Final Work Plan for Supplemental Investigation

R.G. Haley International Site
Bellingham, Washington

for
City of Bellingham

February 23, 2012

GeoEngineers
Earth Science + Technology

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File No. 0356-114-06

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1.0 INTRODUCTION

This Work Plan for Supplemental Investigation (Work Plan) has been prepared on behalf of the City of Bellingham (City) for the R.G. Haley International Site (herein referred to as the Haley Site or Site). The Haley Site is generally located at 500 Cornwall Avenue in Bellingham, Washington and includes portions of approximately 6 acres of upland property and adjacent aquatic lands in Bellingham Bay (Figure 1). The Haley Site includes portions of the former Haley property, adjacent aquatic lands, and portions of the adjacent Cornwall Avenue Landfill (Cornwall) and Whatcom Waterway (Whatcom Waterway) sites. The full extent of contamination associated with historical operations on the Haley property has not been fully evaluated; therefore, the boundaries of the Site as defined by the Washington State Model Toxics Control Act Cleanup Regulation (MTCA) have not been determined.

The Supplemental Investigation is being conducted in accordance with MTCA, Chapter 173-340 of the Washington Administrative Code (WAC 173-340) and the Washington State Sediment Management Standards (SMS), WAC 173-204, to meet the requirements of the First Amendment to Agreed Order No. DE2186 (Order) issued by the Washington State Department of Ecology (Ecology) pursuant to the authority of Chapter 70.105D.050(1) of the Revised Code of Washington and entered into by the City.

The results of previous investigation activities have identified concentrations of diesel- and lube-oil range petroleum hydrocarbons, semivolatile organic compounds (SVOCs) including pentachlorophenol (PCP) and carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and dibenzo-p-dioxins and dibenzofurans (dioxins/furans), collectively referred to herein as the constituents of potential concern (COPCs) in soil, groundwater and/or sediment at the Haley Site. The results of these previous investigations are summarized in the draft Final Remedial Investigation/Feasibility Study Report (GeoEngineers 2007) (draft RI/FS Report), which was submitted to Ecology in September 2007. A Data Gaps Assessment (GeoEngineers 2011) was completed to identify additional data and other information needed to address comments provided by Ecology (Ecology 2010) on the draft RI/FS Report. This Work Plan presents a scope of work to address data gaps identified in the Data Gaps Assessment report.

2.0 SITE HISTORY AND SETTING

This section presents a brief summary of the history and setting of the Haley Site. More detailed information is available in the Upland Remedial Investigation Work Plan and draft RI/FS Report (GeoEngineers 2004, 2007).

2.1. Site History

The Haley property and surrounding waterfront industrial properties were originally developed as lumber mills with associated waterfront docks around 1888. Operations conducted between the mid-1880s to the mid-1900s included sawmill, coal and wharf operations. Historical mill operations included log rafting and burning of wood waste. Wood treatment operations were conducted on the former Haley property between approximately 1948 and 1985. Site structures associated with the former wood treating operations included a planning and boring building, two drying sheds, a kiln building, control building and shed (GeoEngineers 2007). The primary wood treatment facilities included a retort, two aboveground storage tanks (ASTs), one underground storage tank (UST), an oil/water separator, underground surge tank and seepage pit. The control building housed a boiler room, laboratory, PCP storage and equipment storage. Aboveground structures and facilities were removed from the Haley property between 1985 and 2006; underground structures including the UST, surge tank and related facilities remain in place. The locations of historical site features are shown on Figures 2A and 2B.

Several prior cleanup actions have been completed at the Haley Site, including the excavation of soil from the seepage pit, installation of a containment barrier (sheet pile wall), removal of petroleum-contaminated sediment near the shoreline bank, and installation and operation of an oil recovery system. Details of each of the cleanup actions are presented in the draft RI/FS Report (GeoEngineers 2007).

Cornwall, located southwest of the Haley property, was an active landfill between approximately 1953 and 1965. In addition to receiving municipal and medical wastes, pulp waste and oil from a local wood treating company (Frank Brooks Manufacturing Company) were disposed in the landfill (GeoEngineers 2007). Contaminants associated with the Haley and Cornwall sites are comingled in both upland and aquatic portions of the respective sites.

2.2. Site Description and Setting

The upland portion of the Haley property is generally flat with a steep bedrock slope southeast of the property. The upland portion of the Haley property is currently vacant and inactive. The upland property is located at an elevation of approximately 15 feet above mean lower low water (MLLW), relative to a City datum, with a 4 to 7 foot high shoreline bank creating the boundary between the upland property and the aquatic lands of the Haley Site. Current features consist of a small shed and three outfalls, one of which actively discharges stormwater from residential neighborhoods located southeast of the Haley Site into Bellingham Bay. The outfalls include a 12-inch square wood outfall that historically drained stormwater from the wood treatment process area, an 8-inch diameter concrete outfall of unknown origin and use, and the 36-inch diameter city stormwater outfall (Figure 2A).

The shoreline bank is steep and generally covered with shoreline armoring including rip and rap. The surface sediment in the intertidal portion of the aquatic lands predominantly consists of gravel and sand and frequently contains debris including wood, brick and glass fragments. Timber pilings, remnant of various former structures, are located in the upper intertidal portion of the Haley Site.

Both upland property and aquatic lands of the Haley Site are underlain by fill, including former sawmill and construction debris wastes, and landfill wastes associated with Cornwall.

The aquatic lands of the Haley Site overlap with the Whatcom Waterway site, which includes more than 200 acres of aquatic land and a former industrial waste treatment lagoon. Contamination of the Whatcom Waterway is the result of operations at the former Georgia-Pacific pulp and paper plant and consists predominantly of metals (i.e., mercury) and phenolic compounds (RETEC 2006).

3.0 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) was presented for the Haley Site in the draft RI/FS Report (GeoEngineers 2007) and updated in the Data Gap Assessment (GeoEngineers 2011). The CSM has been developed based on existing information and is considered dynamic and will be refined, as needed, based on the results of the supplemental investigation. A CSM identifies potential or suspected sources of hazardous substances, types and concentrations of hazardous substances, potentially impacted media, and actual and potential exposure pathways and receptors. A summary of the CSM is presented below.

3.1. Geology and Hydrogeology

Considerable information concerning geologic and hydrogeologic conditions beneath the upland portion of the Haley Site is presented in the draft RI/FS Report. In general, the site is underlain by fill, which in turn overlies bedrock of the Chuckanut Formation. Glaciomarine Drift (GMD), comprised of hard silt and clay, is locally present between the Chuckanut and overlying fill.

The fill was historically placed along the Bellingham Bay shoreline to produce the current upland portion of the Haley property. The upland boundary of the fill approximately coincides with the southeastern boundary of the Haley property (near the railroad tracks). The fill body thickens toward the current shoreline where it is at least 25 feet thick. The fill extends at least into the intertidal zone and possibly further offshore.

The nature of the fill is highly variable, and generally includes substantial horizons of wood waste from historic waterfront mill operations, interbedded with silts and sands. The silt and sand horizons potentially originated from hydraulic dredging activities, a common historic practice along working waterfront settings in Puget Sound. Construction debris has been observed in the silt and sand units.

According to the current CSM, the fill acts as a single hydrostratigraphic unit vertically bounded by the underlying GMD and Chuckanut Formation. Additional information is required to evaluate the hydrogeologic characteristics of the fill and the potential presence of underlying native soil above the GMD to evaluate whether preferential contaminant transport pathways exist, as further discussed in Section 5.1.1.

3.2. Contaminant Sources and Release Mechanisms

The potential primary sources of hazardous substances consist of chemicals or byproducts used or produced by wood treatment processes, such as petroleum (specifically, P-9 carrier oil) and PCP. Potential release mechanisms for primary sources in the upland portion of the Haley Site include surface and shallow subsurface spills, process water discharge to a seepage pit, leaks and releases from materials storage, handling and use that may have occurred from the retort, aboveground tanks, underground tanks, process piping, and the storage of treated wood. Additional potential sources of hazardous substances on the Haley Site include potentially contaminated fill material on both the Haley and Cornwall sites, including landfill waste (including pulp waste and oil) associated with Cornwall.

The primary release mechanisms impacted environmental media at the Site, which subsequently acted as secondary sources for contaminant migration in the upland and marine environments. Examples include the potential migration of site contaminants from the upland to marine environments as a result of groundwater transport or upland soil erosion. Potential contaminant sources and migration pathways were summarized in the draft RI/FS Report. These pathways will be reconsidered as the CSM is refined after completing the supplemental investigations described in this work plan.

3.3. Contaminants and Media

The COPCs associated with the former wood treatment operations on the Haley Site consist of petroleum hydrocarbons (diesel- and oil-range); SVOCs, including PCP and cPAHs; copper; benzene, toluene, ethylbenzene and xylenes (BTEX); and dioxins/furans. Diesel-range petroleum hydrocarbons are a COPC because the carrier oil used in the former wood treatment operations was P-9 oil, which is similar to number 2 diesel fuel. Concentrations of the COPCs have been detected in soil, groundwater and/or sediment at the Haley Site. Additionally, a plume of oil as light non-aqueous phase liquid (LNAPL) is present beneath portions of the Haley Site.

Additional contaminants associated with Cornwall include the following:

- Polychlorinated biphenyls (PCBs), copper, manganese, fecal coliform and ammonia in groundwater;
- Gasoline-range petroleum hydrocarbons, copper and zinc in soil; and
- PCBs, copper, silver, zinc, lead, and mercury in sediment.
- The key contaminants associated with Whatcom Waterway include mercury and phenolic compounds (RETEC 2006). A detailed discussion of the nature and extent of COPCs in soil, groundwater and sediment at the Haley Site is presented in Section 4.0.

3.4. Potential Receptors and Exposure Pathways

Potential receptors that may be exposed to contaminated media at the Haley Site include humans, terrestrial plants and animals, and aquatic organisms. The primary exposure routes of concern include dermal contact, ingestion and/or inhalation of contaminants in soil, sediment, surface water and indoor air. Details of these and other exposure routes and potential receptors are presented in the Data Gap Assessment (GeoEngineers 2011). The screening levels summarized in Section 4.1 were developed to identify constituents that potentially pose risks based on these potential exposure routes and receptors.

