 | 50 | U |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 57 | U |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 63 | U |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 65 | U |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 71 | UR |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 59 | U |
| B-35 | 7.5 - 11 | 8/14/1990 | 130 | |
| B-36 | 0.5 - 5 | 8/23/1990 | 60 | U |
| B-36 | 6 - 8.5 | 8/23/1990 | 65 | U |
| B-4 | 1.5 - 7.5 | 5/3/1990 | 50 | U |
| B-5 | 1.5 - 5 | 5/3/1990 | 50 | U |
| B-6 | 2.5 - 6.5 | 4/30/1990 | 60 | U |
| B-7 | 1 - 7.5 | 5/5/1990 | 50 | U |
| B-8 | 1 - 7.5 | 5/3/1990 | 50 | U |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 57 | U |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 55 | U |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 55 | UR |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 36 | U |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 43 | U |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 59 | U |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 37 | UJ |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 38 | U |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 39 | U |
| PL2-228A | 2.5 - 4 | 5/4/1990 | 50 | U |
| PL2-229A | 2.5 - 9 | 5/4/1990 | 50 | U |
| PL2-234A | 2.5 - 6 | 5/5/1990 | 50 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 100 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 10 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 130 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 26 | U |

North Area COC Results

Benzo(a)anthracene Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Benzo(a)anthracene (µg/kg) - 2004 Soil Screening Level = 41.9 µg/kg; PMCL = 2.9 µg/kg[3]** | | | | |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 65 | U |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 6.5 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 64 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 6.4 | U |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

North Area COC Results
Benzo(a)pyrene Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Benzo(a)pyrene (µg/kg) - 2004 Soil Screening Level = 113 µg/kg; PMCL = 2.9 µg/kg[3]** | | | | |
| B-11 | 2.5 - 6.5 | 5/5/1990 | 75 | U |
| B-12 | 2.5 - 9 | 5/4/1990 | 75 | U |
| B-13 | 2.5 - 6.5 | 5/4/1990 | 75 | U |
| B-14 | 2.5 - 9 | 5/5/1990 | 75 | U |
| B-15 | 2.5 - 6.5 | 5/5/1990 | 75 | U |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 120 | U |
| B-16 | 7.5 - 9 | 8/14/1990 | 160 | U |
| B-2 | 2.5 - 6.5 | 4/30/1990 | 120 | U |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 110 | UR |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 140 | U |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 1700 | |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 120 | U |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 110 | U |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 110 | U |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 120 | U |
| B-3 | 2.5 - 9 | 5/4/1990 | 75 | U |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 110 | U |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 130 | U |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 130 | U |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 140 | UR |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 120 | U |
| B-35 | 7.5 - 11 | 8/14/1990 | 150 | U |
| B-36 | 0.5 - 5 | 8/23/1990 | 120 | U |
| B-36 | 6 - 8.5 | 8/23/1990 | 130 | U |
| B-4 | 1.5 - 7.5 | 5/3/1990 | 75 | U |
| B-5 | 1.5 - 5 | 5/3/1990 | 75 | U |
| B-6 | 2.5 - 6.5 | 4/30/1990 | 120 | U |
| B-7 | 1 - 7.5 | 5/5/1990 | 75 | U |
| B-8 | 1 - 7.5 | 5/3/1990 | 75 | U |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 110 | U |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 110 | U |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 110 | UR |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 36 | U |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 43 | U |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 120 | U |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 37 | UJ |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 38 | U |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 39 | U |
| PL2-228A | 2.5 - 4 | 5/4/1990 | 75 | U |
| PL2-229A | 2.5 - 9 | 5/4/1990 | 75 | U |
| PL2-234A | 2.5 - 6 | 5/5/1990 | 75 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 100 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 10 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 130 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 26 | U |

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Benzo(a)pyrene (µg/kg) - 2004 Soil Screening Level = 113 µg/kg; PMCL = 2.9 µg/kg[3]** | | | | |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 65 | U |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 6.5 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 64 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 7.1 | |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

North Area COC Results
Benzo(b)fluoranthene Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Benzo(b)fluoranthene (µg/kg) - 2004 Soil Screening Level = 144 µg/kg; PMCL = 2.9 µg/kg[3]** | | | | |
| B-11 | 2.5 - 6.5 | 5/5/1990 | 75 | U |
| B-12 | 2.5 - 9 | 5/4/1990 | 75 | U |
| B-13 | 2.5 - 6.5 | 5/4/1990 | 75 | U |
| B-14 | 2.5 - 9 | 5/5/1990 | 75 | U |
| B-15 | 2.5 - 6.5 | 5/5/1990 | 75 | U |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 120 | U |
| B-16 | 7.5 - 9 | 8/14/1990 | 160 | U |
| B-2 | 2.5 - 6.5 | 4/30/1990 | 120 | U |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 110 | UR |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 140 | U |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 3100 | T |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 120 | U |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 110 | U |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 110 | U |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 120 | U |
| B-3 | 2.5 - 9 | 5/4/1990 | 75 | U |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 110 | U |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 130 | U |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 130 | U |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 140 | UR |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 120 | U |
| B-35 | 7.5 - 11 | 8/14/1990 | 150 | U |
| B-36 | 0.5 - 5 | 8/23/1990 | 120 | U |
| B-36 | 6 - 8.5 | 8/23/1990 | 130 | U |
| B-4 | 1.5 - 7.5 | 5/3/1990 | 75 | U |
| B-5 | 1.5 - 5 | 5/3/1990 | 75 | U |
| B-6 | 2.5 - 6.5 | 4/30/1990 | 120 | U |
| B-7 | 1 - 7.5 | 5/5/1990 | 75 | U |
| B-8 | 1 - 7.5 | 5/3/1990 | 75 | U |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 110 | U |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 110 | U |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 110 | UR |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 36 | U |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 43 | U |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 120 | U |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 37 | UJ |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 38 | U |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 39 | U |
| PL2-228A | 2.5 - 4 | 5/4/1990 | 75 | U |
| PL2-229A | 2.5 - 9 | 5/4/1990 | 75 | U |
| PL2-234A | 2.5 - 6 | 5/5/1990 | 75 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 100 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 10 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 130 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 26 | U |

North Area COC Results

Benzo(b)fluoranthene Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Benzo(b)fluoranthene (µg/kg) - 2004 Soil Screening Level = 144 µg/kg; PMCL = 2.9 µg/kg[3]** | | | | |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 65 | U |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 6.5 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 64 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 7.1 | |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

North Area COC Results
Benzo(k)fluoranthene Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Benzo(k)fluoranthene (µg/kg) - 2004 Soil Screening Level = 144 µg/kg; PMCL = 2.9 µg/kg[3]** | | | | |
| B-11 | 2.5 - 6.5 | 5/5/1990 | 75 | U |
| B-12 | 2.5 - 9 | 5/4/1990 | 75 | U |
| B-13 | 2.5 - 6.5 | 5/4/1990 | 75 | U |
| B-14 | 2.5 - 9 | 5/5/1990 | 75 | U |
| B-15 | 2.5 - 6.5 | 5/5/1990 | 75 | U |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 120 | U |
| B-16 | 7.5 - 9 | 8/14/1990 | 160 | U |
| B-2 | 2.5 - 6.5 | 4/30/1990 | 120 | U |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 110 | UR |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 140 | U |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 3100 | T |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 120 | U |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 110 | U |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 110 | U |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 120 | U |
| B-3 | 2.5 - 9 | 5/4/1990 | 75 | U |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 110 | U |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 130 | U |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 130 | U |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 140 | UR |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 120 | U |
| B-35 | 7.5 - 11 | 8/14/1990 | 150 | U |
| B-36 | 0.5 - 5 | 8/23/1990 | 120 | U |
| B-36 | 6 - 8.5 | 8/23/1990 | 130 | U |
| B-4 | 1.5 - 7.5 | 5/3/1990 | 75 | U |
| B-5 | 1.5 - 5 | 5/3/1990 | 75 | U |
| B-6 | 2.5 - 6.5 | 4/30/1990 | 120 | U |
| B-7 | 1 - 7.5 | 5/5/1990 | 75 | U |
| B-8 | 1 - 7.5 | 5/3/1990 | 75 | U |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 110 | U |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 110 | U |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 110 | UR |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 36 | U |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 43 | U |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 120 | U |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 37 | UJ |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 38 | U |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 39 | U |
| PL2-228A | 2.5 - 4 | 5/4/1990 | 75 | U |
| PL2-229A | 2.5 - 9 | 5/4/1990 | 75 | U |
| PL2-234A | 2.5 - 6 | 5/5/1990 | 75 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 100 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 10 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 130 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 26 | U |

North Area COC Results

Benzo(k)fluoranthene Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Benzo(k)fluoranthene (µg/kg) - 2004 Soil Screening Level = 144 µg/kg; PMCL = 2.9 µg/kg[3]** | | | | |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 65 | U |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 6.5 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 64 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 7.1 | |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

North Area COC Results
Chrysene Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Chrysene (µg/kg) - 2004 Soil Screening Level = 46.6 µg/kg; PMCL = 2.9 µg/kg[3]** | | | | |
| B-11 | 2.5 - 6.5 | 5/5/1990 | 50 | U |
| B-12 | 2.5 - 9 | 5/4/1990 | 50 | U |
| B-13 | 2.5 - 6.5 | 5/4/1990 | 50 | U |
| B-14 | 2.5 - 9 | 5/5/1990 | 50 | U |
| B-15 | 2.5 - 6.5 | 5/5/1990 | 50 | U |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 61 | U |
| B-16 | 7.5 - 9 | 8/14/1990 | 200 | |
| B-2 | 2.5 - 6.5 | 4/30/1990 | 60 | U |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 56 | UR |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 1100 | |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 2900 | |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 60 | U |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 55 | U |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 55 | U |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 61 | U |
| B-3 | 2.5 - 9 | 5/4/1990 | 50 | U |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 57 | U |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 63 | U |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 80 | |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 71 | UR |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 59 | U |
| B-35 | 7.5 - 11 | 8/14/1990 | 150 | |
| B-36 | 0.5 - 5 | 8/23/1990 | 60 | U |
| B-36 | 6 - 8.5 | 8/23/1990 | 65 | U |
| B-4 | 1.5 - 7.5 | 5/3/1990 | 50 | U |
| B-5 | 1.5 - 5 | 5/3/1990 | 50 | U |
| B-6 | 2.5 - 6.5 | 4/30/1990 | 60 | U |
| B-7 | 1 - 7.5 | 5/5/1990 | 50 | U |
| B-8 | 1 - 7.5 | 5/3/1990 | 50 | U |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 160 | |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 55 | U |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 55 | UR |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 36 | U |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 43 | U |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 59 | U |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 37 | UJ |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 38 | U |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 39 | U |
| PL2-228A | 2.5 - 4 | 5/4/1990 | 50 | U |
| PL2-229A | 2.5 - 9 | 5/4/1990 | 50 | U |
| PL2-234A | 2.5 - 6 | 5/5/1990 | 50 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 100 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 12 | |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 130 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 26 | U |

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Chrysene (µg/kg) - 2004 Soil Screening Level = 46.6 µg/kg; PMCL = 2.9 µg/kg[3]** | | | | |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 65 | U |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 6.5 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 64 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 9 | |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

North Area COC Results
Indeno(1,2,3-cd)pyrene Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Indeno(1,2,3-cd)pyrene (µg/kg) - 2004 Soil Screening Level = 406 µg/kg; PMCL = 2.9 µg/kg[3]** | | | | |
| B-11 | 2.5 - 6.5 | 5/5/1990 | 150 | U |
| B-12 | 2.5 - 9 | 5/4/1990 | 150 | U |
| B-13 | 2.5 - 6.5 | 5/4/1990 | 150 | U |
| B-14 | 2.5 - 9 | 5/5/1990 | 150 | U |
| B-15 | 2.5 - 6.5 | 5/5/1990 | 150 | U |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 120 | U |
| B-16 | 7.5 - 9 | 8/14/1990 | 160 | U |
| B-2 | 2.5 - 6.5 | 4/30/1990 | 200 | U |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 110 | UR |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 140 | U |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 450 | |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 120 | U |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 110 | U |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 110 | U |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 120 | U |
| B-3 | 2.5 - 9 | 5/4/1990 | 150 | U |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 110 | U |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 130 | U |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 130 | U |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 140 | UR |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 120 | U |
| B-35 | 7.5 - 11 | 8/14/1990 | 150 | U |
| B-36 | 0.5 - 5 | 8/23/1990 | 120 | U |
| B-36 | 6 - 8.5 | 8/23/1990 | 130 | U |
| B-4 | 1.5 - 7.5 | 5/3/1990 | 150 | U |
| B-5 | 1.5 - 5 | 5/3/1990 | 150 | U |
| B-6 | 2.5 - 6.5 | 4/30/1990 | 200 | U |
| B-7 | 1 - 7.5 | 5/5/1990 | 150 | U |
| B-8 | 1 - 7.5 | 5/3/1990 | 150 | U |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 110 | U |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 110 | U |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 110 | UR |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 36 | U |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 43 | U |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 120 | U |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 37 | UJ |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 38 | U |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 39 | U |
| PL2-228A | 2.5 - 4 | 5/4/1990 | 150 | U |
| PL2-229A | 2.5 - 9 | 5/4/1990 | 150 | U |
| PL2-234A | 2.5 - 6 | 5/5/1990 | 150 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 100 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 10 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 130 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 26 | U |