Groundwater at the Haley Site is not a current or reasonable future drinking water source due to the proximity to marine surface water; therefore, ingestion of groundwater is not a potential exposure pathway. A detailed presentation of potential exposure pathways and receptors was presented in the Data Gap Assessment (GeoEngineers 2011).

4.0 SUMMARY OF EXISTING ENVIRONMENTAL DATA

4.1. Screening Level Summary

Screening levels have been developed for soil, groundwater and sediment to assist in the evaluation of existing data for the identification of data gaps herein and for use in the evaluation of the data collected during the Supplemental Investigation. Screening levels were developed by reviewing potentially applicable laws and regulations to evaluate concentrations of COPCs that are protective of upland and aquatic exposure scenarios as a result of various contaminant transport pathways. A summary of the screening level development process is presented in the Data Gap Assessment report (GeoEngineers 2011).

In addition to the screening levels presented in the Data Gap Assessment report, Ecology requested that the practical quantitation limit (PQL) be used as a screening level for total petroleum hydrocarbons (TPH) in groundwater. The City agrees to use this screening level for the purpose of evaluating data gaps and developing the scope of this investigation. However, this screening level, along with other preliminary screening levels utilized at the request of Ecology (see the Data Gap Assessment report), will be reconsidered prior to use in the RI. An exceedance of certain screening levels does not necessarily indicate that upland sources of contamination (as identified by concentrations of a COPC in soil or groundwater) pose an unacceptable risk to sediment or surface water quality, but indicates that further consideration of site-specific factors is required. The potentially applicable regulatory criteria and the selected screening levels utilized to develop this work plan are presented in Tables 1 through 3.

4.2. Existing Soil and Groundwater Data Evaluation

The existing soil and groundwater data for the Haley Site, as well as easily ascertainable groundwater data for Cornwall, has been evaluated with respect to the screening levels discussed above to identify data gaps and develop a scope of work for addressing the data gaps. The results of the comparison of soil and groundwater data to applicable screening levels are presented below by COPC group. A compilation of all soil and groundwater sampling locations from previous studies within and adjacent to the Haley Site are presented in Figure 3. Figures A-1 through A-11 present a graphic depiction of soil and groundwater analytical results from past studies relative to screening levels; these figures are included in Appendix A.

4.2.1. Data Sources

The soil and groundwater data has been collected during various phases of work completed between 1985 and 2007 with the majority of investigations completed during the remedial investigation, conducted between 2004 and 2007. The draft RI/FS Report presents a detailed summary of the previous investigations conducted at the Haley Site and Cornwall (GeoEngineers 2007). The soil and groundwater data evaluated in this Work Plan was collected during the following investigations:

- Samples collected in 1984 and 1985 by Howard Edde, Inc at the Haley Site as documented in the Engineers Report of Upgraded Environmental Controls at R.G. Haley International Corporation, Inc. (Howard Edde, Inc. 1985).

- Samples collected in 1986 by Ecology and Environment at the Haley Site as documented in the Site Inspection Report (Ecology and Environment 1986).
- Samples collected between 2000 and 2002 during interim action activities by GeoEngineers, at the Haley Site as documented in the following: Interim Cleanup Plan, Addendum No. 1, Abbreviated Work Plan, Sediment Removal in Intertidal Zone, Addendum No. 2 and Interim Cleanup Action Report (GeoEngineers 2000a, 2000b, 2001 and 2002).
- Samples collected by Landau Associates, Inc. on Cornwall as documented in the Ecology Review Draft, Remedial Investigation/Feasibility Study Report (Landau 2009).
- Samples collected between 2004 and 2007 by GeoEngineers during remedial investigation activities at the Haley Site as documented in the draft RI/FS Report (GeoEngineers 2007).

Investigation activities conducted at the Haley Site in 1985 and 1986 included collection of groundwater samples from monitoring wells HS-MW-2 and CL-MW-1H (Figure 3). Because more recent groundwater analytical data exists for both of these monitoring wells, the groundwater analytical results from 1985 are not included in the evaluation of the nature and extent of COPCs in groundwater exceeding the screening levels.

Sediment analytical results from intertidal zone explorations IZ-MW-1 through IZ-MW-4 are used two different ways. The dry weight sediment data is used in this section to evaluate the nature and extent of COPCs at concentrations exceeding the MTCA-derived soil screening levels. In addition, the sediment analytical results are used to interpret the extent of COPCs that exceed sediment screening levels (SMS criteria), as presented in Section 4.3. For comparison to the SMS criteria, the sediment analytical results are organic carbon normalized, when appropriate, as discussed in Section 4.3.

4.2.2. Petroleum Hydrocarbons

Diesel- and lube oil-range hydrocarbons are present in soil beneath the upland portion of the Haley Site at concentrations exceeding the screening levels. The highest concentrations are typically located near the shoreline, in the vicinity of the LNAPL plume that is contained behind the sheetpile wall. Petroleum hydrocarbon concentrations in soil exceed the screening levels at widespread locations throughout the upland, extending into the intertidal zone (Figures A-1 and A-2). Petroleum hydrocarbon concentrations that exceed the screening levels generally occur in the vadose zone and smear zone near the groundwater table. Vertical profile sampling conducted for the RI indicated that concentrations of petroleum hydrocarbons in soil generally decrease rapidly with depth within approximately 4 feet below the water table (GeoEngineers 2007), however additional data is needed to define the vertical extent of petroleum hydrocarbons in soil. The lateral extent of petroleum hydrocarbons in soil has been sufficiently characterized in the upland, except in the southeastern portion of the Haley property, and to the southwest, onto Cornwall.

Dissolved-phase diesel- and lube oil-range hydrocarbons are also present in groundwater (Figure A-3) at the Haley Site, and generally correlate with concentrations of petroleum hydrocarbons in soil. The highest concentrations of petroleum hydrocarbons have been detected in groundwater samples collected from monitoring wells TL-MW-10 and IZ-MW-3 located near the shoreline, HS-MW-4 and HS-MW-13 located in the interior upland portion of the Haley property, and CL-MW-1S and CL-MW-6 located on Cornwall. The lateral extent of petroleum hydrocarbons in groundwater have been reasonably well identified except further south on Cornwall. Additional data is needed to evaluate the vertical extent of petroleum hydrocarbons along the shoreline.

4.2.3. Semi-volatile Organic Compounds

Excluding cPAHs and PCP, which are discussed separately (Sections 4.2.4 and 4.2.5, respectively), the following SVOCs were detected in soil beneath the upland portion of the Haley property at concentrations exceeding screening levels: 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(ghi)perylene, fluoranthene, fluorene, naphthalene, N-nitrosodiphenylamine, phenanthrene and pyrene, all of which are known constituents in diesel, and dibenzofuran, which is a product of combustion (EPA 2011). Soil samples collected from three locations (SB-1, SB-2 and HS-MW-2) in 1985 also contained 2,4,5-trichlorophenol or 2,4-dimethylphenol at concentrations exceeding screening levels. These screening level exceedances in soil occurred throughout a large portion of the upland portion of the Haley property, extending into the intertidal zone where borings were completed to install monitoring wells (see "IZ-MW" explorations in Figure A-4). The lateral extent of screening level exceedances has been identified to the northeast based on analytical results from borings HS-MW-9 and HS-MW-15 (Figure A-4), however, there is limited data for SVOCs in soil in this portion of the Site. The lateral extent of screening level exceedances has not been defined to the southeast (toward the railroad tracks) or to the southwest (onto Cornwall). The vertical extent of screening level exceedances for SVOCs in soil has not been identified at any location where SVOC concentrations exceeded screening levels in shallower soil.

The same SVOCs that exceeded soil screening levels have been detected at concentrations exceeding groundwater screening levels in all of the monitoring wells located on the Haley Site with the exception of the intertidal zone ("IZ-MW") wells, and upland monitoring wells HS-MW-8, HS-MW-9, HS-MW-15 and HS-MW-16 (Figure A-5). Relatively higher concentrations of SVOCs were detected in groundwater samples collected from monitoring wells CL-MW-6 and TL-MW-10. Monitoring well CL-MW-6 is located on Cornwall adjacent to the railroad tracks, and TL-MW-10 is located in a former wood storage area where NAPL has been observed.

The lateral extent of SVOCs in groundwater beneath the upland portion of the Haley property appears reasonably well defined to the northeast, but not to the southeast or southwest (Figure A-5). Analytical results from monitoring wells located on Cornwall indicate that SVOCs are present in groundwater at concentrations exceeding the screening levels. Some of these wells (e.g. AF-MW02 and CL-MW-1), are located several hundred feet cross-gradient from the Haley property in areas unlikely impacted by historical wood treatment operations. However, additional data is needed to evaluate the extent and potential sources of SVOCs in this area.

4.2.4. Carcinogenic Polycyclic Aromatic Hydrocarbons

Individual cPAH compounds, including benzo(a)pyrene, benzo(a)anthracene, benzofluoranthenes, chrysene and indeno(1,2,3-cd)pyrene, have been detected at concentrations exceeding soil screening levels beneath the Haley Site at depths ranging from 1 to 19 feet bgs (Figure A-6). These screening level exceedances occurred throughout a large portion of the Haley upland, extending into the intertidal zone (see "IZ-MW" explorations in Figure A-6). The highest concentrations of individual cPAH compounds were generally detected in soil at depths greater than 5 feet bgs in the upland, and shallower than 5 feet in the intertidal zone. This area (and depth) of elevated cPAH concentrations appears to generally correspond to the NAPL smear zone as identified in the draft

RI/FS Report (GeoEngineers 2007). Elevated cPAH concentrations likely span a broader vertical profile than the current data suggests because past samples were collected with a bias toward the groundwater table and associated smear zone.

The lateral extent of screening level exceedances for cPAHs in soil appears to be bound to the northeast by analytical results from borings HS-MW-9 and HS-MW-15 (Figure A-6); however, there is limited data for SVOCs in this area. Screening level exceedances for cPAHs in soil also have not been bound to the southeast or southwest, onto Cornwall. The vertical extent of cPAH exceedances in soil has generally not been identified.