North Area COC Results

Indeno(1,2,3-cd)pyrene Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Indeno(1,2,3-cd)pyrene (µg/kg) - 2004 Soil Screening Level = 406 µg/kg; PMCL = 2.9 µg/kg[3]** | | | | |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 65 | U |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 6.5 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 64 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 6.4 | U |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

North Area COC Results
Aroclor 1242 Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Aroclor 1242 (µg/kg) - 2004 Screening Level = 33 µg/kg; PMCL = 33 µg/kg[3]** | | | | |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 98 | U |
| B-16 | 7.5 - 9 | 8/14/1990 | 130 | U |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 110 | U |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 90 | U |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 110 | U |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 95 | U |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 88 | U |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 89 | U |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 97 | U |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 91 | U |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 100 | U |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 100 | U |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 110 | U |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 94 | U |
| B-35 | 7.5 - 11 | 8/14/1990 | 120 | U |
| B-36 | 0.5 - 5 | 8/23/1990 | 97 | U |
| B-36 | 6 - 8.5 | 8/23/1990 | 100 | U |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 92 | U |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 88 | U |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 92 | U |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 87 | U |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 100 | U |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 94 | U |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 89 | U |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 92 | U |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 94 | U |
| PL2C-2-122-A | 2.5 - 3.5 | 10/6/2005 | 33 | U |
| PL2C-2-122-C | 2.5 - 3.5 | 10/10/2005 | 33 | U |
| PL2C-2-122-J | 2.5 - 3.5 | 10/10/2005 | 38 | |
| PL2C-2-122-OS | 3 - 3.25 | 4/10/2006 | 32 | U |
| PL2C-2-122-OS | 5.5 - 5.75 | 4/10/2006 | 32 | U |
| PL2C-2-122-OT | 3.5 - 3.75 | 4/14/2006 | 33 | U |
| PL2C-2-122-OU | 3 - 3.25 | 4/18/2006 | 32 | U |
| PL2C-2-122-Q | 2.5 - 3.5 | 10/11/2005 | 32 | U |
| PL2C-2124-01 | 4.5 - 4.5 | 8/3/2005 | 37 | U |
| PL2C-2124-04 | 3.6 - 3.6 | 8/4/2005 | 49 | U |
| PL2C-2124-05 | 3.5 - 3.5 | 8/3/2005 | 39 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 33 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 33 | U |
| PL2C-WCS-03 | 4.5 - 5.5 | 10/31/2005 | 33 | U |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 33 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 33 | U |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

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North Area COC Results
Aroclor 1248 Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Aroclor 1248 (µg/kg) - 2004 Screening Level = 33 µg/kg; PMCL = 33 µg/kg[3]** | | | | |
| B-11 | 2.5 - 6.5 | 5/5/1990 | 50 | U |
| B-12 | 2.5 - 9 | 5/4/1990 | 50 | U |
| B-13 | 2.5 - 6.5 | 5/4/1990 | 50 | U |
| B-14 | 2.5 - 9 | 5/5/1990 | 50 | U |
| B-15 | 2.5 - 6.5 | 5/5/1990 | 50 | U |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 98 | U |
| B-16 | 7.5 - 9 | 8/14/1990 | 130 | U |
| B-2 | 2.5 - 6.5 | 4/30/1990 | 50 | U |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 110 | U |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 90 | U |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 110 | U |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 95 | U |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 88 | U |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 89 | U |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 97 | U |
| B-3 | 2.5 - 9 | 5/4/1990 | 50 | U |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 91 | U |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 100 | U |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 100 | U |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 110 | U |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 94 | U |
| B-35 | 7.5 - 11 | 8/14/1990 | 120 | U |
| B-36 | 0.5 - 5 | 8/23/1990 | 97 | U |
| B-36 | 6 - 8.5 | 8/23/1990 | 100 | U |
| B-4 | 1.5 - 7.5 | 5/3/1990 | 50 | U |
| B-5 | 1.5 - 5 | 5/3/1990 | 50 | U |
| B-6 | 2.5 - 6.5 | 4/30/1990 | 50 | U |
| B-7 | 1 - 7.5 | 5/5/1990 | 50 | U |
| B-8 | 1 - 7.5 | 5/3/1990 | 50 | U |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 92 | U |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 88 | U |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 92 | U |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 87 | U |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 100 | U |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 94 | U |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 89 | U |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 92 | U |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 94 | U |
| PL2-228A | 2.5 - 4 | 5/4/1990 | 50 | U |
| PL2-229A | 2.5 - 9 | 5/4/1990 | 50 | U |
| PL2-234A | 2.5 - 6 | 5/5/1990 | 50 | U |
| PL2C-2-122-A | 2.5 - 3.5 | 10/6/2005 | 33 | U |
| PL2C-2-122-C | 2.5 - 3.5 | 10/10/2005 | 33 | U |
| PL2C-2-122-J | 2.5 - 3.5 | 10/10/2005 | 32 | U |
| PL2C-2-122-OS | 3 - 3.25 | 4/10/2006 | 32 | U |
| PL2C-2-122-OS | 5.5 - 5.75 | 4/10/2006 | 32 | U |
| PL2C-2-122-OT | 3.5 - 3.75 | 4/14/2006 | 33 | U |
| PL2C-2-122-OU | 3 - 3.25 | 4/18/2006 | 40 | |

North Area COC Results
Aroclor 1248 Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Aroclor 1248 (µg/kg) - 2004 Screening Level = 33 µg/kg; PMCL = 33 µg/kg[3]** | | | | |
| PL2C-2-122-Q | 2.5 - 3.5 | 10/11/2005 | 32 | U |
| PL2C-2124-01 | 4.5 - 4.5 | 8/3/2005 | 37 | U |
| PL2C-2124-04 | 3.6 - 3.6 | 8/4/2005 | 49 | U |
| PL2C-2124-05 | 3.5 - 3.5 | 8/3/2005 | 39 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 33 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 33 | U |
| PL2C-WCS-03 | 4.5 - 5.5 | 10/31/2005 | 33 | U |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 33 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 33 | U |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

North Area COC Results
Aroclor 1254 Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Aroclor 1254 (µg/kg) - 2004 Screening Level = 33 µg/kg; PMCL = 33 µg/kg[3]** | | | | |
| B-11 | 2.5 - 6.5 | 5/5/1990 | 50 | U |
| B-12 | 2.5 - 9 | 5/4/1990 | 50 | U |
| B-13 | 2.5 - 6.5 | 5/4/1990 | 50 | U |
| B-14 | 2.5 - 9 | 5/5/1990 | 50 | U |
| B-15 | 2.5 - 6.5 | 5/5/1990 | 50 | U |
| B-16 | 2.5 - 6.5 | 8/14/1990 | 200 | U |
| B-16 | 7.5 - 9 | 8/14/1990 | 260 | U |
| B-2 | 2.5 - 6.5 | 4/30/1990 | 50 | U |
| B-23 | 2.5 - 6.5 | 8/17/1990 | 210 | U |
| B-23 | 7.5 - 11.5 | 8/17/1990 | 180 | U |
| B-24 | 2.5 - 11.5 | 8/16/1990 | 210 | U |
| B-25 | 2.5 - 11.5 | 8/16/1990 | 190 | U |
| B-26 | 2.5 - 6.5 | 8/16/1990 | 180 | U |
| B-29 | 2.5 - 6.5 | 8/15/1990 | 180 | U |
| B-29 | 7.5 - 11.5 | 8/15/1990 | 190 | U |
| B-3 | 2.5 - 9 | 5/4/1990 | 50 | U |
| B-30 | 2.5 - 6.5 | 8/14/1990 | 180 | U |
| B-30 | 7.5 - 11.5 | 8/14/1990 | 200 | U |
| B-32 | 2.5 - 6.5 | 8/17/1990 | 210 | U |
| B-32 | 7.5 - 11.5 | 8/17/1990 | 230 | U |
| B-35 | 2.5 - 6.5 | 8/14/1990 | 190 | U |
| B-35 | 7.5 - 11 | 8/14/1990 | 240 | U |
| B-36 | 0.5 - 5 | 8/23/1990 | 190 | U |
| B-36 | 6 - 8.5 | 8/23/1990 | 210 | U |
| B-4 | 1.5 - 7.5 | 5/3/1990 | 50 | U |
| B-5 | 1.5 - 5 | 5/3/1990 | 50 | U |
| B-6 | 2.5 - 6.5 | 4/30/1990 | 50 | U |
| B-7 | 1 - 7.5 | 5/5/1990 | 50 | U |
| B-8 | 1 - 7.5 | 5/3/1990 | 50 | U |
| HP-AL-20 | 2.5 - 11.5 | 8/20/1990 | 180 | U |
| HP-AL-27 | 2.5 - 6.5 | 8/20/1990 | 180 | U |
| HP-AL-27 | 7.5 - 11.5 | 8/20/1990 | 180 | U |
| HP-AL-28 | 2.5 - 6.5 | 8/21/1990 | 170 | U |
| HP-AL-28 | 7.5 - 11.5 | 8/21/1990 | 210 | U |
| HP-AL-31 | 2.5 - 6.5 | 8/22/1990 | 190 | U |
| HP-AL-33 | 2.5 - 6.5 | 8/21/1990 | 180 | U |
| HP-AL-34 | 2.5 - 6.5 | 8/21/1990 | 180 | U |
| HP-AL-34 | 7.5 - 11.5 | 8/21/1990 | 190 | U |
| PL2-228A | 2.5 - 4 | 5/4/1990 | 50 | U |
| PL2-229A | 2.5 - 9 | 5/4/1990 | 50 | U |
| PL2-234A | 2.5 - 6 | 5/5/1990 | 50 | U |
| PL2C-2-122-A | 2.5 - 3.5 | 10/6/2005 | 47 | |
| PL2C-2-122-C | 2.5 - 3.5 | 10/10/2005 | 33 | U |
| PL2C-2-122-J | 2.5 - 3.5 | 10/10/2005 | 76 | |
| PL2C-2-122-OS | 3 - 3.25 | 4/10/2006 | 32 | U |
| PL2C-2-122-OS | 5.5 - 5.75 | 4/10/2006 | 32 | U |
| PL2C-2-122-OT | 3.5 - 3.75 | 4/14/2006 | 33 | U |
| PL2C-2-122-OU | 3 - 3.25 | 4/18/2006 | 42 | |

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Aroclor 1254 (µg/kg) - 2004 Screening Level = 33 µg/kg; PMCL = 33 µg/kg[3]** | | | | |
| PL2C-2-122-Q | 2.5 - 3.5 | 10/11/2005 | 32 | U |
| PL2C-2124-01 | 4.5 - 4.5 | 8/3/2005 | 37 | U |
| PL2C-2124-04 | 3.6 - 3.6 | 8/4/2005 | 49 | U |
| PL2C-2124-05 | 3.5 - 3.5 | 8/3/2005 | 39 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 9/30/2005 | 33 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 9/30/2005 | 33 | U |
| PL2C-WCS-03 | 4.5 - 5.5 | 10/31/2005 | 33 | U |
| PL2C-WCS-04a | 6.6 - 7.6 | 9/30/2005 | 33 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 9/30/2005 | 33 | U |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - PMCL - Preliminary Media Cleanup Level (Weston, 1999)

North Area COC Results
Trichloroethene Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Trichloroethene (µg/kg) - 2004 Soil Screening Level = 2.0 µg/kg; PMCL = 5,500 µg/kg[3]** | | | | |
| B-11 | 2.5 - 4 | 05-May-90 | 1.4 | U |
| B-11 | 8 - 9 | 05-May-90 | 1.6 | U |
| B-12 | 2.5 - 4 | 04-May-90 | 1.4 | U |
| B-12 | 8.5 - 9 | 04-May-90 | 1.2 | U |
| B-13 | 2.5 - 4 | 04-May-90 | 1.2 | U |
| B-13 | 7.5 - 9 | 04-May-90 | 1.5 | U |
| B-14 | 7.5 - 9 | 05-May-90 | 1.2 | U |
| B-15 | 2.5 - 6.5 | 05-May-90 | 1.1 | U |
| B-15 | 7.5 - 9 | 05-May-90 | 1.3 | U |
| B-16 | 2.5 - 4 | 14-Aug-90 | 2 | U |
| B-16 | 7.5 - 9 | 14-Aug-90 | 2 | U |
| B-2 | 2.5 - 4 | 30-Apr-90 | 1.2 | U |
| B-2 | 5 - 6.5 | 30-Apr-90 | 1.4 | U |
| B-23 | 2.5 - 4 | 17-Aug-90 | 2 | U |
| B-23 | 7.5 - 9 | 17-Aug-90 | 2 | U |
| B-24 | 2.5 - 4 | 16-Aug-90 | 2 | U |
| B-25 | 2.5 - 4 | 16-Aug-90 | 2 | U |
| B-26 | 2.5 - 4 | 16-Aug-90 | 2 | U |
| B-29 | 2.5 - 4 | 15-Aug-90 | 2 | U |
| B-29 | 7.5 - 9 | 15-Aug-90 | 2 | U |
| B-3 | 2.5 - 9 | 04-May-90 | 1.3 | U |
| B-3 | 7.5 - 9 | 04-May-90 | 1.4 | U |
| B-30 | 2.5 - 4 | 14-Aug-90 | 2 | U |
| B-30 | 7.5 - 9 | 14-Aug-90 | 2 | U |
| B-32 | 2.5 - 4 | 17-Aug-90 | 2 | U |
| B-32 | 7.5 - 9 | 17-Aug-90 | 2 | U |
| B-35 | 2.5 - 4 | 14-Aug-90 | 1 | U |
| B-35 | 10 - 11 | 14-Aug-90 | 2 | U |
| B-36 | 2.5 - 3 | 23-Aug-90 | 2 | U |
| B-36 | 6 - 6.5 | 23-Aug-90 | 2 | U |
| B-4 | 1.5 - 5 | 03-May-90 | 1.1 | U |
| B-4 | 4 - 5 | 03-May-90 | 1 | U |
| B-5 | 1.5 - 2.5 | 03-May-90 | 1.1 | U |
| B-5 | 4 - 5 | 03-May-90 | 1.3 | U |
| B-6 | 2.5 - 4 | 30-Apr-90 | 1.2 | U |
| B-6 | 5 - 6.5 | 30-Apr-90 | 1.3 | U |
| B-7 | 1 - 2.5 | 05-May-90 | 1.2 | U |
| B-7 | 6 - 7.5 | 05-May-90 | 1.8 | U |
| B-7 | 6 - 7.5 | 05-May-90 | 1.9 | U |
| B-8 | 1.5 - 2.5 | 03-May-90 | 1.2 | U |
| B-8 | 6.5 - 7.5 | 03-May-90 | 1.8 | U |
| HP-AL-20 | 2.5 - 4 | 20-Aug-90 | 5 | U |
| HP-AL-27 | 2.5 - 4 | 20-Aug-90 | 6 | U |
| HP-AL-27 | 7.5 - 9 | 20-Aug-90 | 2 | U |
| HP-AL-28 | 2.5 - 4 | 21-Aug-90 | 2 | U |
| HP-AL-28 | 7.5 - 9 | 21-Aug-90 | 1 | U |
| HP-AL-31 | 2.5 - 4 | 22-Aug-90 | 2 | U |