Individual cPAH compounds have been periodically detected at concentrations exceeding screening levels in groundwater samples collected between 2000 and 2005. Most of the cPAH screening level exceedances in groundwater depicted in Figure A-7 reflect exceedances during a single monitoring event, with no detections above the laboratory PQLs during previous and/or subsequent monitoring events The only monitoring wells on the Haley Site where cPAHs have been detected at concentrations exceeding screening levels during more than one sampling event are HS-MW-13, TL-MW-9, TL-MW-11, IZ-MW-1, IZ-MW-2, IZ-MW-4 (Figure A-7). All of these wells, except for HS-MW-13, are located near the shoreline LNAPL plume.

The lateral extent of cPAH exceedances in groundwater has been identified on the northeast portion of the Haley Site. Some sporadic exceedances on Cornwall (CL-MW-1S, CL-MW-1H and CL-MW-6) require updated data to evaluate current conditions, after which additional investigation may be required to identify the lateral limits.

4.2.5. Pentachlorophenol

PCP concentrations in soil exceed the screening level in a large portion of the upland portion of the Haley Site, extending into the intertidal zone (Figure A-8). PCP occurrence is frequently associated with petroleum hydrocarbons, and similar to hydrocarbons, PCP concentrations are highest near the groundwater table and decrease rapidly with depth (GeoEngineers 2007).

The highest concentrations of PCP in Haley Site soil were detected in boring SB-1 [160 milligrams per kilogram (mg/kg)], located near the former wood treatment area, and test pit TP-6 (221 mg/kg), located near the LNAPL plume. The elevated PCP concentrations were detected at depths of 1.5 and 6 feet bgs, respectively, in these explorations. Excluding these sample results, PCP concentrations that exceeded the screening level (0.0063 mg/kg) ranged from 0.0869 to 43.2 mg/kg; these exceedances ranged in depth from ground surface to 15 feet bgs. The extent of soil that contains PCP at concentrations exceeding the screening level has not been defined vertically or laterally to the northeast, southeast, or southwest onto Cornwall.

PCP has been detected in groundwater at concentrations exceeding the screening level primarily in the vicinity of the former wood treatment facilities and drying sheds, with the exception of two monitoring wells (TL-MW-10 and HS-MW-6) located near the shoreline (Figure A-9). PCP concentrations exceeded the screening level only one time in each of the two wells near the shoreline, and the concentration detected in TL-MW-10 (September 2005 monitoring event) is the highest concentration detected on the Haley Site. Petroleum hydrocarbon concentrations in this same sample suggest that LNAPL was present in TL-MW-10 on this date. In monitoring wells located further upgradient, relatively low concentrations of PCP have been detected in groundwater frequently; however, screening level exceedances have been infrequent, with the majority of results exceeding the screening level during only one sampling event at any one monitoring well.

4.2.6. Dioxins/Furans

Total dioxin/furan TEQ concentrations have been detected exceeding the screening levels in seven soil samples collected and analyzed from depths ranging from the ground surface to a depth of 9 feet bgs (Figure A-10). Only one of these samples was collected at a shallow depth (0-1 foot bgs). Five of the samples were collected at or a few feet below the groundwater table; these samples generally consisted of silts, sands and gravels, often with wood debris. The other sample analyzed for dioxins was collected approximately 2 feet bgs in the intertidal zone; this sample was predominantly composed of wood debris.

Dioxin/furan TEQ concentrations also exceeded the screening level in groundwater samples collected from two locations: monitoring wells HS-MW-10 and IZ-MW-3 (Figure A-11). These wells are located near the former wood treatment equipment (HS-MW-10) and in the intertidal zone (IZ-MW-3). The data for dioxins/furans in soil and groundwater at the Haley Site is limited and additional investigation of these constituents is needed.

4.2.7. Other Constituents of Potential Concern

A comparison of existing soil and groundwater data to the revised screening levels has identified the presence of copper, benzene, ethylbenzene and xylenes in soil and/or groundwater at concentrations that warrant additional investigation.

Copper was detected in soil at boring HS-DP-1, at depths of 8 to 14 feet bgs, and in groundwater samples collected from monitoring wells HS-MW-10, HS-MW-11 AND HS-MW-13 at concentrations exceeding the revised screening levels (Figure 3). Copper concentrations in three additional soil samples collected from boring HS-DP-5B did not exceed the revised screening level. The data for copper in soil and groundwater at the Haley Site is limited; however, copper is not anticipated to be a constituent of primary concern for future remedial action. The scope of work for the supplemental investigation will include collection and analysis of select soil and groundwater samples for copper.

One soil sample was collected from each of several borings (HS-DP-6, TL-DP-2, HS-MW-10 and TL-MW-10) for laboratory analysis of benzene, toluene, ethylbenzene and xylenes (BTEX). Concentrations of ethylbenzene and xylenes were detected in the soil sample collected from a depth of 8 to 10 feet bgs from sample location TL-DP-2 (Figure 3). Groundwater samples collected from monitoring wells HS-MW-10, HS-MW-11 AND HS-MW-13 were submitted for laboratory analysis of BTEX (Figure 3). Benzene was detected at a concentration exceeding the revised screening level in the groundwater sample collected from monitoring well HS-MW-11. The scope of work for the supplemental investigation will include collection and analysis of select groundwater samples for BTEX.

4.3. Existing Sediment Data Evaluation

4.3.1. Data Sources

Multiple previous investigations have characterized sediment in Bellingham Bay adjacent to the upland portion of the Haley Site, and other nearby locations. Several phases of investigation were performed to evaluate the nature and extent of contaminants in sediment at the Haley Site to support development of the draft RI/FS Report. Other sediment investigations have been performed to support the development and design of remedial alternatives for Cornwall and Whatcom Waterway Sites. Some of these other studies evaluated sediment quality throughout the broader Bellingham Bay. A compilation of all sediment sampling locations from these previous studies within and adjacent to the Haley Site are presented in Figure 4. These sediment samples were collected during the following studies:

- Samples collected in 2002 as reported in the Anchor Environmental, L.L.C. and Landau Associates, Inc., March 2003 Whatcom Waterway Pre-Remedial Design Evaluation Data Report, prepared for the Georgia-Pacific Corporation, Washington Department of Natural Resources, Port of Bellingham and City of Bellingham (Anchor and Landau 2002).
- Samples collected in 2004 as reported in the GeoEngineers, Inc., October 2005 Supplemental Sediment Remedial Investigation Memorandum (GeoEngineers 2005).
- Samples collected in 2004 and 2005 as reported in GeoEngineers, Inc., September 2007 RG Haley Remedial Investigation, prepared for Douglas Management Company (GeoEngineers 2007).
- Samples collected in 2008 as reported in the Anchor QEA, August 2010 Whatcom Waterway Pre-Remedial Design Investigation Data Report, prepared for Port of Bellingham (AnchorQEA 2010).
- Samples collected in 2008 as reported in the Hart Crowser, June 2009 Sediment Site Characterization Evaluation of Bellingham Bay Creosote Piling and Structure Removal, Cornwall Avenue Landfill Mapping, Boulevard Park Overwater Walkway Feasibility, and Dioxin Background Sampling and Analysis, prepared for the Washington State Department of Ecology (Hart Crowser 2009).

Sediment data from these previous investigations provides information that characterizes the nature and extent of contamination within and adjacent to the Haley Site. Data from all of the previous studies has been compiled and is summarized in Figures B-1 (Surface Sediment) and B-2 (Near-surface and Subsurface Sediment). Figure B-3 provides the legend for Figures B-1 and B-2 and describes the symbols that summarize the sediment analytical results.

The sediment analytical results used to interpret the extent of COPCs that exceed sediment screening levels (SMS criteria) are organic carbon normalized, when appropriate, in accordance with SMS. As described in the Data Gaps Assessment report (GeoEngineers 2011), the analytical results for non-ionizable SVOCs and PCBs are organic carbon normalized when the total organic carbon (TOC) concentration in a sediment sample ranges from 0.5 to 3.5 percent. The carbon normalized analytical results are then compared to the SMS criteria. Analytical results for samples with TOC concentrations outside of the 0.5 to 3.5 percent range are screened against the Apparent Effects Threshold (AET) values that are based on dry weight (EPA 1988).

The previous investigations have identified that COPCs associated with the Haley Site, Cornwall, and Whatcom Waterway are comingled. In addition, landfill refuse from Cornwall overlaps with the upland portion of the Haley property that has been impacted by historical operations. As a result, the proposed remedial action areas for Cornwall and Whatcom Waterway extend onto the Haley Site. The portions of Cornwall and Whatcom Waterway remedial action areas that extend onto the Haley Site are presented in Figure 4.

The following sections summarize results of the chemical and biological testing performed during the previous studies referenced above, and are shown in Figures B-1 and B-2. The results are graphically presented on the figures relative to the sediment screening levels described in Section 4.1. Sediment results are described based on the depth of the sediment samples using the following terminology:

- Surface sediment – samples collected from the sediment surface (mudline) to a depth of approximately 10 to 15 centimeters (cm).
- Near-surface sediment – samples collected from the mudline to a depth of approximately 2 feet.
- Subsurface sediment – samples collected from depths greater than 2 feet below the mudline.

4.3.2. Pentachlorophenol (PCP)

Numerous surface sediment samples were submitted for analysis of PCP (Figure B-1). Detected PCP concentrations were greater than the SMS numerical criteria in three surface samples. Two of these samples were collected from the upper intertidal zone in the central portion of the Haley Site (PS-4, and PS-20). The PCP concentrations in these two surface sediment samples were 3,200 and 4,700 micrograms per kilogram (ug/kg), respectively, and were greater than the SMS Cleanup Screening Level (CSL) (690 ug/kg). The remaining location where PCP was detected in surface sediment at a concentration greater than SMS numerical criteria (SRI-3) was located in a shallow subtidal area further offshore from sample PS-20. The detected PCP concentration at this location (560 ug/kg) was greater than the SQS (360 ug/kg) but less than the CSL (690 ug/kg). The PCP detection limit was greater than SMS numerical criteria in surface sediment at three locations in the upper intertidal zone.

Near-surface and subsurface sediment samples also were submitted for analysis of PCP (Figure B-2). The samples were collected from depths up to 6.8 feet below the mudline. The PCP concentrations in nine samples exceeded the lowest screening level (SQS), and five of these exceeded the CSL. The concentrations in these nine samples ranged from 380 to 4,100 ug/kg. Most of the subsurface samples with PCP concentrations greater than SMS numerical criteria were located in the upper intertidal zone.

The aerial (horizontal) extent of surface sediment with concentrations of PCP greater than SMS criteria is generally bounded to the northeast and southwest, except near the shoreline. In addition, the screening level exceedance in surface sediment at sampling location SRI-3 is not bounded to the northwest. Screening level exceedances in near-surface and subsurface sediment have not been bounded to the northeast and northwest; nor has the depth limit of PCP exceedances been identified in subsurface sediment at several locations.

4.3.3. Petroleum Hydrocarbons

Total petroleum hydrocarbons (the sum of diesel- and oil-range petroleum hydrocarbon concentrations) were detected at concentrations greater than the screening level of 200 mg/kg in six surface sediment samples (Figure B-1). All six of these samples were collected from the upper intertidal zone in the central portion of the Haley Site (PS-2, PS-4, PS-7, PS-13, PS-16 and PS-20). The concentration of total petroleum hydrocarbons ranged from 372 mg/kg to 50,000 mg/kg in the six samples.

The total petroleum hydrocarbon concentrations in 18 of the near-surface and subsurface samples were greater than the screening level (Figure B-2) and ranged from 233 to 5,480 mg/kg. Petroleum hydrocarbon concentrations were generally greatest in subsurface samples in the upper intertidal zone. Several near-surface sediment samples contained total petroleum hydrocarbon concentrations that were greater than the screening level in the lower intertidal/shallow subtidal portion of the Haley Site. Surface sediment samples collected in this portion of the Site were not analyzed for petroleum hydrocarbons.

The aerial extent of surface, near-surface and subsurface sediment with concentrations of petroleum hydrocarbons greater than the screening level is not bounded northeast, northwest or southwest of existing exceedances. The depth limit of petroleum hydrocarbon screening level exceedances also has not been identified at most locations where exceedances were identified.

4.3.4. Polycyclic Aromatic Hydrocarbons (PAHs)

The laboratory analytical results for PAHs were evaluated relative to screening levels for individual compounds, total low molecular weight PAHs (LPAHs) and total high molecular weight PAHs (HPAHs). PAH concentrations were greater than one or more SMS numerical criteria in three surface sediment samples (Figure B-1). The three surface samples were collected from the upper intertidal zone in the central portion of the Haley Site (PS-4, PS-13 and PS-20). The PAH concentrations in the three surface sediment samples were greater than SQS/LAET and/or CSL/2LAET criteria. Multiple surface sediment samples with PAH concentrations less than the SQS/LAET bound the screening level exceedances to the northwest; however, the screening level exceedances are not bounded to the northeast and southwest, near the shoreline.

PAHs were detected in 11 near-surface and subsurface sediment samples at concentrations greater than SMS numerical criteria (Figure B-2). The 11 samples were predominantly located in the upper intertidal zone but some were also in the lower intertidal/shallow subtidal area. The aerial extent of near-surface and subsurface sediment with concentrations of PAHs greater than screening levels is not bounded to the northeast, northwest or southwest of existing exceedances.

The vertical (depth) extent of SMS exceedances has not been delineated at several intertidal sampling locations, and a couple shallow subtidal locations. PAH exceedances of SMS criteria in subsurface sediment in the lower intertidal/shallow subtidal area are overlain by sediment with PAH concentrations less than SMS criteria.

4.3.5. Dioxins/Furans

Six surface sediment samples have been analyzed for dioxins/furans (Figure B-1). The total dioxins/furans TEQ concentrations in these samples ranged from 52 ng/kg to 201 ng/kg. Ten near-surface and subsurface sediment samples have also been analyzed for dioxins/furans (Figure B-2). The total dioxin/furan TEQ concentrations in these ten samples ranged from 24 ng/kg to 557 ng/kg.

Investigations of Whatcom Waterway and broader Bellingham Bay included surface sediment sampling and analysis for dioxins and furans (Anchor 2009 and 2010; Hart Crowser 2009). These studies identified total dioxin/furan TEQ concentrations ranging from 13.4 ng/kg to 14.8 ng/kg in Whatcom Waterway surface sediment, considerable distances northwest of the Haley Site and Cornwall.

Existing sediment data for dioxins/furans in the immediate vicinity of the shoreline adjacent to the upland portion of the Haley property is limited. In addition, limited data exists between these sampling locations and sampling locations in Whatcom Waterway. Additional data is needed to characterize dioxin and furan concentrations in surface and subsurface sediment between the Haley Site and Whatcom Waterway.

4.3.6. Mercury

The mercury concentration was greater than the SMS numerical criteria in one surface sample (RI-1) (Figure B-1). The detected mercury concentration in this sample (0.45 mg/kg) was greater than the SQS criteria (0.41 mg/kg) but less than the CSL (0.59 mg/kg). Mercury also was detected at concentrations exceeding the SQS criteria but less than the CSL in two samples collected as part of the Whatcom Waterway study (samples AN-SS-29 and HC-SS-28). These samples were collected at considerable distances north and west of the Haley shoreline. The data for the samples collected north and west of the Site are from 2002 and older and, therefore, may not represent current conditions.

The mercury concentrations in near-surface and subsurface sediment were greater than SMS numerical criteria in 11 samples collected near the shoreline adjacent to the upland portion of the Haley property and two samples collected further north during the Whatcom Waterway study (Figure B-2). The mercury concentrations near the shoreline adjacent to the upland portion of the Haley property ranged from 0.48 mg/kg to 11.3 mg/kg; mercury concentrations in the Whatcom Waterway samples ranged from 0.45 mg/kg to 0.52 mg/kg. The mercury concentrations increased with depth at all locations where near surface and subsurface samples were collected.

Mercury is a constituent of concern for the Whatcom Waterway cleanup. The extent of mercury concentrations greater than SMS numerical criteria in surface and subsurface sediment is not being delineated as part of the investigation of the Haley Site. However, available data for mercury will be evaluated at locations where the mercury footprint overlaps with constituents from the Haley Site.

4.3.7. Other Chemicals

Several additional constituents were detected in one or more sediment samples collected near the shoreline adjacent to the upland portion of the Haley property. Phthalates including dimethyl phthalate and butylbenzyl phthalate were detected at concentrations greater than the LAET and 2LAET criteria in surface (RI-1 and SRI-1) and subsurface sediment samples (RGH-SC-02, RGH-SC-03, RGH-SC-07 and RGH-SC-08). Dibenzofuran was detected at two locations (PS-4 and PS-20) in surface sediment and N-nitrosodiphenylamine was detected at two locations (IZ-MW-3 and IZ-DP-1) in subsurface sediment at concentrations greater than the CSL/2LAET criteria. Additionally, 2,4-dimethylphenol and phenol were detected at one location in surface (PS-16) and subsurface (RGH-SC-07) sediment at concentrations greater than the SQS/CSL.

The detection limits for multiple contaminants were greater than the SMS numerical criteria in sediment samples. Generally, samples collected from locations with elevated contaminant concentrations had the most non-detect results with detection limits greater than SMS numerical criteria.

The aerial extent of surface, near-surface and subsurface sediment with concentrations of the additional constituents discussed in this section greater than screening levels is not bounded northeast, northwest or southwest of the existing exceedances. The vertical (depth) extent of screening level exceedances also has not been delineated at locations where these constituents exceeded screening levels.

4.3.8. Bioassays

Bioassay testing was performed on surface sediment from seven locations (RI-1 through RI-5, RGH-SS-01 and RGH-SS-03) immediately offshore from the upland portion of the Haley property and three locations (AN-SS-29, 6B-03-SS, and 6B-04-SS) located further north and northwest (Figure B-1). The bioassays failed SQS criteria for three samples and failed CSL criteria for four samples collected near the shoreline. The bioassays performed on samples collected further north and northwest passed SMS criteria.

Relatively few chemicals were detected in samples on which the bioassays were performed, including the bioassay failures. Chemicals that were detected include butyl benzyl phthalate and dimethyl phthalate. The extent of SMS biological criteria exceedances is not bounded by the existing bioassay data.

5.0 SUPPLEMENTAL INVESTIGATION WORK ELEMENTS

5.1. Soil and Groundwater Investigation

The assessment of data gaps pertaining to soil and groundwater at the Haley Site has resulted in the following conclusions:

- Additional geologic information is needed beneath the upland portion of the Haley property to refine the CSM relative to the continuity of fill materials, and the vertical profile of fill and native soil units.

- The nature and extent of COPCs in soil and groundwater, as summarized in Section 4.2, has not been fully delineated relative to the revised screening levels.
- The hydraulic properties of the fill and native soil units (e.g. hydraulic conductivity) and vertical groundwater gradients, require further investigation to evaluate the groundwater to surface water pathway.
- Further evaluation of the lateral extent of Haley constituents onto Cornwall is required.
- Information on LNAPL mobility is needed to evaluate additional upland remedial technologies.

The scope of work to address these data gaps associated with soil and groundwater is presented in the following sections. Figure 5 depicts the approximate locations of soil and groundwater investigation locations proposed as part of the supplemental investigation. The sample collection, handling and analysis procedures for the soil and groundwater portion of the supplemental investigation are presented in the Upland Sampling and Analysis Plan, which is attached to this Work Plan as Appendix C. These activities will be performed in accordance with procedures specified in the project Quality Assurance Project Plan (QAPP, Appendix E) and the Site Health and Safety Plan (HASP, Appendix F).

5.1.1. Data Gap 1: Subsurface Geology and Hydrogeology

The shallow unconfined aquifer beneath the upland portion of the Haley property is a fill unit generally comprised of wood debris, sand and silt, as described in Section 3.1. Several deep borings are proposed to obtain additional information about the composition and thickness of fill beneath the Site, however most, but not all, of the current data suggests that the fill unit is sufficiently heterogeneous (i.e., individual lithologies vary laterally and vertically over a short distance) and/or the various lithologies that constitute the fill unit are hydraulically similar enough beneath the site to justify treating the fill as a single hydrostratigraphic unit. Limited investigation is proposed to test and refine this model, and if necessary develop a more complex (i.e., multilayered) hydrogeologic CSM. The proposed investigation will collect sufficient data to develop an alternative CSM that has more than one hydrostratigraphic unit, if this appears to be necessary to reflect site groundwater flow

The first work element associated with hydrogeologic investigation will be to evaluate the variability of hydraulic characteristics in the fill unit by performing slug tests in existing monitoring wells. Slug tests provide data to estimate the hydraulic conductivity of the screened interval. The slug testing will target wood waste zones because wood waste is prevalent along the upland to surface water pathway and thus is a key unit potentially controlling groundwater flow and contaminant fate and transport. Hydraulic conductivity was previously estimated for five monitoring wells screened in the fill horizon during a tidal study. These monitoring wells were screened across varying lithologies of silt, sand and wood debris. The data from the tidal study suggests the wood waste may have a higher hydraulic conductivity than clastic (silt and sand) deposits. These results may be anomalous or the wood waste may exhibit a wide range of hydraulic properties. The scope of work outlined in this Work Plan will evaluate the influence of wood waste on groundwater flow. Slug testing will be conducted in select existing monitoring wells based on well screen length, lithology of the screened interval and well construction details. The locations and procedures for the slug testing are presented in the Upland Sampling and Analysis Plan (Appendix C).