North Area COC Results
Trichloroethene Concentrations in Soil

| Sample Location | Sample Interval[1] (ft. bgs) | Sample Date | Concentration (µg/kg) | Data Qualifier[2] |
|---|---|---|---|---|
| **Trichloroethene (µg/kg) - 2004 Soil Screening Level = 2.0 µg/kg; PMCL = 5,500 µg/kg[3]** | | | | |
| HP-AL-33 | 2.5 - 4 | 21-Aug-90 | 2 | U |
| HP-AL-33 | 7.5 - 9 | 21-Aug-90 | 5 | U |
| HP-AL-34 | 2.5 - 4 | 21-Aug-90 | 9 | |
| HP-AL-34 | 7.5 - 9 | 21-Aug-90 | 2 | U |
| PL2-228A | 2.5 - 4 | 04-May-90 | 1.2 | U |
| PL2-229A | 2.5 - 4 | 04-May-90 | 1.3 | U |
| PL2-229A | 7.5 - 9 | 04-May-90 | 1.4 | U |
| PL2-234A | 2.5 - 4 | 05-May-90 | 1.1 | U |
| PL2-234A | 7.5 - 9 | 05-May-90 | 1.6 | U |
| PL2C-2-122-A | 2.5 - 3.5 | 06-Oct-05 | 1 | U |
| PL2C-2-122-C | 2.5 - 3.5 | 10-Oct-05 | 1.1 | U |
| PL2C-2-122-J | 2.5 - 3.5 | 10-Oct-05 | 1.1 | U |
| PL2C-2-122-OS | 3 - 3.25 | 10-Apr-06 | 1.1 | U |
| PL2C-2-122-OS | 5.5 - 5.75 | 10-Apr-06 | 1.1 | U |
| PL2C-2-122-OT | 3.5 - 3.75 | 14-Apr-06 | 1.1 | U |
| PL2C-2-122-OU | 3 - 3.25 | 18-Apr-06 | 1.1 | U |
| PL2C-2-122-Q | 2.5 - 3.5 | 11-Oct-05 | 1.1 | U |
| PL2C-2124-01 | 4.5 - 4.5 | 03-Aug-05 | 1.1 | U |
| PL2C-2124-04 | 3.6 - 3.6 | 04-Aug-05 | 1.6 | U |
| PL2C-2124-04 | 3.6 - 3.6 | 04-Aug-05 | 1.6 | U |
| PL2C-2124-05 | 3.5 - 3.5 | 03-Aug-05 | 1.1 | U |
| PL2C-WCS-01 | 3.8 - 4.8 | 30-Sep-05 | 1.1 | U |
| PL2C-WCS-02 | 5.6 - 6.6 | 30-Sep-05 | 1.2 | U |
| PL2C-WCS-04a | 6.6 - 7.6 | 30-Sep-05 | 1.4 | U |
| PL2C-WCS-04a | 6.6 - 7.6 | 30-Sep-05 | 1.3 | U |
| PL2C-WCS-05 | 2.8 - 3.8 | 30-Sep-05 | 1.1 | U |

Note: (1) - Data restricted from surface to 12ft bgs.
(2) - Definitions for data qualifiers are provided on Table B-3.
(3) - PMCL - Preliminary Media Cleanup Level (Weston, 1999).

**Boeing Plant 2**
**Seattle/Tukwila, Washington**

# Uplands Corrective Measures
# Volume VIIa: North Area

# Data Gap Investigation Work Plan

# Attachment C
# Health & Safety Plan

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ENVIRONMENTAL PARTNERS INC

# Attachment C: Health and Safety Plan for North Area Data Gap Investigation

## Boeing Plant 2
## Seattle/Tukwila, Washington

**Prepared For:**

## The Boeing Company
## P.O. Box 3707
## M/C 1W-12
## Seattle/Tukwila, WA 98124

April 2008

**Prepared By:**

Environmental Partners, Inc.
295 NE Gilman Blvd. Suite 201
Issaquah, WA 98027
(425) 395-0010

Douglas C. Kunkel L.G., L.H.G.
Principal Hydrogeologist

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**BOEING CONTACTS**

Jennifer Parsons: ..... **(206) 715-7981 (cell)**
Will Ernst: ..... **(425) 891-7724 (cell)**
Mike Gleason: ..... **(206) 290-6576**

**EPI CONTACTS**

Josh Bernthal: ..... **(425) 241-5400 (cell) (425) 395-0024 (office)**
Doug Kunkel: ..... **(425) 241-8170 (cell) (425) 395-0016 (office)**

**GOLDER CONTACT**

Ted Norton ..... **(206) 755-4970 (cell) (425) 885-7648 (office)**

**EMERGENCY CONTACTS AND EMERGENCY INFORMATION**

****Boeing Emergency Number:..... 206-655-2222 Call First****
POLICE: ..... **911**
FIRE: ..... **911**
FIRST AID: ..... **911**

**In the event of an emergency, be prepared to give the following information:**

- Location of Emergency

  Site Location: ..... **The Boeing Company**
  **7755 East Marginal Way South**
  **Seattle, Washington 98108**
  Landmarks: ..... **West of Boeing Field and East of the Duwamish Waterway**
  Nearest Cross Street: ..... **South of 16th Ave South**

- Phone Number That You Are Calling From: ..... **LOOK ON PHONE**

- What Happened?
  * Type of Accident
  * Type(s) of Injuries
- How Many People Need Help?

**Additional Emergency Information:**

- **Boeing Emergency Number:..... 206-655-2222**

- Hospital Name: ..... **Harborview Medical Center**
  Address: ..... **325 9th Avenue (Map in Figures Section)**
  City, State, Zip Code: ..... **Seattle, Washington 98104**
  Phone Number: ..... **(206) 731-3000**

- Contact a Principal at Environmental Partners, Inc. after Emergency Services have been called.
  Environmental Partners, Inc. ..... **(425) 395-0010 (office)**
  Thom Morin (Principal) ..... **(206) 342-6957 (cell)**
  Doug Kunkel (Principal) ..... **(425) 241-8170 (cell)**

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## 1.0 PLAN OBJECTIVES AND APPLICABILITY

This Health and Safety Plan has been written to comply with the standards prescribed by the Occupational Safety and Health Act (OSHA) and the Washington Industrial Safety and Health Act (WISHA).

The purpose of this health and safety plan is to establish protection standards and mandatory safe practices and procedures for all personnel involved with field activities associated with the North Area Data Gap Investigation at the Boeing Plant 2. This plan assigns responsibilities, establishes standard operating procedures, and provides for contingencies that may occur during field activities. The plan consists of site and facility descriptions, a summary of work activities, an identification and evaluation of chemical and physical hazards, monitoring procedures, personnel responsibilities, a description of site zones, decontamination and disposal practices, emergency procedures, and administrative requirements.

Mr. Josh Bernthal, of Environmental Partners, Inc. (EPI) is the designated Site Health and Safety Officer. Mr. Doug Kunkel and Mr. Ted Norton are designated as alternate Site Health and Safety Officers. As Site Health and Safety Officer, Mr. Bernthal has total responsibility for ensuring that the provisions outlined herein adequately protect worker health and safety and that the procedures outlined by this Health and Safety Plan are properly implemented. In this capacity, Mr. Bernthal will conduct ongoing oversight and site inspections to ensure that this Health and Safety Plan remains current with potentially changing site conditions. Mr. Bernthal has the authority to make health and safety decisions that may not be specifically outlined in this plan, should site conditions warrant such actions. In the event that Mr. Bernthal leaves the site while work is in progress, an alternate Site Health and Safety Officer will be designated.

The provisions and procedures outlined by this Health and Safety Plan apply to all contractors, subcontractors, owner's representatives, oversight personnel, and any other persons involved with the field activities described herein. All such persons are required to read this Health and Safety Plan and indicate that they understand its contents by signing the Site Health and Safety Officer's copy of the Plan. In addition, all such persons are required to provide documentation of their current certification under Occupational Safety and Health Administration's (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) regulation, 29 CFR 1910.120. Copies of this Health and Safety Plan have been distributed to a designated representative of the following companies and/or organizations:

- The Boeing Company

It should be noted that this Health and Safety Plan is based on information that was available as of the date indicated on the Title Page. It is possible that additional hazards that are not specifically addressed by this Health and Safety Plan may exist at the work-site, or may be created as a result of on-site activities. It is EPI's firm belief that active participation in health and safety procedures and acute awareness of on-site conditions by all site workers is crucial to the health and safety of everyone involved. If you identify a site condition that is not addressed by this Health and Safety Plan, or if you have any questions or concerns about site conditions or this Plan, immediately notify the Site Health and Safety Officer.

## 2.0 BACKGROUND INFORMATION

The work site is located at: The Boeing Company, Plant 2
7755 East Marginal Way South
Seattle, Washington 98108

### 2.1 Site History

This Health and Safety Plan relates specifically to data gap investigation work that will be performed at in the North Area of the Facility. Figure 2-1 shows the boundaries of the North Area and locations and outlines of various RCRA units present within the North Area. The area contains one RCRA unit that has undergone clean closure. Building 2-122 in the North Area remains in place. The interior portion of the North Area is almost entirely paved or covered by buildings limiting the potential for incidental exposure to contaminated soil and groundwater. Portions of the North Area bordering Slip 4 and the Duwamish Waterway are unpaved and there is the opportunity to access potentially contaminated soil, groundwater, sediment, and surface water in those areas.

### 2.2 Scope of Work

Following is a brief summary of the on-site work activities that are covered by this Health and Safety Plan:

Task 1 – Monitoring well installation and development
Task 2 – Soil and groundwater sampling using direct-push probes
Task 3 – Groundwater sampling in monitoring wells
Task 4 – Surveying well and probe locations

## 3.0 HAZARD EVALUATION AND RISK ANALYSIS

In general, there are three broad hazard categories that may be encountered during site work; Chemical Exposure Hazards, Fire/Explosion Hazards, and Physical Hazards. Subsections 3.1 through 3.3 deal with specific hazards falling within each of these broad categories.

### 3.1 Chemical Exposure Hazards

Table 1 presents chemical-specific data regarding permissible exposure levels (PELs), likely pathways of exposure, target organs that will likely be affected by exposure, and likely symptoms of exposure for hazardous substances that are potentially present at the site. Table 1 data were compiled from the NIOSH Pocket Guide to Chemical Hazards, September 2007 edition. It should be noted that the PELs are the regulated limits; Recommended Exposure Limits (RELs) by NIOSH are guidance but are listed as a reference.

**Table 1: Chemical-Specific Exposure Data**

| Chemical Name | REL* | PEL* | IDLH* | Exposure Route | Target Organs | Symptoms |
|---|---|---|---|---|---|---|
| Aroclor (1242) [CAS 53469-21-9] | NE | NE | NE | See Total PCB | See Total PCB | See Total PCB |
| Aroclor (1248) [CAS 12672-29-6] | NE | NE | NE | See Total PCB | See Total PCB | See Total PCB |
| Aroclor (1254] [CAS 11097-69-1]] | NE | NE | NE | See Total PCB | See Total PCB | See Total PCB |
| Arsenic (elemental) [CAS 7440-38-2] | 0.002 $mg/m^3$ | 0.010 $mg/m^3$ | 5 $mg/m^3$ | Inhalation; ingestion; skin/eye contact | Skin; respiratory system; kidneys; central nervous system; liver; GI tract; respiratory system | Irritation of skin; dermatitis; respiratory distress; diarrhea; kidney damage; muscle tremor; convulsions; GI tract; reproductive effects; lover damage |
| Benzo(a)anthracene [CAS 56-55-3] | NE | NE | NE | | | |
| Benzo(a)pyrene (coal tar pitch volatiles) [CAS 50-32-8] | 0.1 $mg/m^3$ | 0.2 $mg/m^3$ | 80 $mg/m^3$ | Inhalation; skin/eye contact | Skin; respiratory system; bladder, kidneys. | Dermatitis; bronchitis. |
| Benzo(b)fluoranthene (coal tar pitch volatiles) [CAS 205-99-2)] | 0.1 $mg/m^3$ | 0.2 $mg/m^3$ | 80 $mg/m^3$ | See Benzo(a)pyrene (coal tar pitch volatiles) | See Benzo(a)pyrene (coal tar pitch volatiles) | See Benzo(a)pyrene (coal tar pitch volatiles) |
| Benzo(k)fluoranthene (coal tar pitch volatiles) [CAS 207-08-9] | NE | NE | NE | See Benzo(a)pyrene (coal tar pitch volatiles) | See Benzo(a)pyrene (coal tar pitch volatiles) | See Benzo(a)pyrene (coal tar pitch volatiles) |
| Cadmium (dust) [CAS 7440-43-9] | Lowest possible exposure | 0.005 $mg/m^3$ | 9 $mg/m^3$ | Inhalation; ingestion | Respiratory system, kidneys, prostate, blood | Pulmonary edema, dyspnea, cough, chest tightness, substernal pain, headache, chills, muscular aches, nausea, vomiting, diarrhea, anosmia, emphysema, proteinuria, mild anemia |
| Chrysene [CAS 218-01-9] (1,2-benzphenanthrac | NE | NE | NE | See Benzo(a)pyrene (coal tar pitch volatiles) | See Benzo(a)pyrene (coal tar pitch volatiles) | See Benzo(a)pyrene (coal tar pitch volatiles) |

| | | | | | | |
|---|---|---|---|---|---|---|
| ene) | | | | | | |
| Copper (dust) [CAS 7440-5-8] | 1 mg/m$^3$ | 1 mg/m$^3$ | 100 mg/m$^3$ | Inhalation; ingestion; skin/eye contact | Eyes, skin, respiratory system, liver, kidneys | Irritation of eyes, nose and pharynx, nasal septum perforation, metallic taste, dermatitis. |

**Table 1: Chemical-Specific Exposure Data (continued)**

| Chemical Name | REL* | PEL* | IDLH* | Exposure Route | Target Organs | Symptoms |
|---|---|---|---|---|---|---|
| Indeno(1,2,3-cd)pyrene [CAS 193-39-5] | NE | NE | NE | See Benzo(a)pyrene (coal tar pitch volatiles) | See Benzo(a)pyrene (coal tar pitch volatiles) | See Benzo(a)pyrene (coal tar pitch volatiles) |
| Mercury Compounds | Ceiling 0.1 $mg/m^3$ (skin) | 0.1 $mg/m^3$ | 10 $mg/m^3$ | Inhalation; absorption; ingestion; skin/eye contact | Eyes; skin; respiratory system; central nervous system; kidneys. | Irritation of eyes and skin, cough, chest pain, dyspnea, bronchitis, Pneumonia, tremor, insomnia, irritability, indecision, headaches, lassitude, stomatitis, salvation, GI disturbance, anorexia, , low weight, proteinuria |
| PCB (Total) | NE | TWA 0.5 $mg/m^3$ | | Ingestion, inhalation, skin absorption. | Skin, liver, reproductive system | Irritation eyes; chloracne; liver damage; reproductive effects |
| Trichloroethene | 25 ppm | 100 ppm | 1000 ppm | Inhalation; ingestion; absorption; skin/eye contact | Eyes, skin, respiratory system, heart, liver, kidneys, central nervous system | Irritation eyes, skin; headache, visual disturbance, lassitude, dizziness, tremor, drowsiness, nausea, vomiting; dermatitis, cardiac arrhythmias, paresthesia, liver injury |
| Vinyl Chloride | Lowest possible exposure | 0.5 ppm (29 CFR 1910.1017) | Not determined | Inhalation; skin/eye contact | Liver, central nervous system, blood, respiratory system, lymphatic system | Lassitude; abdominal pain; GI bleeding; enlarged liver; pallor or cyanosis of extremities; liquid; frostbite |
| Zinc (dust) | 5 $mg/m^3$ Ceiling 15 $mg/m^3$ (skin) | 15 $mg/m^3$ | 500 $mg/m^3$ | Inhalation | Respiratory system | Metal fume fever: chills, muscle ache, nausea, fever, dry throat and cough; lassitude; metallic taste; headache; blurred vision; lower back pain; vomiting; malaise; chest tightness; dyspnea; rales; decreased pulmonary function. |

REL – Recommended Exposure Limit (NIOSH) Pocked Guide to Chemical Hazards, September 2007
PEL – Permissible Exposure Limit (OSHA) Table Z-1 in 29 CFR 1910.1000
IDLH – Immediately Dangerous to Life or Health
NE – None established

## 3.2 Fire and Explosion Hazards

It is highly unlikely that vapors from the contaminated soils will be present at levels sufficient to create an explosion and/or fire hazard. It should be noted, however, that the 1996 Emergency Response Guidebook, published by the United States Department of Transportation, identifies the following explosion and/or fire hazards associated with fuel vapors.

- Flammable/combustible material
- May be ignited by heat, sparks or flames
- Vapors may travel to a source of ignition and flash back
- Containers may explode in heat or fire
- Vapor explosion hazards indoors, outdoors or in sewers
- Run-off to sewers may cause a fire or explosion hazard

## 3.3 Physical Hazards

Following is a summary of a variety of physical hazards that may be encountered on the job-site. For convenience, these hazards have been categorized into several general groupings and suggested preventative measures are also included.

| Category | Cause | Prevention |
|---|---|---|
| Head Hazards | Falling and/or sharp objects, bumping hazards. | Hard hats will be worn by all personnel at all times when overhead hazards are present. |
| Foot/Ankle Hazards | Sharp objects, dropped objects, uneven and/or slippery surfaces, chemical exposure | Chemical resistant, steel-toed boots must be worn at all times on-site. |
| Eye Hazards | Sharp objects, poor lighting, bright lights (welding equipment), exposure due to splashes | Safety glasses/face shields will be worn when appropriate. Shaded welding protection will be worn when appropriate. |
| Electrical Hazards | Underground utilities, overhead utilities | Locator service mark-outs, visual inspection of work area prior to starting work. |
| Mechanical Hazards | Heavy equipment such as drill rigs, service trucks, excavation equipment, saws, drills, etc. | Competent operators, backup alarms, regular maintenance, daily mechanical checks, proper guards. |
| Noise Hazards | Machinery creating >85 decibels TWA, >115 decibels continuous noise, or peak at >140 decibels | Wear earplugs or protective ear muffs when appropriate. |
| Fall Hazards | Elevated and/or slippery or uneven surfaces. Trips caused by poor "housekeeping" practices | Care should be used to avoid such accidents and to maintain good “housekeeping". Fall protection devices must be used when work proceeds on elevated surfaces. |
| Lifting Hazards | Injury due to improper lifting techniques, overreaching/overextending, heavy objects | Use proper lifting techniques, mechanical devices where appropriate. |
| Lighting Accidents | due to improper illumination | Work will proceed during daylight hours only, or under sufficient artificial illumination. |

## 4.0 AIR/SITE MONITORING

The following section describes monitoring techniques and equipment that are to be used during site work. The Site Health and Safety Officer, or a designated alternate, is responsible for performing all monitoring activities. Air and site monitoring will be used to determine the level of protection that is required for work to proceed safely.

### 4.1 Air Monitoring

Air monitoring will be performed to ensure that personnel are not exposed to harmful vapor concentrations in excess of PELs. This monitoring will also be used to identify any increases in airborne contaminant concentrations during work activities.

#### 4.1.1 Air Monitoring Equipment

All monitoring equipment used during this project will be inspected and calibrated at least daily to ensure that it is in proper working condition. If any piece of required monitoring equipment does not work properly, work in the monitored area will stop and will not continue until the monitoring equipment is repaired.

PID: Because exposure to airborne contaminants is expected to be limited to volatile organic compounds (VOCs), air monitoring will be performed with a Photoionization Detector (PID). The range of contaminants expected to be present require that the PID be equipped with a 10.2 eV detector lamp. The most likely airborne constituents include TCE and vinyl chloride. Because the site action level for VOCs is set and 5 ppm and the PEL for vinyl chloride is 1.0 ppm it will be important to determine if the total VOCs detected in the air contain greater than 1.0 ppm vinyl chloride. This determination will be made using colorimetric tubes specifically designed to detect and quantify vinyl chloride concentrations in the air. If total VOC concentrations are greater than 1.0 ppm over background (sustained for >15 minutes) EPI or Golder field personnel will use colorimetric tubes to evaluate the vinyl chloride concentration. If vinyl chloride is detected at concentrations greater than 1.0 ppm in the breathing zone engineering controls will be implemented and the breathing zone will be re-tested. Work will not be resumed until vinyl chloride concentrations are below 1.0 ppm in the breathing zone.

The PID must be "zeroed" and calibrated according to manufacturer instructions at least daily. Initial monitoring will be performed every 5 minutes, unless odors, tastes, or a PID response indicate the presence of airborne contaminants above background levels. If airborne contaminants are detected, air monitoring will be performed continuously. If airborne contaminants are not detected in the first 30 minutes of monitoring then monitoring intervals can be increased to every 15 minutes.

#### 4.1.2 Action Levels

**Photoionization Detector (PID)**

| Response | Length of Time | Protective Measure |
|---|---|---|
| < 5 ppm | 15 minute average | Level D PPE |
| >1 ppm over background | 15 minute average | Evaluate vinyl chloride concentrations relative to total VOCs using colorimetric tubes |
| 5-25 ppm | 15 minute average | Allow work area to vent. If persistent: Level C |
| 25-50 ppm | Sustained over 15 minutes | Level C PPE, High-efficiency organic vapor cartridges in respirator |
| > 50 ppm | One (1) minute average | Vacate work area, notify Site Health and Safety Officer or designated alternate immediately |

It should be noted that these action levels are based on the presence of benzene and vinyl chloride which have the lowest PELs and STELs of the compounds listed in Table 1.

### 4.2 Site Monitoring

The Site Health and Safety Officer will visually inspect the work-site at least daily to identify whether any new potential hazards have arisen. If and whenever possible, immediate measures will be taken to eliminate, or reduce the risks associated with these hazards.

### 4.3 Personal Protective Equipment (PPE)

It is anticipated that all field tasks will be performed in Level D PPE unless additional PPE is required because of task or site-specific upgrades. Level D PPE includes the following items:

- Nitrile inner and outer gloves
- Steel toe, steel shank work boots. Neoprene steel-toe, steel shank boots for ground water sampling and for drilling below the water table
- Hearing protection during drilling activities
- Hard hat during drilling activities and excavation work
- Safety glasses
- Cotton or Tyvek coveralls required

Level C PPE includes all Level D items plus the following:

- Full-face respirator equipped with organic vapor/HEPA combination cartridges (full face respirator replaces safety glasses for eye protection),
- Tyvek or Saranex coveralls
- Neoprene steel-toe, steel shank boots

## 5.0 HAZARD ANALYSIS BY TASK

The following section identifies potential hazards associated with each task listed in Section 2.2 of this Health and Safety Plan. Unless otherwise noted, work will begin and proceed in Level D personal protective equipment. The level of protection will be upgraded accordingly by the Site Health and Safety Officer whenever warranted by conditions present in the work area.

Task 1 – Monitoring Well Installation and Development: Exposure to volatile organic compounds in soil, air and groundwater; head, foot/ankle, and eye hazards; electrical and mechanical hazards; noise, fall, lifting, and overhead hazards.

Task 2 – Direct-Push Probe Groundwater and Soil Sampling: Exposure to volatile organic compounds in soil, air and groundwater; head, foot/ankle, and eye hazards; electrical and mechanical hazards; noise, fall, lifting, and overhead hazards.

Task 3 – Groundwater Sampling: Exposure to volatile organic compounds; head, foot/ankle, and eye hazards; electrical and mechanical hazards; noise, fall, and lifting hazards.

Task 4 - Surveying Well and Probe Locations: Limited potential for exposure to volatile organic compounds in air, potential slip, trip and fall hazards.

**Personnel:** EPI – Josh Bernthal, Doug Kunkel, Mary Holder, Monica Mogg, Tom Sparley
Golder - Ted Norton, Liz, Shea, Ian Young, Daniel Gorman, Jill Lamberts

**Contractor Names**: Cascade Drilling or other drilling company for drilling and probing
Dwayne Hartman and Associates for surveying tasks
APS or other utility locating company for subsurface utility locating
Cascade Concrete Sawing or other company for concrete coring

## 6.0 SITE CONTROL

The following section identifies several activity zones located on the work-site. It should be noted that access to some of these activity zones (i.e. the exclusion zone) will be restricted to designated personnel.

The work site is secured. Pedestrians and other unauthorized personnel will not be allowed within the exclusion zone.