Additional monitoring wells will be installed to evaluate three dimensional groundwater flow. Five new deep wells (HS-MW-18, TL-MW-13, -14, -15, and -16) will be installed at the locations shown in Figure 5. These wells are located to provide data to assess groundwater flow beneath the existing sheet pile wall versus outside the hydrologic influence of the sheet pile wall. These wells are also located adjacent to existing monitoring wells with screens (Figure 5) across the groundwater table to allow evaluation of vertical groundwater gradients.

The proposed five deep monitoring wells will have short (3-feet long) screens constructed immediately above the top of the GMD. Ideally, these screens will be positioned in sand and/or gravel horizons that have been encountered between fill and the GMD in nearby explorations. Monitoring wells will not be installed at these locations if the thickness of the fill unit is less than anticipated and the existing wells provide sufficient coverage to address the data gap. Proposed well TL-MW-13 will be located within a portion of the landfill waste body that extends onto Haley and will only be completed as a well if native soil is encountered beneath the landfill waste.

In addition, soil samples collected from these borings will provide vertical profiles of lithology and contaminant concentration trends throughout the fill prism and into underlying native soil. This information, when combined with similar information from previous upland explorations and new sediment cores to be collected in the intertidal and subtidal zones (see Section 5.3), will enable refinement of the CSM, particularly with respect to the groundwater to surface water pathway.

In addition to the five deeper wells described above, one water table well (TL-MW-12) will be installed adjacent to new deep well TL-MW-13 to establish a shallow/deep well pair at this location This shallower well will have a 5 to 10-foot screen constructed at an elevation that spans the groundwater table. The remaining deep wells will be located adjacent to existing shallow wells. The proposed locations of the six new monitoring wells (five deep and one shallow) described above may be modified, if appropriate, based on the slug test results from the existing wells.

Slug tests will be conducted in the new deep and shallow monitoring wells after they are installed. In addition, groundwater samples will be obtained from these new wells to evaluate the vertical and lateral extent of constituents in groundwater at concentrations exceeding screening levels, as described in Section 5.1.2.2.

Groundwater levels will be measured at low tide and high tide in all of the new and selected existing monitoring wells after well installation. This will provide a snapshot of horizontal and vertical groundwater gradients across the upland portion of the Haley Site and Cornwall. In addition, transducers will be installed in key wells along selected transects to evaluate tidal influence. This tidal study will be used to evaluate hydraulic conductivity and net gradients as well as provide data for transient model calibration. During the tidal study a transducer will also be placed offshore of the Site to record tidal changes.

Groundwater flow model development/calibration may be used to test the current CSM and evaluate whether a more complex CSM is needed to characterize groundwater flow. The flow model will be used to estimate groundwater flux (seepage velocities) along the mudline (points of discharge) for evaluation and subsequent design of sediment remedies (e.g. sediment cap), and evaluate potential upland remedies, some of which will include groundwater containment (e.g. pump and treat, barrier wall, etc.).

5.1.2. Data Gap 2: Extent of COPCs in Groundwater

5.1.2.1. PRELIMINARY GROUNDWATER EVALUATION

The most recent indication of groundwater conditions beneath the site is represented by the 2005 data presented in the draft RI/FS Report. The 2005 data includes groundwater chemical analytical results, gauged LNAPL thicknesses and groundwater elevations in wells located on the upland portion of the Haley property and adjacent portion of Cornwall. The initial task proposed in this Work Plan is to obtain information on current groundwater conditions.

The first step will be to sample existing monitoring wells to document current groundwater quality on Haley and Cornwall. These data will be evaluated to identify locations where additional monitoring wells may be required to define the lateral and/or vertical extent of COPCs in groundwater at concentrations exceeding the screening levels. The groundwater monitoring and sampling event will consist of the following work elements:

- Confirm that monitoring wells HS-MW-2 through HS-MW-11, HS-MW-13, HS-MW-15, HS-MW-16, TL-MW-1, TL-MW-10 and TL-MW-11 on the Haley property and monitoring wells CL-MW-1, CL-MW-1S, CL-MW-1D, CL-MW-1H, CL-MW-6 and AF-MW02 on Cornwall still exist and are accessible. Cornwall monitoring wells CL-MW-7, -8, and -10 were abandoned October 2011 as part of an interim remedial action on the Cornwall site.
- Assess the viability of the monitoring wells for sampling, which will include measuring the total depth of each well for comparison to well construction logs to evaluate whether redevelopment of any monitoring well may be necessary to remove accumulated sediment prior to sampling.
- Measure groundwater levels and LNAPL thickness (if present) in all monitoring wells.
- Collect groundwater samples for laboratory analysis from viable monitoring wells located on Haley and monitoring wells CL-MW-1, CL-MW-1S, CL-MW-1D, CL-MW-1H, CL-MW-6 and AF-MW02 on Cornwall that do not contain a measurable thickness of LNAPL. Groundwater samples collected from all of the monitoring wells will be submitted for laboratory analysis of diesel range- and oil range- petroleum hydrocarbons by Northwest Method NWTPH-Dx and SVOCs, including PCP and cPAHs, by EPA Method 8270C/SIM. Select groundwater samples will also be collected for field measurement or laboratory analysis of total organic carbon, dissolved oxygen, nitrate, ferrous iron, sulfate, methane, temperature, pH, conductivity, alkalinity and oxidation-reduction potential. Groundwater samples from monitoring wells HS-MW-11, HS-MW-13 and TL-MW-10 will be submitted for laboratory analysis of dissolved copper and BTEX. If measureable LNAPL is present in monitoring well TL-MW-10, TL-MW-1 may be selected for collection of a groundwater sample for laboratory analysis of copper.

Because of the waterfront industrial history and the low screening levels for dioxins/furans in groundwater, it is anticipated that concentrations of dioxins/furans in shallow groundwater beneath the Haley property and Cornwall will exceed the screening levels. Therefore, the lateral characterization of dioxins in shallow groundwater will be evaluated by analyzing groundwater samples from only a few monitoring wells located outside of the current LNAPL plume on the Haley property and Cornwall, including HS-MW-13, HS-MW-15 and CL-MW-1S. If these wells are not viable or have measureable LNAPL, other wells representing similar spatial coverage will be sampled. Alternative wells may include HS-MW-6, HS-MW-8, and new well CL-MW-101.

The vertical extent of dioxins in groundwater beneath the LNAPL plume also will be evaluated by analyzing a groundwater sample from TL-MW-11. This well has a discrete screen below the groundwater table and is intended to characterize the quality of groundwater flowing beneath the sheet pile barrier. These existing wells (HS-MW-15, HS-MW-13, CL-MW-1S and TL-MW-11) will be sampled and analyzed for dioxins at the same time. Two of the new wells HS-MW-18 and TL-MW-16 will be sampled for dioxins (see Section 5.1.2.2 below).

5.1.2.2. INSTALLATION AND SAMPLING OF NEW MONITORING WELLS

As described in Section 5.1.1, six new monitoring wells will be installed to refine the hydrogeologic CSM. These wells will be sampled and analyzed to further evaluate the vertical and lateral extent of constituents that exceed groundwater screening levels. In addition to the new wells described in Section 5.1.1, two new monitoring wells will be installed on Cornwall (CL-MW-101 and CL-MW-102) and one monitoring well (HS-MW-17) will be installed on the northeast portion of the upland portion of the Haley property. The locations of all proposed monitoring wells are depicted on Figure 5. The locations of proposed monitoring wells CL-MW-101 and CL-MW-102 on Cornwall may be revised based on the results of the preliminary groundwater evaluation. The objectives of sampling these new wells are summarized below.

- Monitoring well HS-MW-17 (Section 5.1.1) will be constructed with a 5-foot screen across the groundwater table and sampled to refine the northeastern limit of groundwater screening level exceedances in the shallow portion of the aquifer.
- Monitoring wells HS-MW-18, TL-MW-13, -14, -15, and -16 will be deeper wells screened below the groundwater table, in native soil beneath the fill horizon (Section 5.1.1). The primary objective of sampling these wells is to evaluate the vertical extent of groundwater impacts in the saturated horizon, and assess whether a deeper preferential migration pathway exists beneath the wood waste horizon.
- Monitoring well TL-MW-12 will be constructed with a 10-foot long screen across the groundwater table. The primary objective of monitoring well TL-MW-12 is to evaluate the lateral extent of LNAPL to the southwest of monitoring well TL-MW-10. However, groundwater samples will also be obtained from this well if LNAPL is not present to evaluate the lateral extent of dissolved phase constituents that exceed screening levels.
- Monitoring well CL-MW-101 will be constructed with a 5- to 10-foot long screen constructed across the groundwater table. This well will be located upgradient of the landfill waste horizon. The primary objective of this well is to provide groundwater quality and water level information between the former wood treatment area and wells previously installed further southwest (CL-MW-10 and AF-MW02) as part of the Cornwall RI.
- Monitoring well CL-MW-102 will also be constructed with a 5- to 10-foot long screen constructed across the groundwater table. This well will be located near the upgradient boundary of the Cornwall property, and will provide groundwater quality and water level information between the former wood treatment area and existing Cornwall wells (CL-MW-1 and CL-MW-9).