### 6.1 Contamination Reduction Zone

A specified area will be established for the decontamination of sampling equipment and personnel. Because the location of this zone will change during the course of the investigation the site safety office will discuss the contaminant reduction zone location during each daily safety briefing.

#### 6.1.1 Decontamination Procedures - Equipment

Split-spoon samplers and other down-hole equipment will be decontaminated with a solution of Liquinox™ or equivalent soap and potable water and rinsed with distilled or deionized water prior to collecting soil samples for analysis as noted in Section 3.8.2 of the work plan. An alternative method of decontamination is to hot water pressure wash all down-hole sampling and drilling equipment. All decontamination wastes will be containerized, properly marked, and left in a designated on-site location for disposition by Boeing.

#### 6.1.2 Decontamination Procedures - Personnel

All personal protective clothing (i.e. nitrile gloves) and other miscellaneous waste will be bagged in opaque garbage bags and will be discarded in the trash. All on-site personnel must, at a minimum, wash their face and hands before eating, before break periods, and prior to leaving the site as noted in Section 3.8.3 of the work plan.

## 7.0 EMERGENCY RESPONSE AND CONTINGENCY PLAN

The purpose of this section is to define procedures and specific responsibilities that are to be followed in the event that a chemical spill or release, a fire or explosion, or an accident involving injuries occurs. The Site Health and Safety Officer, or a designated alternate, will determine when emergency and/or regulatory agencies should be contacted and which agencies are appropriate to contact. It should be noted that if injuries have occurred, all site workers have the responsibility to secure medical help for the affected worker(s). Medical emergency help can be contacted at the appropriate phone numbers listed on the pink pages of this Plan. A route map to the nearest hospital (Harborview Medical Center) is included with the attached figures.

In all emergency situations, the rule is SAFETY FIRST! Do not, under any circumstances, endanger yourself or others to rescue a fallen co-worker. It is far better to rescue one person after proper safety measures for the rescue have been carefully considered, than to have to rescue additional people whose haste to help out got them in trouble.

In case of injury: call 206-655-2222 first, then 911 if necessary.

# 8.0 ADMINISTRATIVE

## 8.1 Medical Surveillance

Personnel involved with field activities must be covered under their employer's medical surveillance program that includes annual physical examinations and certification to wear respiratory protective equipment. These medical monitoring programs must be in compliance with all applicable worker health and safety regulations.

## 8.2 Record Keeping

The Site Health and Safety Officer, or a designated alternate, will be responsible for keeping daily logs of workers and visitors present at the work site, attendance lists of personnel present at site health and safety meetings, accident reports, air monitoring results, and signatures of all personnel who have read this Health and Safety Plan.

**SIGNATURE PAGE**

I have read this Health and Safety Plan and understand its contents. I agree to abide by its provisions and will immediately notify the Site Health and Safety Officer (Josh Bernthal, (425) 241-5400), or designated alternate if site conditions or hazards not specifically designated herein are encountered.

| Name (Print) | Signature | Date | Company/Affiliation |
|---|---|---|---|
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# Figures

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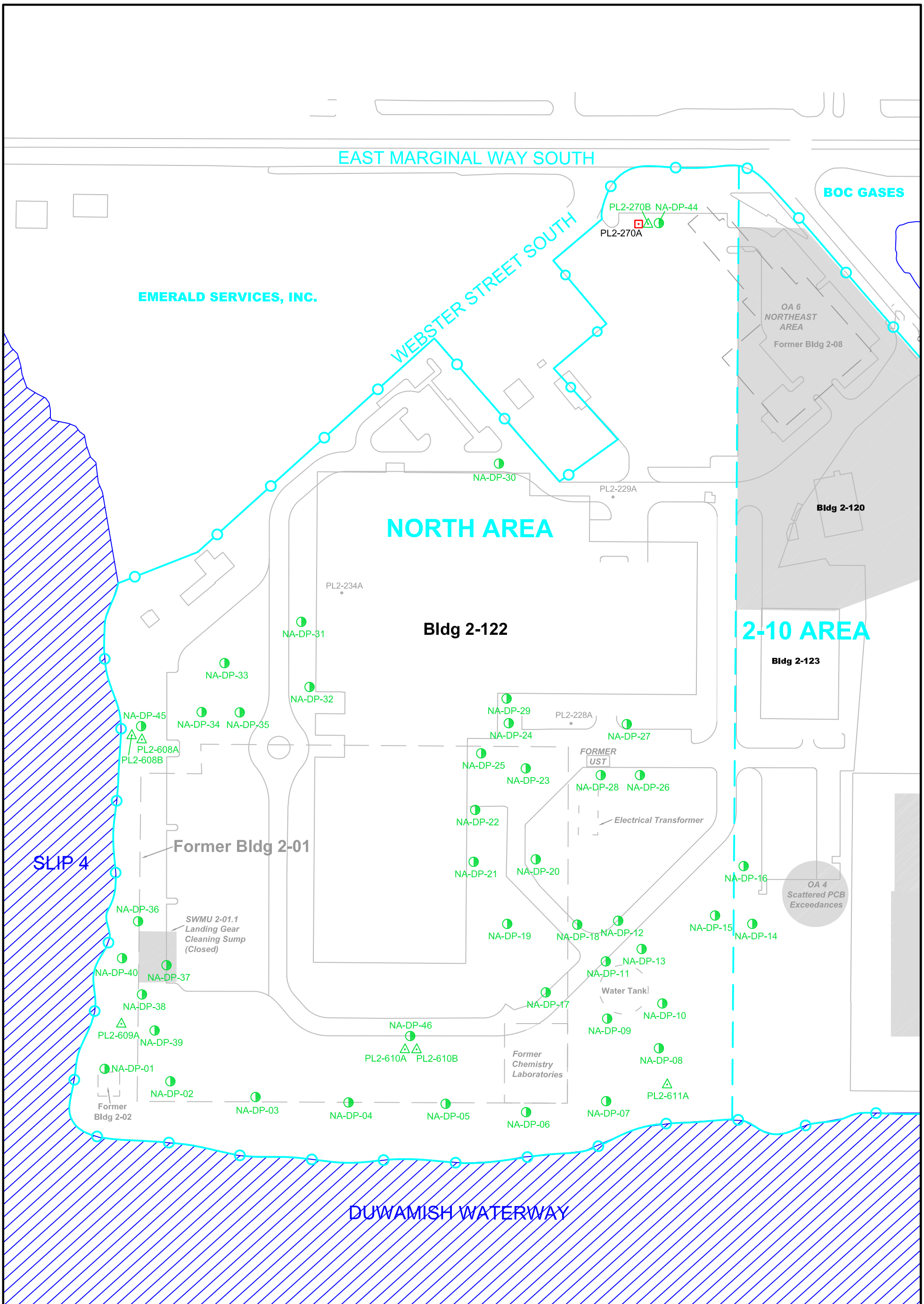


KEY:

- WELL SAMPLED FOR DATA GAPS
- PROPOSED MONITORING WELL LOCATION
- PROPOSED DIRECT PUSH PROBE LOCATION
- AREA BOUNDARY
- PROPERTY BOUNDARY
- DECOMMISSIONED WELL
- RCRA REGULATED UNIT

0 30' 60' 120'
SCALE: 1" = 120'

ENVIRONMENTAL PARTNERS INC
295 NE Gilman Boulevard, Suite 201
Issaquah, Washington 98027

**FIGURE 2-1**
**NORTH AREA**
**GROUNDWATER AND SOIL**
**DATA GAP SAMPLING LOCATIONS**

| | |
|---|---|
| PROJECT | BOEING PLANT 2 |
| PREPARED FOR | THE BOEING COMPANY |
| LOCATION | 7725 EAST MARGINAL WAY SEATTLE/TUKWILA, WASHINGTON |

| SHEET | DRAWN BY | REVIEWED BY | DATE |
|---|---|---|---|
| 1 of 1 | MMH | DCK | 03/31/08 |

**Directions from Boeing Plant 2 to** **Harborview Medical Center**
**325 9th Avenue, Seattle, Wa, 98104**

Driving Directions:

1 From Boeing Plant 2, turn left onto East Marginal Way S and drive northwest 1.1 miles to Corson Avenue.
2 Turn right onto Corson Avenue S and proceed north 0.4 miles to S Bailey Street.
3 Turn right on S Bailey Street and proceed east 0.2 miles to the I-5 freeway entrance.
4 Turn left to the I-5 freeway ramp, get in the left hand lane, and proceed to northbound I-5
5 Continue on I-5 northbound 2.8 miles to exit 164A
6 Turn right onto the ramp for exit 164 A and proceed north 0.1 miles
7 Get in the left hand lane to stay on the exit ramp, and proceed north 0.2 miles
8 Get in the left hand lane to stay on the exit ramp, and proceed north 0.5 miles
9 Get in the right hand lane to stay on the exit ramp and proceed 0.2 miles to the James Street exit.
10 Turn right onto James Street and proceed 0.1 miles east to 9th Street
11 Turn right on 9th Street and proceed 0.1 miles south to Harborview Medical Center

**Boeing Plant 2**
**Seattle/Tukwila, Washington**

# Uplands Corrective Measures
# Volume VIIa: North Area

# Data Gap Investigation Work Plan

# Attachment D
# Technical Procedures

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ENVIRONMENTAL PARTNERS INC

# TECHNICAL PROCEDURE TP-1.0

# Standard Procedures for Field Parameter Measurement

**Revision 1**
**September 2003**

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# Introduction

One or more of the following field instruments might be used to monitor ground water field parameters during purging or sampling. The equipment and methodologies presented below are applicable for field measurements during standard high-flow (3 casing volumes) purging, low-flow purging, process water measurements and also for surface water measurements.

Multi-parameter meters such as the Horiba are easier to calibrate and operate compared to using several single-parameter instruments, especially when used to monitor well purging. However, it should be noted that the Horiba U-10 does not measure Oxidation-Reduction Potential (ORP), which is an important field parameter for evaluation of site geochemistry. In addition, if turbidity is an important parameter it may be prudent to use a turbidity-only instrument for this parameter as the turbidity probe in the multi-parameter Horiba is not as robust as those used in single-parameter models.

The following sections describe the procedures for calibration and field measurements using a variety of commonly-available instruments. However, it should be note that this Technical Procedure includes only a few of the many water sampling field instruments that are available. For additional details regarding calibration, operation, or troubleshooting or for instruments not included in this Technical Procedure, it is recommended that field staff consult the appropriate manufacturer's operation manual or call their technical service line. Another potential source of technical help for rental instruments is the technical assistance number of the rental company.

## Horiba U-10 or U-20 Water Checker Calibration and Use

These instructions cover the calibration and operation of the Horiba™ model U-10 and U-20 multi-parameter water quality meters which are used to measure the following six field parameters:

- pH (standard units)
- Conductivity (mS/cm)
- Temperature (Celsius)
- Turbidity (NTU)
- Salinity (%)
- Dissolved oxygen (mg/L)

.A copy of the instruction manual for the Horiba meter should accompany the instrument as a reference, particularly for nonstandard calibration procedures, measurements, and troubleshooting. If a multi-parameter instrument other than the Horiba U-10 or U-20 is used, field staff should follow the manufacturer's instructions for specific calibration and use and should refer to these procedures only for general guidance. Field staff should record the meter manufacturer and all identification numbers in the Instrument Calibration Log.

## Preparing the Meter and Electrodes for Calibration

The meter and the probes may not function properly if they have reached temperatures below 45 degrees Fahrenheit (°F). Keep this equipment in a warm environment prior to calibration and use.

Turn on the meter. Remove the rubber protector from the glass bulb on the pH probe.

The meter will show a **LOW BATT** message if the 9-volt battery has insufficient voltage to properly power the meter. Replace the battery whenever the **LOW BATT** message appears and perform a new calibration.

Inspect the supplied Autocal solution to be sure that the expiration date has not been passed. Document the manufacturer, lot number, expiration date, and standard readings of the Autocal solution in the Instrument Calibration Log.

Fill the supplied calibration cup with Autocal solution. Be sure to the fill the cup to the line noted on the side the container. Lower the probe over the calibration cup and allow the probes to come into equilibrium with the solution for one minute

Press the **MODE** button until the indicator on the screen is under **AUTO** then press **ENTER** and the Horiba will automatically perform a 1-point calibration to the Autocal solution. A two-point calibration may be performed if more precise data are required. Consult the manufacturer's instruction manual to perform two-point calibration. It should be noted that additional standards or buffer solutions are needed to perform two-point calibration.

## Taking Field Measurements

Field measurements should be performed on the sample without delay to minimize changes in temperature and chemistry. The sample should not be aerated by the sampling process. The probes need to be thoroughly rinsed in distilled water between sampling locations.

### The Cup Method

Obtain a sample volume in a cup large enough to completely submerge the Horiba probe. Field measurements should be performed on the sample without delay to minimize changes in sample temperature and chemistry. Immerse the probe completely in the sample for at least 60 seconds to allow the probe temperature to equalize with the sample temperature. Jiggle the probe to displace any air bubbles that may have attached to the probe. Then gently move the probe up and down. Press the blue **Display** button to cycle through the six field parameters measured by this instrument. Record the sample field parameters in the field logbook. Rinse the probe in distilled water. After use, the probe can be stored either wet or dry.

### The Flow-Through-Cell Method

Direct the continuous sample flow from the sampling pump so that it discharges at the bottom of the flow-through cell. The cell will then fill from the bottom up and overflow out the top of the cell, which prevents aeration of the sample except at the air-surface interface. The flow rates should be low enough that the sample is not aerated below the air-water interface as it passes through the cell. Place the Horiba probe into the cell so that

it is fully submerged. Jiggle the probe to displace any air bubbles that may have attached to the probe.

Allow 60 seconds for the probe temperature to equalize with the sample temperature and then record the sample field parameters. Press the blue **Display** button to cycle through the six field parameters measured by this instrument. Record the sample field parameters in the field logbook. Rinse the probe in distilled water. After use, the probe can be stored either wet or dry.

# pH Meter and Electrode Calibration and Use

## pH Meters

These instructions cover the calibration and operation of the Orion® 250A and 290A pH meters, which may be used for taking field pH measurements of groundwater and surface water. A copy of the instruction manual for the Orion pH meters should accompany the instruments as a reference, particularly for nonstandard calibration procedures, measurements, and troubleshooting (see Information Sources, below). If a pH meter other than the Orion 250A or 290A is used, field staff should follow the manufacturer's instructions for specific calibration and use and should refer to these procedures only for general guidance. Field staff should record the meter manufacturer and all identification numbers in the Instrument Calibration Log.

## pH Electrodes

Two types of pH electrodes are generally used with the Orion pH meters. Instruction manuals for these electrodes are also available and should be kept with the equipment for reference and troubleshooting.

- The Orion Model 9107BN Low Maintenance Triode is a gel-filled, non-refillable electrode with an integral temperature probe. The 9107BN Low Maintenance Triode is designed to be stored dry, with or without the protective cap in place.
- The Orion Model 9157BN Triode is a liquid-filled, refillable electrode with an integral temperature probe. Use Orion 900011 fill solution to refill the electrode. The 9157BN Triode must be stored in a pH electrode storage solution for silver/silver chloride (Ag/AgCl) electrodes or in a pH 4 buffer solution.

During calibration and field measurement, the internal solution level of either electrode must remain a minimum of 1 inch above the surface of the liquid being measured. In addition, the vent hole on the 9157BN Triode must be uncovered while measurements are taken with this electrode. Both of these electrodes provide automatic temperature compensation (ATC) for pH measurements when the temperature probe is connected properly to the pH meter. The meter will read a constant 25 degrees Celsius (°C) if the temperature probe is not connected or not functioning.

## Preparing the Meter and Electrodes for Calibration

The meters and the probes may not function properly if they have reached temperatures below 45 degrees Fahrenheit (°F). Keep this equipment in a warm environment prior to calibration and use.

Connect the BNC-type pH electrode connector and the DIN-type ATC connector to the top of the pH meter. Turn on the meter. Check to make sure the meter is in the pH mode.

The meter will show a **LOW BATT** message if the 9-volt battery has insufficient voltage to properly power the meter. Replace the battery whenever the **LOW BATT** message appears and perform a new calibration.

Use the **SETUP MENU** to set the meter's internal operating parameters (refer to the Orion manual for instructions). The decimal point resolution should be set to two decimal places rather than at the default setting of three. Three is too high for field measurements, and more time is needed to obtain stable meter readings using three decimal places.

## Auto calibrating with Two Buffers (Orion 250A and 290A pH Meters)

Choose two buffers, 7.00 and 4.00 or 7.00 and 10.00, that will bracket the expected sample range. Use only new, unused pH buffers for calibration. Never return used buffer to a bottle containing unused buffer solution.

Rinse the electrode in clean distilled water and gently shake excess water from the electrode. (All rinses specified in these instructions should be performed using clean distilled water.) Do not wipe the electrode because the static electrical charge generated can affect the electrode's measurements.

Insert the electrode into the 7.00 buffer until the **READY** message appears. If the **READY** message does not appear, check the meter setup menu to make sure the **READY** function has been enabled (refer to Orion manual for instructions). Record the buffer temperature in the calibration log.

Press the **2nd** and then the **CAL** buttons to place the meter in calibration mode. The **P-1** message will appear at the bottom of the screen, indicating that the meter is ready for the first buffer. The meter will automatically recognize the buffer. The **READY** message will be displayed, and the pH buffer value will flash as soon as the electrode has achieved a stable, temperature-corrected reading. Record the flashing pH value in the calibration log. Press the **YES** button to enter the first calibration point into the meter. The meter will now show the **P-2** message at the bottom of the screen, indicating that the meter is ready for the second buffer.

Rinse the electrode and place it in either the 4.00 or 10.00 buffer. Once the **READY** message appears, record the flashing pH value in the calibration log. Press the **YES** button to enter the second calibration point into the meter. The meter will automatically display the slope value. Record this value and then return the electrode to the **MEASURE** mode. The slope value should be in the 92 percent to 102 percent range for an acceptable calibration, according to the electrode manual. In general, any slope of less than 97 percent or greater than 101 percent is suspicious and indicates that the calibration process should be repeated. If recalibration fails, consider using a new set of standards and/or refilling the electrode (if it's the refillable type). The manufacturer's instructions cover procedures for additional remedies, such as cleaning the electrode bulb, checking out the meter function, and calibrating the meter manually.

Rinse the electrode. It is ready for use.

A one-point calibration check should be performed every 4 hours or anytime a sample pH value is suspected to be in error. To perform a one-point calibration check, place the rinsed

electrode in the buffer closest to the sample pH and see if the value obtained is within ± 0.5 pH units of the table value for that buffer at that temperature (see Table C-1 at end of this appendix). If it is not, perform another calibration for the instrument and record the new values. Thoroughly document all sample measurements and calibration values before and after recalibration.

## Auto calibrating with Three Buffers (Orion 290A Meter Only)

The three-point calibration uses the 4.00, 7.00, and 10.00 buffers. Use only new, unused pH buffers for calibration. Never return used buffer solution to a bottle containing unused solution.

Rinse the electrode in clean distilled water and gently shake excess water from electrode. Do not wipe the electrode because the static electrical charge generated can affect the electrode's measurements.

Insert the electrode into the 4.00 buffer until **READY** message appears. If the **READY** message does not appear, check the meter setup menu to make sure the **READY** function has been enabled (refer to Orion manual for instructions). Record the buffer temperature in the calibration log.

Press the **2nd** and then the **CAL** buttons to place the meter in calibration mode. The **P-1** message will appear at the bottom of the screen, indicating that the meter is ready for the first buffer. The meter will automatically recognize the buffer. The **READY** message will be displayed, and the pH buffer value will flash once the electrode has achieved a stable, temperature-corrected reading. Record the flashing pH value in the calibration log. Press the **YES** button to enter the first calibration point into the meter. The meter will now show the **P-2** message at the bottom of the screen, indicating that the meter is ready for the second buffer.

Rinse the electrode and place it in the 7.00 buffer. Once the **READY** message appears, record the flashing pH value in the calibration log. Press the **YES** button to enter the second calibration point into the meter. The meter will now show the **P-3** message at the bottom of the screen, indicating that the meter is ready for the third buffer.

Rinse the electrode and place it in the 10.00 buffer. Once the **READY** message appears, record the flashing pH value in the calibration log. Press the **YES** button to enter the third calibration point into the meter. The meter will now show the P-4 message at the bottom of the screen, indicating that the meter is ready for the fourth buffer***.*** Press the **MEASURE button** to bypass the fourth calibration point. The meter will automatically display the slope value; record this value and then return the meter to the **MEASURE** mode. The slope value should be in the 92 percent to 102 percent range for an acceptable calibration, according to the electrode manual. In general, any slope of less than 97 percent or greater than 101 percent is suspicious and indicates that the calibration process should be repeated.

Rinse the electrode. It is ready for use.

A one-point calibration check should be performed every 4 hours or anytime a sample pH value is suspected to be in error. To perform a one-point calibration check, place the rinsed electrode in the buffer closest to the sample pH and see if the value obtained is within ± 0.5 pH units of the table value for that buffer at that temperature (see Table C-1 at end of

this appendix). If it is not, perform another calibration for the instrument and record the new values. Thoroughly document all sample measurements and calibration values before and after recalibration.

## Taking pH Measurements

Measurement of pH should be performed on the sample without delay to minimize changes in temperature and chemistry. The sample should not be aerated by the sampling process. The electrode needs to be thoroughly rinsed in distilled water between samples.

### The Cup Method

Obtain a sample volume in a cup large enough to submerge the electrode bulb. Gently swirl the probe in the sample until the **READY** message appears. Record this pH value and the sample temperature and units.

### The Flow-Through-Cell Method

Direct the continuous sample flow from the sampling pump so that it discharges at the bottom of the flow-through cell. The cell will then fill from the bottom up and overflow out the top of the cell, which prevents aeration of the sample except at the air-surface interface. The flow rates should be low enough that the sample is not aerated below the air-water interface as it passes through the cell. Place the pH electrode into the cell 2 to 4 inches below the surface of the sample.

Record the pH value and temperature when the **READY** message appears.

## Information Sources

Orion Research Incorporated. Orion Laboratory Products Group Portable pH/ISE Meters Instruction Manual (Model 230A, 250A, and 290A). 1991.

Orion Research Incorporated. Orion Research Laboratory Products Group Model 9107 Low Maintenance Triode pH Electrode Instruction Manual. 1991.

Orion Research Incorporated. Orion Research Laboratory Products Group Model 9157 Triode pH Electrode Instruction Manual.

Orion Research Incorporated Telephone: (800) 225-1480.

# Conductivity Meter and Probe Calibration and Use

## Conductivity Meters

These instructions cover the calibration and operation of the YSI® conductivity meters used for taking field conductivity measurements. A copy of the YSI conductivity meter instruction manual should accompany the instrument as a reference, particularly for nonstandard calibration procedures, measurements, and troubleshooting (see Information Sources, below). If a conductivity meter other than the YSI 30 or YSI 33 is used, the user should follow the manufacturer's instructions for specific calibration and use and should refer to these procedures only for general guidance. Field staff should record the meter manufacturer and all identification numbers in the Instrument Calibration Log.

Two types of conductivity meters are in general use: the YSI 30, which measures electrical conductivity and specific conductance, and the YSI 33, which measures only electrical conductivity. Specific conductance is the sample's electrical conductivity at 25°C. Electrical conductivity values are relative to the sample temperature at the time of measurement and must be converted to specific conductance by use of a mathematical conversion formula. Specific conductance allows for the comparison of conductivities at a standard temperature.

Conductivity is measured in microsiemens/centimeter (µS/cm) or millisiemens/centimeter (mS/cm) on the YSI 30 and in micromhos/centimeter (µmhos/cm) on the YSI 33. One microsiemen/centimeter is equal to one micromho/centimeter.

## Calibrating the YSI 30 Conductivity Meter

Turn the meter on by pushing the **ON/OFF** button. If the **LO BAT** message is displayed, put six new AA alkaline batteries in the meter. Always replace the batteries when the **LO BAT** message appears and check the meter calibration afterward.

Clean the conductivity probe on the inside and outside using a solution of Alconox or common foam-type bathroom toilet cleaner before each calibration. A small pipette brush is necessary to clean the inside of the probe. Thoroughly rinse the probe with clean distilled water until no residual cleaner is left on the probe that will interfere with the calibration standard's value. Gently shake excess water from the probe.

Press the **MODE** button until a flashing **°C** is displayed. This symbol indicates that the meter in the specific conductance mode. Temperature compensation is automatic when the meter is in the specific conductance mode.

> ***Warning***: The only difference on the meter readout between specific conductance mode and electrical conductivity is whether or not the **°C** is flashing. The operator needs to check the mode frequently when taking meter readings to ensure the meter is in the desired mode.

Immerse the probe completely in fresh conductivity standard for at least 60 seconds to allow the probe temperature to equalize with the standard's temperature. Generally, a conductivity standard of either 1,000 or 1,413 µS/cm is used. Gently move the probe up and down in the standard without touching the sides of the container or raising the probe above the surface.

Compare the readout on the meter to the conductivity standard's value. If the readings do not agree, simultaneously press the up arrow button and the down arrow button. The **CAL** message should appear in the lower left corner. Press the up arrow and down arrow buttons as appropriate to change the meter readout so that it agrees with the conductivity standard's value. Press **ENTER** to lock the new calibration in the meter's memory. The **CAL** message should disappear. Record the conductivity value of the standard in the calibration log.

If the YSI 30 meter is to be used to measure electrical conductivity, the meter should be switched to the electrical conductivity mode using the **MODE** button after calibration has been completed. Record the conductivity value and temperature of the standard used to calibrate the instrument in the calibration log.

Thoroughly rinse the probe with distilled water, making sure all the calibration standard is washed off. The conductivity meter and probe are ready for use.

## Taking Conductivity Measurements Using the YSI 30 Meter

Select the desired mode of measurement by pressing the **MODE** button. The meter is in the specific conductance mode when the **°C** is flashing. The meter is in the electrical conductivity mode when the **°C** is NOT flashing.

> ***Warning***: When you record the readings in the log, make sure to indicate clearly whether specific conductance or electrical conductance was measured. The sample temperature is considered a part of the sample measurement and must also be recorded, with the proper units of measurement indicated.

The YSI 30 has four conductivity ranges: 0 to 499.9 µS/cm; 0 to 4,999 µS/cm; 0 to 49.99 mS/cm; 0 to 200.0 mS/cm. The meter has an auto-range function that automatically places the meter readout in the correct range for the sample being measured.