The new monitoring wells will be sampled after installation. Groundwater samples from these wells will be submitted for analysis of petroleum hydrocarbons and SVOCs as described in Section 5.1.2.1. Two of the new deep wells, HS-MW-18 and TL-MW-14, also will be sampled and analyzed for dioxins. Four existing wells (HS-MW-15, HS-MW-8, CL-MW-1S and TL-MW-11) will be sampled for dioxins at the same time to characterize the vertical and lateral distribution of dioxins in the unconfined aquifer (see Section 5.1.2.1). Groundwater samples collected from monitoring wells HS-MW-17, HS-MW-18 and TL-MW-15 will be submitted for laboratory analysis of dissolved copper.

The analytical results from the preliminary groundwater investigation and the sampling of newly-installed monitoring wells will be evaluated to determine whether additional groundwater data is necessary to fully characterize the nature and extent of COPCs in groundwater at concentrations exceeding the screening levels.

5.1.3. Data Gap 3: Extent of COPCs in Soil

Based on an evaluation of existing soil data, the following data gaps have been identified:

- The lateral extent of petroleum hydrocarbons and SVOCs, including cPAHs and PCP, in soil southwest of the Haley property, onto Cornwall, has not been fully evaluated.
- The vertical extent of petroleum hydrocarbons and SVOCs, including cPAHs and PCP, in soil beneath the Haley Site has not been fully characterized.
- The lateral and vertical extent of dioxins/furans in soil has not been delineated.
- The lateral and vertical extent of copper in soil has not been evaluated.

A description of the scope of work to address these data gaps is presented in the following sections.

5.1.3.1. LATERAL EXTENT SOUTHWEST OF THE HALEY PROPERTY

Four soil borings, CL-SB-101 through CL-SB-104 (Figure 5), will be completed on Cornwall to evaluate the lateral extent of petroleum hydrocarbons and SVOCs, including cPAHs and PCP in soil. Each soil boring will be advanced to the depth necessary to obtain samples to confirm the vertical extent of COPCs in soil exceeding the screening levels or to bedrock, whichever is shallower. Three soil samples will be submitted from each boring for chemical analysis: one sample from the vadose zone, one from the groundwater table and one deeper sample to evaluate the vertical (depth) limits of any screening level exceedances. Soil samples will also be collected from the well screen interval in monitoring well borings CL-MW-101 and CL-MW-102 for chemical analysis (Figure 5). Additional samples may be collected from these two borings if evidence of contamination is observed during drilling. Soil analytical results from these combined six borings on Cornwall will provide information concerning the lateral extent of Haley constituents southwest of the current known area of impact.

Soil samples will not be obtained from the boring completed to install monitoring well TL-MW-12 because this exploration will be completed in a portion of the landfill waste horizon that extends onto the Haley property. This monitoring well will be installed to evaluate the potential presence of LNAPL, as described in Section 5.1.2.2.

5.1.3.2. LATERAL EXTENT NEAR THE SOUTHEAST BOUNDARY OF THE HALEY PROPERTY

The thickness of the fill unit decreases toward the southeastern property line, ultimately terminating against the bedrock surface as the bedrock (Chuckanut) rises to within a few feet of the ground surface beneath the railroad tracks and is exposed on the steep slope across the railroad tracks. The fill unit near the southeastern boundary of the Haley property is above the groundwater table.

Existing chemical analytical results for the fill unit near the southeastern property boundary indicate that several constituents exceed screening levels. These analytical results were obtained from soil borings completed within approximately 30 feet of the property line, and likely closer to the southeastern terminus of the fill unit. This data is considered sufficient to complete the FS, and no further data collection is proposed in this area at this time. If necessary, the fill unit adjacent to the southwestern property line can be investigated in more detail during remedial design.

5.1.3.3. VERTICAL EXTENT ON THE HALEY PROPERTY

Soil samples will be obtained from eleven explorations to be completed to bedrock on the Haley property. These explorations include the five deep monitoring well borings and six deep soil borings shown in Figure 5. Soil samples will not be collected from TL-MW-13 within the landfill waste horizon; however, samples of native soil beneath the landfill waste horizon will be collected, if encountered. The number of soil samples submitted for chemical analysis will depend on field screening results and lithologic variation. For planning purposes, approximately three soil samples will be analyzed from each boring, including one from the vadose zone, one from the smear zone and one from below the smear zone. The location of the deepest soil samples will likely correlate with the well screen intervals. Fewer soil samples may be collected from boring TL-MW-13 because of the presence of landfill waste. Soil samples obtained from the borings will be submitted for analysis of petroleum hydrocarbons and SVOCs, including cPAHs and PCP.

5.1.3.4. LATERAL AND VERTICAL EXTENT OF DIOXINS/FURANS

The majority of the existing dioxin/furan data exists for silt and sand in the upper part of the saturated fill horizon, at or a few feet below the groundwater table. Only one shallow (0-1 foot bgs) soil sample (TL-HA-1) has been analyzed for dioxins. To evaluate the lateral extent of dioxins in shallow soil on the Haley property, four additional soil samples will be obtained from a depth interval of 0-1 foot bgs and submitted for analysis. The shallow soil sample locations, HS-SS-101 through HS-SS-104, are shown in Figure 5. The vertical extent of dioxins beneath the Haley property will be evaluated using soil samples collected from two of the deep monitoring wells HS-MW-18 and TL-MW-16 described in Section 5.1.1. At least one, but not more than two soil samples, will be collected from each of these borings for dioxin analysis. The samples will be collected from depths below the groundwater table to evaluate deeper portions of the unconfined aquifer that have not yet been tested for dioxins including one soil sample that corresponds to the well screen interval.

Dioxin testing is not proposed at this time for the Cornwall property, except for a groundwater sample to be collected from monitoring well CL-MW-1S (see Section 5.1.2.1). This approach is proposed because the landfill waste is a likely source of dioxins unrelated to the Haley Site. Human health exposure risks posed by dioxins in the landfill will be addressed by the upland capping remedy already developed for Cornwall. The other primary exposure pathway of concern that would not be addressed by capping is the groundwater to surface water pathway.

5.1.3.5. COPPER

In addition to the work described above, soil samples collected from HS-SB-103 will be submitted for laboratory analysis of copper. This boring is the proposed exploration that is nearest to sample location HS-DP-1, where concentrations of copper exceeded the revised screening level in the soil samples collected between 8 and 14 feet bgs. Wood waste was identified between approximately 8.5 and 13.5 feet bgs at sample location HS-DP-1; therefore, sampling in boring HS-SB-103 will target the wood waste unit and deeper soil for laboratory analysis of copper.

5.1.4. Data Gap 4: LNAPL Mobility

Information to evaluate LNAPL mobility will be obtained by conducting digital imaging, including white light (visible light) photography and ultraviolet photography (UV), and petrophysical testing on cores from selected new borings and conducting LNAPL bail down tests on selected existing and new monitoring wells. A description of these is presented in the following sections.

DIGITAL IMAGING

Continuous soil cores will be collected at boring locations TL-MW-15 and TL-MW-16 for visible light and UV light photography. Boring TL-MW-15 was selected to provide data from the LNAPL plume area behind the sheet pile wall. Boring TL-MW-16 was selected to provide data outside of the sheet pile wall along the shoreline near existing well TL-MW-10, where LNAPL has been present intermittently. The cores will be collected through the smear zone, as determined during the observation and lithologic description of soil cores collected from borings completed adjacent to TL-MW-15 and TL-MW-16; which will be advanced solely to determine the thickness of the smear zone in these locations. The visible light photography will provide a permanent record of the relative variation of impacts in different lithologies within the core interval. The UV light photography will provide the hydrocarbon fluorescence of the core interval to identify the most heavily impacted portion of each core and visible variation in impact between lithologies in the core. Petroleum hydrocarbons (in this case the P-9 oil) contain PAHs that fluoresce when excited by UV light. Therefore evaluation of the intensity and color of the florescence in the UV photograph will provide an indication of where hydrocarbons are present and the relative saturation of hydrocarbons.

PETROPHYSICAL TESTING

Petrophysical testing refers to the analysis of physical properties that define the behavior of LNAPL. GeoEngineers will select samples for petrophysical testing after reviewing the digital images obtained from the UV light and visible light photography. Samples will be tested from each core that are representative of 1) most impacted portion corresponding to the vadose zone at the time of collection, 2) sample of wood and a sample of soil (if both are present) from most impacted portion corresponding to the saturated zone at the time of collection. The petrophysical testing includes testing of LNAPL physical characteristics (permeability, density, specific gravity, viscosity) and Free Product Mobility (FPM) testing. FPM testing involves centrifuging samples and quantifying the volumetric percent saturation of air/oil/water in the samples at various pressures that represent gravity drainage to approximately 1,000 times the force of gravity. In addition to the volumetric percent saturation provided by the FPM test, the total petroleum hydrocarbon concentrations representative of gravity drainage will be determined by chemical analyses of centrifuge samples.

The test results will be used to evaluate whether LNAPL present in the samples is mobile and, if so, what the residual saturation is after the mobile LNAPL is removed from the sample. The residual saturation values representative of gravity drainage will be used to establish site specific screening levels to estimate the vertical and lateral extent of soil that could still generate mobile LNAPL. This data will also be used to develop a de-saturation curve that represents the changes in saturation over a range of capillary pressures that represent gravity drainage to approximately 1,000 times the force of gravity. The de-saturation curve will be used in the evaluation of potential LNAPL recovery remedial technologies in the FS.

LNAPL BAIL-DOWN TESTS

These tests provide data to evaluate the transmissivity of LNAPL and these transmissivity values will be used in the evaluation of LNAPL mobility and recoverability. The test requires the presence of LNAPL in the well and will be completed in monitoring wells identified in the preliminary groundwater assessment as having at least a foot of LNAPL present. Based on the most recent monitoring data this includes monitoring wells TL-MW-2, TL-MW-4, TL-MW-5A, and TL-MW-6 located in the LNAPL plume area behind the sheetpile wall. New groundwater monitoring wells will also be tested if at least a foot of LNAPL is present.

5.2. Stormwater System Investigation

The following data gaps related to existing stormwater outfalls on the Haley property have been identified:

- The potential for ongoing discharge to be a source of contamination to Bellingham Bay and the evaluation of stormwater piping as a preferential migration pathway for contaminated groundwater have not been evaluated.

Following review of the draft RI/FS Report, Ecology requested the evaluation of the existing stormwater system, including an evaluation of current discharges as potential on-going sources of contamination and an evaluation of the storm drain lines as potential preferential groundwater flow pathways (Ecology 2010).

One stormwater outfall historically discharged stormwater and process (cooling) water from the former Haley wood treatment facility to the shoreline bank on the southwest portion of the Haley property. The stormwater outfall consists of a 12-inch square, wood culvert that is visible on the shoreline bank. In addition, an 8-inch diameter concrete pipe daylights on the shoreline bank further northeast; however, the alignment, purpose and condition this pipe are unknown. These outfalls appear inactive, which will be confirmed during the supplemental investigation. These storm drains likely will be removed during future remedial action at the Haley Site. In the interim, measures will be taken to evaluate the source of the stormwater in these two outfalls and eliminate discharge to the maximum extent practicable if they are discovered to be active.

An active City of Bellingham stormwater outfall, which consists of a 36-inch diameter concrete pipe, discharges stormwater runoff from residential neighborhoods located southeast of the Haley Site to the shoreline bank on the northeastern portion of the Haley Site. There are no known catch basins, drains or other connections to this stormwater line on the Haley Site but there is an access manhole. The potential pathways for contaminants associated with this active storm drain to reach sediment include the following:

- Breaks in the pipe that allows contaminated soil to enter the pipe with subsequent discharge as stormwater solids.
- Breaks and/or leaks in the pipe that allow infiltration of contaminated groundwater with subsequent discharge.
- Preferential migration of contaminated groundwater through backfill materials surrounding the pipes.

The supplemental investigation will include work to confirm the status of the apparent inactive stormwater lines, and evaluate whether the active City storm drain may be acting as a preferential migration pathway for the transport of Haley constituents to the bay. The Upland Sampling and Analysis Plan (Appendix C) provides the detailed scope of work to address this data gap.

5.3. Sediment Investigation

5.3.1. Overview of Sediment Data Gaps

Data gaps have been identified for sediment based on a review of existing data characterizing chemical concentrations and biological affects as well as documentation concerning the physical conditions and habitat features. The identified data gaps for sediment include the following:

- The lateral and vertical limits of Haley constituents that exceed SMS chemical and biological criteria have not been fully delineated.
- The boundary between elevated dioxin concentrations associated with the Haley Site versus broader bay-wide dioxin concentrations that reflect historic contributions from multiple sources has not been evaluated.
- Additional information is needed regarding the relationship between sediment stratigraphy and constituent concentrations to further refine the CSM and support evaluation and design of remedial alternatives.
- The extent of overlap between the Haley Site and adjacent sediment cleanup sites has not been fully delineated to allow evaluation of the compatibility of remedies.
- A survey of aquatic habitat has not been performed for the Haley Site.

Additional sediment investigation will be performed as part of this Work Plan to address the data gaps identified above. Three separate work elements will be performed to address the sediment data gaps that include the following:

- Investigation of surface sediment (0 to 12 cm in depth).
- Investigation of near-surface sediment (0 to 2 feet in depth) and subsurface sediment (greater than 2 feet in depth).
- Performance of a habitat survey.

The following sections describe the investigation approach and methodology for each of the work elements and specify the data gaps to be addressed.

5.3.2. Surface Sediment Investigation

Surface sediment (0 to 12 cm in depth) sampling will be performed to address the following data gaps:

- Evaluate the horizontal limits of Haley constituents that exceed SMS chemical and biological criteria as well as petroleum hydrocarbons that exceed the screening level.
- Further characterize dioxins and furans in sediment to evaluate the boundary between elevated dioxin concentrations associated with the Haley Site versus broader bay-wide dioxin concentrations that reflect historic contributions from multiple sources.
- Further evaluate the extent of overlap between the Haley Site and adjacent sediment cleanup sites.
- A phased approach will be used to delineate the horizontal limits of surface sediment with SMS chemical and biological criteria exceedances, petroleum hydrocarbon screening level exceedances, and to characterize dioxin/furan concentrations.

5.3.2.1. PHASE I SAMPLING

The initial phase (Phase 1) of surface sediment sampling will include collection and biological testing and/or chemical analysis on samples positioned bay-ward of sample locations from previous investigations that have had chemical and/or biological exceedances of SMS criteria or petroleum hydrocarbon concentrations greater than the screening level. Samples that will undergo simultaneous chemical analysis and biological testing in Phase 1 will be collected from locations COB-SS-02 through COB-SS-05 shown in Figure 6. A sample collected from location COB-SS-01 will undergo chemical analysis but not biological testing in Phase 1. Chemical analyses to be performed on surface samples collected from locations COB-SS-01 through COB-SS-05 will include a combination of the following (see Table 1 in Appendix D for details):

- Conventional parameters including total solids, total organic carbon (TOC), and grain size;
- SVOCs (SMS chemicals of concern) including PCP and PAHs;
- Diesel- and oil-range petroleum hydrocarbons;
- Dioxins and furans; and
- Mercury.

The following bioassay testing will be performed on surface samples collected from locations COB-SS-02 through COB-SS-05 as part of Phase 1:

- 10-day amphipod mortality test (acute toxicity);
- 20-day juvenile infaunal growth test (chronic toxicity); and
- Sediment larval test (acute toxicity).

Additional surface sediment samples will also be collected from locations COB-SS-06 through COB-SS-08 during Phase 1 offshore from COB-SS-01 through COB-SS-05 (Figure 6). Samples collected from locations COB-SS-06 through COB-SS-08 as well as COB-SS-03 and COB-SS-05 will be archived for potential analysis of dioxins/furans. Samples collected from locations COB-SS-03, COB-SS-05, and COB-SS-06 through COB-SS-08 may be analyzed for dioxins/furans if the dioxin/furan concentrations in samples collected from locations COB-SS-01, COB-SS-02 and COB-SS-04 are greater than 14 ng/kg . The purpose of this sampling and analysis is to identify an approximate boundary between elevated dioxin/furan concentrations near the Haley Site and lower concentrations (approximately 14 ng/kg) in the Whatcom Waterway.

The Phase 1 sediment sampling and analysis will be performed in accordance with procedures specified in the Sediment Sampling and Analysis Plan (SAP, Appendix D), the project Quality Assurance Project Plan (QAPP, Appendix E) and the Site Health and Safety Plan (HASP, Appendix F) that provide descriptions of the surface sediment grab sampling and testing protocols and quality assurance/quality control (QA/QC) and health and safety procedures.

5.3.2.2. POTENTIAL PHASE II SAMPLING

The potential need for a second phase of surface sediment sampling will be evaluated based on the results of Phase I sampling and analysis. A second phase (Phase 2) of sampling would be conducted bay-ward of the Phase 1 samples if the results of Phase 1 analyses identify one of the following:

- SMS bioassay criteria exceedances (SQS or CSL failure);
- Diesel- and oil-range petroleum hydrocarbon screening level exceedances; or
- A dioxin/furan concentration substantially greater than 14 ng/kg.

Surface sediment samples collected during the Phase 2 investigation would be submitted for a combination of the following analyses, depending on the Phase I analytical results as described above:

- Conventional parameters (i.e., total solids, total organic carbon, and grain size);
- SVOCs including PCP and PAHs;
- Diesel- and oil-range petroleum hydrocarbons;
- Dioxins and furans; and
- Bioassays (i.e. 10-day amphipod, 20-day juvenile infaunal growth test, and sediment larval test).

An addendum to this Work Plan will be prepared if Phase 2 surface sediment sampling is needed to further delineate the horizontal extent of exceedances of SMS criteria or further evaluate dioxin/furan concentrations. The additional Phase 2 sediment sampling and analysis will be performed in accordance with procedures specified in the Sediment SAP (Appendix D) and project QAPP) (Appendix E).

5.3.3. Sediment Coring Investigation

Sediment coring and sample collection and analysis will be performed to address the following data gaps:

- Evaluate the sediment stratigraphy to further refine the CSM and support evaluation and design of remedial alternatives.
- Evaluate the vertical profile of constituent concentrations to further refine the CSM and support evaluation and design of remedial alternatives.
- Evaluate the vertical extent of Haley constituents that exceed SMS numerical criteria as well as petroleum hydrocarbons that exceed the screening level.

Sediment coring and sample collection will be performed at locations COB-SC-01 through COB-SC-09 shown in Figure 6. Sediment coring will be performed to document the sediment stratigraphy, associated constituent concentrations, and the vertical extent of contamination. Coring stations COB-SC-01, COB-SC-02, COB-SC-07, and COB-SC-08 are located at upper intertidal elevations (approximately +4 feet to +5 feet MLLW), and COB-SC-03 and COB-SC-04 are located at lower intertidal elevations (approximately -3 feet to -4 feet MLLW). These cores will evaluate sediment stratigraphy and the vertical limits of Haley constituents in the area where previous chemical and/or bioassay results have exceeded CSL criteria. Coring station COB-SC-05, COB-SC-06, and COB-SC-09 are located further offshore at a subtidal elevation (approximately -13 feet to -15 feet MLLW) to provide additional data concerning sediment stratigraphy and the bay-ward extent of near-surface and subsurface contamination associated with the Haley Site. Sediment coring and sample collection will be performed using the following methodology:

- **Document the sediment stratigraphy** – At coring locations COB-SC-01 through COB-SC-08, coring will attempt to advance through more recently deposited sediment containing anthropogenic material and into underlying native sediment deposits. At coring location COB-SC-09, coring will advance through more recently deposited sediment to a depth of 6 feet. Continuous sampling will be performed and the sediment in the cores will be logged to document the stratigraphy and composition of different stratigraphic units.
- **Characterize near-surface sediment** – At each location, a sediment sample will be collected from the surface to a depth of 2-feet. At coring locations COB-SC-01 through COB-SC-08 the 0 to 2 foot sample will be analyzed to provide additional characterization of the near-surface sediment. At coring location COB-SC-09, the 0 to 2 foot sample will be archived and analyzed if the concentration of one or more chemicals is greater than the SMS chemical criteria or the concentration of petroleum hydrocarbons is greater than the screening level in the surface sample collected from COB-SS-01.
- **Characterize subsurface sediment** – At each location, sediment samples will be collected from multiple additional depths at 2-foot sample intervals to characterize selected sediment horizons that include the following:
    - 2 to 4 feet and 4 to 6 feet depth intervals;
    - Distinct stratigraphic units, including fill units that may vary by the type and amount of anthropogenic material, and underlying native sediments; and

- Sediment horizons that may vary by contaminant concentration based on field screening observations.