> ***Warning***: The meter must be checked each time a reading is taken to determine which range the meter is displaying—µS/cm or mS/cm (1 mS/cm equals 1,000 µ S/cm).

### The Cup Method

Obtain a sample volume in a cup large enough to completely submerge the conductivity probe. Conductivity measurements should be performed on the sample without delay to minimize changes in temperature and chemistry. Immerse the probe completely in the sample for at least 60 seconds to allow the probe temperature to equalize with the sample temperature. Jiggle the probe to displace any air bubbles that may have attached to the probe. Then gently move the probe up and down, and record the sample conductivity reading and temperature. Rinse the probe in distilled water. After use, the probe can be stored either wet or dry.

### The Flow-Through-Cell Method

Direct the continuous sample flow from the sampling pump so that it discharges at the bottom of the flow-through cell. The cell will then fill from the bottom up and overflow out the top of the cell, which prevents aeration of the sample except at the air-surface interface. The flow rates should be low enough that the sample is not aerated below the air-water interface as it passes through the cell. Place the conductivity probe into the cell

so that it is fully submerged and not in contact with any surfaces. Jiggle the probe to displace any air bubbles that may have attached to the probe.

Allow 60 seconds for the probe temperature to equalize with the sample temperature and then record the conductivity value and temperature. Rinse the probe in distilled water. After use, the probe can be stored either wet or dry.

### In-Situ Method

Lower the conductivity probe into the water to the depth at which measurement is to be taken. Jiggle the probe to displace any air bubbles that may have attached to the probe. Gently move the probe up and down, allow 60 seconds for the probe temperature to equalize with the sample temperature, and then record the sample conductivity reading and temperature. Rinse the probe in distilled water. After use, the probe can be stored either wet or dry.

## Calibrating the YSI 33 Conductivity Meter

The YSI 33 conductivity meter calibration is factory set and cannot be adjusted in the field. Meter function is checked by measuring the conductivity of a known conductivity standard to ensure that the meter is reading correctly.

With the **MODE** knob in the **OFF** position and the meter in the normal 45 degree operating position, check whether the indicator needle is reading zero. If it is not, adjust the meter by turning the slot screw on the face of the meter (below the needle) with a small screwdriver.

Turn the **MODE** knob to the **RED LINE** position and, using the **RED LINE** knob, adjust the indicator needle so that it lines up with the red line on the meter readout (it is located at the 370 µmhos mark). If the meter will not line up with the red line**,** then replace the two D-cell alkaline batteries and try again.

> ***Note:*** The YSI 33 has three conductivity scales available: **X1**, **X10**, and **X100**. The **X1** scale ranges from 0 to 500 µmhos/cm; the conductivity is read directly from the meter scale. The **X10** scale ranges from 0 to 5,000 µmhos/cm; conductivity is obtained by reading the meter scale and then multiplying that reading by 10. The **X100** scale reads from 0 to 50,000 µmhos/cm and is obtained multiplying the meter scale reading by 100. To select the desired scale, turn the **MODE** knob to **X1**, **X10**, or **X100**.

Turn the **MODE** knob to the **X10** conductivity scale. (This is the recommended mode for 1,000 or 1,413 µmhos/cm standard.)

Rinse the conductivity probe in distilled water. Immerse the probe completely in fresh conductivity standard for at least 60 seconds to allow the probe temperature to equalize with the standard's temperature. Generally, a conductivity standard of either 1,000 or 1,413 µS/cm is used. Gently move the probe up and down within the standard without touching the sides of the container or raising the probe above the surface. Record the electrical conductivity reading in the calibration log.

Turn the **MODE** knob to the **TEMPERATURE** position and read the conductivity standard's temperature. The temperature scale reads backwards in increasing values from right to left. Record the conductivity standard's temperature in the calibration log.

Look up the temperature (see Table C-1 at end of this appendix) value for the conductivity standard at the temperature at which it was measured and compare that value to the measured value. The measured value should be within ± 10 percent of the table value. If the meter and table values vary by more than 10 percent, clean the conductivity probe on the inside and outside by soaking it for 5 minutes in a solution of Alconox or common foam-type bathroom cleaner. Do not use anything to clean inside the small holes at the end of the probe. Thoroughly rinse the probe with distilled water until no residual cleaner is left on the probe that will interfere with the calibration standard's value. Repeat all steps of the calibration check.

> ***Note***: The separate temperature knob at the top right of the meter is for salinity measurements only and is disabled when the meter is in the conductivity mode.

Thoroughly rinse the calibration standard from the probe with distilled water. The conductivity meter and probe are ready for use.

## Taking Conductivity Measurements Using the YSI 33 Meter

Select the desired mode of measurement by turning the **MODE** knob to the **X1**, **X10**, or **X100** conductivity scale. After recording the electrical conductance reading for the sample measured, *always* immediately turn the **MODE** knob to the **TEMPERATURE** position and record the temperature of the sample.

> ***Warning***: When you record the readings in the log, make sure to indicate clearly that electrical conductance was measured. The sample temperature is considered a part of the sample measurement and must also be recorded, with the proper units of measurement indicated.

### The Cup Method

Obtain a sample volume in a cup large enough to completely submerge the conductivity probe. Conductivity measurements should be performed on the sample without delay to minimize changes in sample temperature and chemistry. Immerse the probe completely in the sample for at least 60 seconds to allow the probe temperature to equalize with the sample temperature. Jiggle the probe to displace any air bubbles that may have attached to the probe. Then gently move the probe up and down, and record the sample conductivity reading and temperature. Rinse the probe in distilled water. After use, the probe can be stored either wet or dry.

### The Flow-Through-Cell Method

Direct the continuous sample flow from the sampling pump so that it discharges at the bottom of the flow-through cell. The cell will then fill from the bottom up and overflow out the top of the cell, which prevents aeration of the sample except at the air-surface interface. The flow rates should be low enough that the sample is not aerated below the air-water interface as it passes through the cell. Place the conductivity probe into the cell so that it is fully submerged and not in contact with any surfaces. Jiggle the probe to displace any air bubbles that may have attached to the probe.

Allow 60 seconds for the probe temperature to equalize with the sample temperature and then record the conductivity value and temperature. Rinse the probe in distilled water. After use, the probe can be stored either wet or dry.

### In-Situ Method

Lower the conductivity probe into the water to the depth where measurement is to be taken. Jiggle the probe to displace any air bubbles that may have attached to the probe. Gently move the probe up and down, allow 60 seconds for the probe temperature to equalize with the sample temperature, and then record the sample conductivity reading and temperature. Rinse the probe in distilled water. After use, the probe can be stored either wet or dry.

## Information Sources

YSI Incorporated. Operations Manual: YSI Model 30 Handheld Salinity, Conductivity and Temperature System.

YSI Incorporated. Instructions for YSI Model 33 and 33M S-C-T Meters.

YSI Incorporated Telephone: (800) 765-4974. Internet address: http://www.ysi.com.

# Dissolved Oxygen Meter and Probe Calibration and Use

These instructions cover the calibration and use of the YSI 54A meter, which is used for field measurements of dissolved oxygen (DO). A copy of the YSI DO meter instruction manual should accompany the instrument as a reference, particularly for nonstandard calibration procedures, measurements, and troubleshooting (see Information Sources, below). If a DO meter other than the YSI 54A is used, then the user should follow the manufacturer's instructions for specific calibration and use and should refer to these procedures only for general guidance. Field staff should record all manufacturer names and identification numbers in the Instrument Calibration Log.

The YSI 54A measures DO in the **0-10** and **0-20** milligrams per liter (mg/L) ranges. Resolution is 0.05 mg/L on the **0-10** scale and 0.1 mg/L on the **0-20** scale. DO measurements are affected by temperature, altitude, and salinity. Temperature changes are automatically compensated for by the YSI 54A. All waters to be measured are fresh water.

## Preparing the YSI 54A DO Meter for Calibration

Connect the DO probe to the meter. Inspect the DO probe membrane for bubbles underneath the membrane or for wrinkles in the membrane. Use a blunt tool such as the eraser end of a pencil to apply pressure to the diaphragm located in the side of the DO probe while checking the membrane for pinhole leaks. If any problem is observed, replace the membrane and probe solution using parts from the YSI Model 5775 Oxygen Probe Service Kit and following instructions in the YSI instruction manual (pages 8 and 9).

The following functions (mechanical zero, red line, and instrument zero) are independent of the DO probe status and can be performed with the probe in or out of the water.

- **Mechanical Zero—**With the function knob in the **OFF** position and the meter in its operating position, check whether the indicator needle is reading zero. If it is not, adjust the meter by turning the slot screw on the face of the meter (below the needle) with a small screwdriver.
- **Red Line—**Turn the function knob to the **RED LINE** position and, using the **RED LINE** knob, adjust the indicator needle so that it lines up with the red line on the meter readout (it is located at the 31°C mark). If the meter will not line up, replace the four C-cell alkaline batteries and try again. A defective probe will also prevent the meter from red-lining properly.
- **Instrument Zero—**Turn the function knob to the **ZERO** position and, using the **ZERO** knob, adjust the indicator needle so that it reads zero. The zero function is an internal electronic function that is independent of the DO probe.

## Calibrating the YSI 54A DO Meter

The YSI 54A DO meter calibration method specified in these instructions is the air calibration method. Other calibration methods are outlined in the YSI instruction manual, but the air calibration method is the easiest for field use.

Wet the sponge in the calibration bottle thoroughly with distilled water and shake any excess from the bottle. Insert the probe until it seals around the entire circumference of the probe. An alternative method is to saturate a paper towel with distilled water, wrap the membrane end of the DO probe completely in the wet paper towel (making sure the towel does not touch the probe membrane) and place the probe paper towel in a plastic bag to reduce evaporation. Either method places the probe in an atmosphere of air saturated with water and the DO value in this atmosphere is a known value at any given temperature.

Allow 15 minutes for the probe to stabilize before beginning calibration.

After the warm-up period, turn the function knob to the **TEMP** function and note the probe temperature. Record the temperature in the calibration log. If the temperature is 16°C or higher, turn the function knob to the **0-10** mg/L scale. If the temperature is less than 16°C, turn the function knob to the **0-20** mg/L scale.

Using Table 1, Solubility of Oxygen in Fresh Water, on page 14 of the YSI instruction manual (also printed on the back of the instrument case), find the mg/L of DO value for the probe temperature noted above. Use the **CAL** knob to adjust the indicator needle so that it reads the same as the table value. Rotate the probe 180 degrees vertically, and the meter reading should vary by no more than 0.05 mg/L.

If any problem is observed during calibration, replace the membrane and probe solution using parts from the YSI Model 5775 Oxygen Probe Service Kit and following instructions in the YSI instruction manual (pages 8 and 9). The meter will then need to be recalibrated.

Record the meter manufacturer name, identification number, calibration method (air saturation), calibration reading in mg/L, temperature in °C, and elevation above sea level (less than 100 feet for most Seattle-area sites).

## Taking DO Measurements Using the YSI 54A Meter

The probe must be allowed a 15-minute warm-up period anytime it has been turned off, or false readings may be indicated. The probe is usually left in the on position (**0-10** or **0-20** position) after it has been calibrated. Battery drawdown is minimal.

DO measurements with the YSI 54A meter require a constant flow across the membrane. This flow can be maintained manually or by using a stirrer or flow-through cell. Typically, a stirrer is not used for field measurements.

### The Flow-Through-Cell Method

Direct the continuous sample flow from the sampling pump so that it discharges at the bottom of the flow-through cell. The cell will then fill from the bottom up and overflow out the top of the cell, which prevents aeration of the sample except at the air-surface interface. The flow rates should be low enough that the sample is not aerated below the air-water interface as it passes through the cell. Place the DO probe into the cell so that it rests at the bottom of the cell.

Set the meter to the **0-10** or **0-20** mg/L scale as appropriate. Allow the probe temperature to equalize with the sample temperature and the DO measurement to stabilize. Record the DO value and temperature. Rinse the probe in distilled water and store it in the calibration bottle.

### In-Situ Method

Lower the DO probe into the water to the depth where measurement is to be taken. Wait for the probe temperature to stabilize, then gently move the probe up and down at a rate of 1 foot per second until a stable DO reading is obtained. Record the DO value and temperature. Rinse the probe in distilled water and store it in the calibration bottle.

## Information Sources

YSI Incorporated. Instruction Manual: YSI Models 54ARC and 54 ABP Dissolved Oxygen Meters.

YSI Incorporated Telephone: (800) 765-4974. Internet address: http://www.ysi.com

# Field Turbidity Meter Calibration and Use

These instructions cover the calibration and operation of the HF Scientific® Model DRT-15CE portable turbidimeter, which is used to take field turbidity measurements of groundwater and surface water. A copy of the HF Scientific operating and maintenance manual should accompany the meter as a reference, particularly for nonstandard procedures, measurements, and troubleshooting (see Information Sources, below). If a turbidimeter other than the DRT-15CE is used, the user should follow the manufacturer's instructions for specific calibration and use and refer to these procedures only for general guidance. Field staff should record the meter manufacturer and all identification numbers in the Instrument Calibration Log.

The DRT-15CE has three ranges to measure sample turbidity: 0-10, 0-100, 0-1,000. The meter reads in nephelometric turbidity units (NTUs). The meter is powered by a rechargeable NiCad battery and may be turned off between sample measurements to conserve the battery power. The meter can be run off of the battery charger when plugged into a 110-volt power source.

## Standardizing the DRT-15CE (Calibration)

The meter comes with a 0.02 NTU reference standard. The reference standard cuvette is indexed (marked) so that it can be oriented in the same direction each time it is placed into the optical well.

Clean and dry the outside of the reference standard cuvette with a lint-free wipe. The DRT-15CE measures turbidity by measuring the light refracted from the sample placed in the optical well. Any obstruction that will refract light from the cuvette—such as lint, smudges, or staining—will alter the turbidity reading.

Temperature variations and humidity can cause condensation on the reference standard cuvette and various lenses inside the meter. Try to keep the meter and reference standard cuvette at a constant temperature when performing standardization adjustments.

The meter can be sensitive to ambient light infiltrating the optical well. Keep the meter out of direct sunlight or bright light when standardizing or taking sample measurements.

Place the 0.02 NTU reference standard cuvette in the optical well of the turbidimeter. Align the cuvette to the indexing mark. Turn the **RANGE** knob to the **10** scale. Adjust the digital readout on the meter to **0.02** NTUs using the up or down arrows on the **REFERENCE ADJUST** buttons. Record the reference standard cuvette value in the calibration log.

Remove the reference standard cuvette and store it in the instrument case. Turn the **RANGE** knob to the **OFF** position to conserve battery power. The meter is ready for use.

## Taking Turbidity Measurements

To check the cleanliness of the sample cuvette before use, fill the sample cuvette with distilled water and screw on the cap. Clean and dry the outside of the sample cuvette with a lint-free wipe. Insert the sample cuvette into the optical well so that it is aligned with the indexing mark. Turn the **RANGE** knob to the **10** scale. The turbidity reading should be approximately 0.3 NTUs if store-bought water is used.

Turbidity samples should be measured as soon as possible to avoid changes in sample chemistry. Samples with suspended solids that settle out rapidly must be measured while the solids are still in suspension.

Ambient high humidity combined with cold sample temperatures can cause condensation on the outside of the sample cuvette, which will yield false high turbidities. Drying the sample cuvette thoroughly and taking the measurement quickly before condensation occurs usually overcomes this problem. Chilling the sample cuvette in ice will also work to prevent condensation.

Fill the sample cuvette with the sample water and screw on the cap. Clean and dry the outside of the sample cuvette with a lint-free wipe. Insert the sample cuvette into the optical well so that it is aligned with the indexing mark.

Turn the **RANGE** knob to the **10** scale. If the turbidity value is greater than 10 NTUs, a small triangle will appear in the top left of the meter's digital readout screen.

Turn the **RANGE** knob to the **100** scale. The small triangle should disappear from the top left of the meter's digital readout screen and the meter reading value should be less than 100 NTUs.

If this does not occur, turn the **RANGE** knob to the **1,000** scale. The small triangle should disappear from the top left of the meter's digital readout screen and the meter reading value should be less than 1,000. If the small triangle does not disappear from the top left of the meter's digital readout screen and/or the meter reading value is greater than 1,000, the sample turbidity is beyond the range of this meter.

Once you have selected the correct range, read and record the turbidity value from the digital readout.

## Information Resource

HF Scientific, Inc. DRT-15CE Portable Trubidimeter Operating and Maintenance Manual. March 1995.

HF Scientific, Inc., Telephone: (813) 337-2116.

# Oxidation-Reduction Potential Electrode and Meter Calibration and Use

These instructions cover the oxidation-reduction potential (ORP) electrode and meter. Together, these instruments measure the redox (reduction/oxidation potential) of groundwater and surface water. The ORP electrode generally used is the Orion 9678BN Platinum Redox Electrode. This electrode is generally used with the Orion 250A or 290A pH meter. The 9678BN ORP electrode combines a platinum redox and Ag/AgCl reference electrode in a single unit and requires a liquid fill solution to operate. ORP field measurements are specific to the electrode and the fill solution used.

Copies of the Orion instruction manuals for the 9678BN electrode and the 250A or 290A pH meters should be kept with the equipment as a reference, particularly for nonstandard procedures, measurements, and troubleshooting (see Information Sources, below). If an electrode other than the 9678BN or a pH meter other than the 250A or 290A is used, the user should follow the manufacturer's instructions for specific calibration and use and refer to these procedures only for general guidance. Field staff should record both the meter and electrode manufacturer and all identification numbers in the Instrument Calibration Log.

## Summary of Field Procedures

The steps required to calibrate and take readings with the ORP electrode are summarized briefly below. A detailed description of each step follows the summary.

1. Record ORP electrode type and identification number
2. Record type of fill solution used
   - 900001 (for weak ionic strength groundwater conditions)
   - 900011(for strong ionic strength groundwater conditions)
3. Prepare meter and electrode for calibration
4. Perform two-point calibration (operational check)
   - Zobell solution
   - Orion fill solution
5. Record measurement
   - Flow-through cell
   - In-situ measurement
   - Conversion of OPR readings to Eh values

## ORP Electrode—General Operating Information

### Fill Solution

The ORP electrode requires a liquid fill solution to operate. The field measurements are specific to the electrode and the fill solution used. Two different fill solutions are available from Orion for use with the electrode. One solution is used with the electrode when measuring the ORP of dilute solutions (low ionic strength) and the other solution is used for measurements in high ionic strength solutions, such as brine water or salt water.

- **Orion 900001** is used for measurement of dilute solutions, with a total ionic strength less than 0.2 molarity (M) (equivalent to moles/L). This fill solution matches the potential of the commonly used calomel electrode.
- **Orion 900011** is used for measurement of concentrated solutions, with total ionic strength greater than 0.2 M. This fill solution is 4 M potassium chloride (KCl) saturated with Ag/AgCl.

### Converting ORP Field Measurements to Eh Values

ORP field measurements using the 9678BN electrode are specific to that electrode and the fill solution used. Field ORP measurements must be mathematically converted to yield values relative to the normal hydrogen electrode (Eh). The Orion 9678BN instruction manual (pages 4 and 5) outlines the steps necessary to convert the 9678BN ORP readings to Eh values.

### Important Points for Electrode Use

- The vent hole on the 9678BN electrode must be uncovered while measurements are taken.
- During calibration and field measurement, the electrode internal fill solution level must remain a minimum of 1 inch above the surface of the liquid being measured.

## Meters Used with the OPR Electrode

The Orion 250A and 290A pH meters are typically used for field ORP measurements of groundwater and surface water. General calibration and use procedures are provided below; refer to the Orion instruction manual if you encounter problems.

## Preparing the Meter and Electrodes for Calibration

The meters and the electrodes may not function properly if they have reached temperatures below 45°F. Keep this equipment in a warm environment prior to calibration and use.

Push the **POWER** button to turn on the meter. The meter will show a **LOW BATT** message if the 9-volt battery has insufficient voltage to properly power the meter. Replace the battery whenever the **LOW BATT** message appears and perform a new calibration.

Connect the BNC-type electrode connector to the top of the pH meter. Push the **MODE** button until the arrow points to the **mV** (millivolt ) mode. Do not use the **Rel mV** mode. The meter read out will now be in millivolts.

ORP measurement calculations require that sample temperature at the time of measurement be recorded. The temperature may be obtained from a hand thermometer or from another meter that measures temperature. The same Orion 250A or 290A meter used for ORP mV measurements can also be used for the temperature measurements by connecting the temperature electrode DIN connector to the top of the Orion meter. The Orion 250A and 290A meters do not have automatic temperature compensation (ATC) when in the mV mode even though the temperature readout shows **ATC °C** on the screen in that mode.

Use the **SETUP MENU** to set the meter's internal operating parameters (refer to Orion manual for instructions). The decimal point resolution should be set to two decimal places

rather than to the default setting of three. Three is too high for field measurements, and more time is needed to obtain stable meter readings using three decimal places.

## Two-Point Electrode Operation Check (Calibration)

### Zobell Solution Check

Use fresh YSI 3682 Zobell solution to check that the 9678BN ORP electrode is operating correctly. Use only new, unused standards for calibration. Never return used standards to a bottle containing unused standards. The YSI 3682 Zobell solution is good for 24 months on the shelf before hydration and for 6 months after hydration. Pour approximately 1 inch of Zobell solution into a 40 milliliter (mL) vial.

Rinse the electrode in clean distilled water and gently shake excess water from electrode. Do not wipe the electrode because the static electrical charge generated can affect the electrode's measurements. Insert the electrode into the Zobell solution and wait until the **READY** message appears. Record the ORP mV reading in the calibration log. If the **READY** message does not appear, check the meter setup menu to make sure the **READY** function has been enabled (refer to Orion manual for instructions).

Rinse the temperature electrode in clean distilled water and gently shake excess water from electrode. Insert the electrode into the Zobell solution and wait until the temperature reading is stable. Record the Zobell solution temperature (in °C) in the calibration log.

Look up the table value for the Zobell solution at the recorded temperature (see Table C-1 at the end of this appendix). The table value and actual value of the Zobell solution should be within ± 10 mV of each other. Record the measured value and temperature of the Zobell solution as well as the table value of the Zobell solution in the calibration log.

If calibration fails, consider using a new standard and/or refilling the electrode. The manufacturer's instruction manuals cover procedures for additional remedies, such as cleaning the electrode and checking out the meter function.

### Orion 900001 Fill Solution Check

Use fresh Orion 900001 fill solution as a second check that the 9678BN ORP electrode is operating correctly. Use only new, unused standards for calibration. Never return used standards to a bottle containing unused solution. Pour approximately 1 inch of 900001 solution into a 40 mL vial.

Rinse the electrode in clean distilled water and gently shake excess water from electrode. Do not wipe the electrode because the static electrical charge generated can affect the electrode's measurements. Insert the electrode into the 900001 solution and wait until the **READY** message appears. Record the ORP mV reading in the calibration log.

Rinse the temperature electrode in clean distilled water and gently shake excess water from electrode. Insert the electrode into the 900001 solution and wait until the temperature reading is stable. Record the 900001 solution temperature (in °C) in the calibration log.

Look up the table value for the 900001 solution at the recorded temperature (see Table C-1 at the end of this appendix). The table value and actual value of the 900001 solution should be within ± 10 mV of each other. Record the measured value and temperature of the 900001 solution as well as the table value of the 900001 solution in the calibration log.

If calibration fails, consider using a new standard and/or refilling the electrode. The manufacturer's instruction manual covers procedures for additional remedies, such as cleaning the electrode and checking out the meter function.

Rinse the electrode in distilled water. It is ready for use.

### Calibration Verification

A one-point calibration check should be performed every 4 hours and anytime a sample ORP value is suspected to be in error. To perform a one-point calibration check, place the rinsed electrode in either the Zobell or 900001 solution and see if the value obtained is within ± 10 mV of the table value for that buffer at that temperature. Thoroughly document all values before and after calibration.

## Taking ORP Measurements

For ORP field measurements, *Standard Methods for the Examination of Water and Wastewater* (American Public Health Association, 1992) lists a one standard deviation value of ±22 mV for an individual electrode measuring groundwater. *Standard Methods* also indicates that there can be a ± 15 mV variation between ORP electrodes. The accuracy of ORP readings is subject to these variabilities.

ORP measurements can vary greatly because of changes in chemistry within the groundwater sample that result from exposing the water to atmospheric conditions. Therefore, the accuracy of the recorded measurement is highly dependent upon sampling methodology. To minimize chemical changes within the groundwater sample, use a flow-through cell or take the measurement in situ.

### Flow-Through-Cell Method

Direct the continuous sample flow from the sampling pump so that it discharges at the bottom of the flow-through cell. The cell will then fill from the bottom up and overflow out the top of the cell, which prevents aeration of the sample except at the air-surface interface. The flow rates should be low enough that the sample is not aerated below the air-water interface as it passes through the cell. Place the ORP electrode into the cell so that it rests near the bottom of the cell.

Allow the electrode temperature to equalize with the sample temperature. The **READY** message will appear when the ORP mV reading has stabilized. Record the ORP mV value and temperature. Rinse and store the electrode in distilled water when reading(s) are complete.

### In-Situ Method

Lower the ORP electrode into the water to a depth at which the sample level is 1 inch below the liquid level in the electrode. Allow the electrode temperature to equalize with the sample temperature. The **READY** message will appear when the ORP mV reading has stabilized. Record the ORP mV value and temperature. Rinse and store the electrode in distilled water when reading is complete.

### Converting ORP Field Measurements to Eh Values

As noted above, ORP field measurements using the 9678BN electrode are specific to that electrode and the fill solution used. Field ORP measurements must be mathematically

converted to yield values relative to the normal hydrogen electrode (Eh). The Orion 9678BN instruction manual (pages 4 and 5) outlines the steps necessary to convert the 9678BN ORP readings to Eh values.

## OPR Electrode Storage

Store the 9678BN electrode in distilled water when not in use.

## Information Sources

Orion Research Incorporated. Instruction Manual: Platinum Redox Electrodes (Models 96-78-00 and 97-78-00). 1991. (This manual covers the 9678BN electrode.)

Orion Research Incorporated. Orion Laboratory Products Group Portable pH/ISE Meters Instruction Manual (Models 230A, 250A, and 290A). 1991.

Orion Research Incorporated Telephone: (800) 225-1480.