Subsurface sediment sample intervals will be selected based on the factors described above as well as existing data near a given coring location. The multiple objectives for subsurface samples will be considered, and where possible, a subsurface sampling interval will be selected to provide information that, when combined with existing data, characterizes the vertical (depth) limit of contamination and yields general information about constituent concentrations in different stratigraphic units.

It is anticipated that a minimum of four samples will be collected from each core except COB-SC-09 for potential analysis. Three samples (i.e., 0 to 2, 2 to 4, and 4 to 6 foot depth intervals) will be collected from COB-SC-09. Upon completion of coring and core sample collection, the core logs and sample descriptions will be reviewed to identify the samples to be analyzed to characterize subsurface sediment. The samples that are not selected for analysis will be retained and archived at the analytical laboratory.

Near-surface and subsurface sediment samples will be analyzed for a combination of the following (see Table 1 in Appendix D):

- Conventional parameters including total solids, total organic carbon (TOC), and grain size;
- SVOCs including PCP and PAHs;
- Diesel- and oil-range petroleum hydrocarbons;
- Dioxins and furans; and
- Mercury.

Near-surface and subsurface sediment samples will be collected using sonic drilling techniques. The Sediment SAP (Appendix D) and project QAPP (Appendix E) provide descriptions of the coring and near-surface and subsurface sediment sampling and testing protocols and QA/QC procedures for the sediment coring investigation.

The proposed coring is anticipated to provide sufficient information to develop cleanup alternatives for sediment at the Haley Site. However, it is always possible that additional coring may be needed to further refine remedial activities to be performed at the Site. If additional coring is warranted, it is anticipated that the coring would be associated with pre-remedial design studies performed to support development of the remedial design for Site. Any additional coring that is performed will be coordinated with Ecology.

5.3.4. Aquatic Habitat Survey

An aquatic habitat survey will be performed along the shoreline of the Site to identify areas of eelgrass and macroalgae. The purpose of the survey will be to document the location, aerial extent, and approximate density of eelgrass shoots as well as macroalgae in the intertidal and shallow subtidal area of the Site. The survey will consist of a visual survey of the intertidal area (from land), and an underwater video camera survey with follow-up dive survey in the shallow subtidal area where eelgrass and macroalgae are observed to be present. The results of the video camera survey will be digitally recorded using a digital converter and laptop computer. GPS will be used to continuously record the position, in latitude and longitude, of underwater images and overly the position directly onto the video.

The dive survey will be completed by experienced eelgrass divers using standard SCUBA equipment. The divers will have experience identifying eelgrass and macroalgae species in Puget Sound including the ability to differentiate between *Zostera marina* and *Zostera japonica*. Divers will count shoot densities in the areas shoreward of approximately -15 MLLW. A Dive Plan will be prepared before performing the aquatic habitat survey, detailing the dive to be performed including transect spacing. The results of the aquatic habitat survey will be in the form of a map showing eel grass beds and approximate density (ranging from "no eel grass" to "dense bed," represented by areas with greater than 50 percent coverage of eel grass).

5.4. Historical and Cultural Resources

According to the Washington State Department of Archeology and Historic Preservation on-line database (http://www.dahp.wa.gov/learn-and-research/find-a-historic-place) there are no historic structures at the Haley Site. Archaeologically sensitive areas that were used by Native Americans as seasonal fishing encampments are located within the general vicinity of the Haley Site. Therefore, there is a possibility that buried cultural artifacts may be present on the former tidal flat surface that is present beneath the fill on the Haley Site. These buried cultural artifacts may include chipped or ground stone, historic refuse, building foundations, or human bone.

The investigation activities will include installation of soil borings and monitoring wells, which will produce minimal ground disturbance. To address the possibility of encountering cultural artifacts, the following procedures will be implemented:

- The soils in the borings will be observed and logged by a geologist, with attention paid to looking for evidence of native soil units and potential cultural artifacts in that native soil;
- If apparent or suspected cultural artifacts are encountered, an archeologist will be contacted immediately to notify the appropriate regulatory agencies and tribes, and to evaluate and document the discovery; and
- If apparent or suspected human remains are encountered, work will be immediately halted in the discovery area and the remains will be covered and secured against further disturbance. The appropriate regulatory agencies will be immediately contacted.

6.0 SCHEDULE

The schedule for field activities includes preparation and permitting, performance of upland and sediment investigation activities, and reporting activities. The schedule for planned field activities and reporting is presented in the following table.

Activity	Date
Pre-fieldwork logistics, contracting, permitting, and access approvals for DNR and Port properties	Anticipated to be completed within six weeks after Ecology approves the Final Work Plan for upland work and four months after Ecology approves the Final Work Plan for sediment investigation.
Complete upland field work	Begin field activities approximately two months after Ecology approves the Final Work Plan. Upland investigation to be completed approximately six months after beginning field work.
Complete sediment field work	Begin field activities approximately three months after Ecology approves the Final Work Plan. Sediment investigation to be completed approximately six months after beginning field work.
Compile and validate analytical data	Data validation to be completed within six weeks of receiving laboratory certification packages for all data.
Supplemental Investigation Data submittal to Ecology	Submit to Ecology within 30 days of completing data validation.
Agency Review Draft of Revised RI Report	Submit to Ecology within 120 days of completing data validation.

The proposed schedule includes time to obtain the necessary permits and approvals to conduct the work. Investigation activities must be performed in consideration of City of Bellingham land use permit requirements including shoreline requirements for sediment sampling activities. The Washington Department of Fish and Wildlife (WDFW) requires a Hydraulic Project Approval (HPA) for the proposed sediment explorations. The HPA application and consideration of shoreline requirements for sediment sampling includes preparation of a Joint Aquatic Resource Permit Application (JARPA) and compliance with SEPA.

The sediment explorations must be completed within the in-water work periods allowed by WDFW for salmon and forage fish (i.e., Fish Window). Fish window requirements for salmon allow work below ordinary high water in the dry starting July 15 and over-water starting August 1 and ending February 15. Work in potential forage fish habitat areas is not allowed between October 15 and February 15. One exploration (COB-CS-07) is located within a potential forage fish habitat area. Observation for the presence of forage fish is necessary prior to initiation of work in potential forage fish areas to ensure that fish are not present.

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TABLES

TABLE 1

SOIL SCREENING LEVELS FOR THE SUPPLEMENTAL INVESTIGATION

R.G. HALEY INTERNATIONAL SITE
BELLINGHAM, WASHINGTON

Analyte Group	CASRN	Constituent	Background Concentration (d) (mg/kg)	MTCA Method B Screening Levels for Direct Contact - Unrestricted Land Use (WAC 173-340)		Ecological Indicator Soil Concentration for Protection of Terrestrial Plants and Animals (MTCA Table 749-3) (mg/kg)	MTCA Method B Screening Levels (b) Protection of Groundwater (Surface Water)		MTCA Method B Screening Levels (b) Protection of Groundwater (Sediment)		MTCA Method B Screening Levels (b) Protection of Groundwater (Indoor Air)		Preliminary Revised Screening Level (before adjustment for PQL) (mg/Kg)		PQL (c)	Preliminary Revised Screening Level (after adjustment for PQL) (mg/Kg)	
				Carcinogen (mg/kg)	Noncarcinogen (mg/kg)		Vadose (mg/kg)	Saturated (mg/kg)	Vadose (mg/kg)	Saturated (mg/kg)	Vadose (mg/kg)	Saturated (mg/kg)	Vadose (mg/kg)	Saturated (mg/kg)	(mg/kg)	Vadose (mg/kg)	Saturated (mg/kg)
Total Petroleum Hydrocarbons	--	Gasoline-range (e)	--	1.0E+02		-	--	--	--	--	--	--	1.0E+02	1.0E+02	**5.0E+00**	1.0E+02	1.0E+02
	68334-30-5	Diesel-Range	--	1.275E+03 to 3.39E+03 (d)		2.0E+02	--	--	--	--	--	--	2.0E+02	2.0E+02	5.0E+00	2.0E+02	2.0E+02
	--	Lube Oil-Range	--			2.0E+02	--	--	--	--	--	--	2.0E+02	2.0E+02	1.0E+01	2.0E+02	2.0E+02
BETX	71-43-2	Benzene	--	1.8E+01	2.4E+02	--	1.3E-01	7.9E-03	--	--	1.4E-02	8.4E-04	1.4E-02	8.4E-04	1.4E-03	1.4E-02	1.4E-03
	100-41-4	Ethylbenzene	--	--	8.0E+03	--	1.8E+01	1.0E+00	--	--	2.4E+01	1.4E+00	1.8E+01	1.0E+00	2.5E-02	1.8E+01	1.0E+00
	108-88-3	Toluene	--	--	1.6E+04	2.0E+02	1.1E+02	6.4E+00	--	--	1.1E+02	6.4E+00	1.1E+02	6.4E+00	2.5E-02	1.1E+02	6.4E+00
	1330-20-7	Xylenes (total)	--	--	1.6E+05	--	--	--	--	--	2.7E+00	1.6E-01	2.7E+00	1.6E-01	7.5E-02	2.7E+00	1.6E-01
SVOCs	58-90-2	2,3,4,6-Tetrachlorophenol	--	--	2.4E+03	--	--	--	--	--	--	--	2.4E+03	2.4E+03	1.0E-01	2.4E+03	2.4E+03
	120-83-2	2,4-Dichlorophenol	--	--	2.4E+02	--	1.3E+00	8.3E-02	--	--	--	--	1.3E+00	8.3E-02	5.0E+00	5.0E+00	5.0E+00
	105-67-9	2,4-Dimethylphenol	--	--	1.6E+03	--	4.5E+00	2.7E-01	1.7E-02	1.0E-03	--	--	1.7E-02	1.0E-03	4.0E-02	4.0E-02	4.0E-02
	95-95-4	2,4,5-Trichlorophenol	--	--	8.0E+03	4.0E+00	--	--	--	--	--	--	4.0E+00	4.0E+00	1.0E-01	4.0E+00	4.0E+00
	88-06-2	2,4,6-Trichlorophenol	--	9.1E+01	8.0E+00	1.0E+01	2.8E-02	1.6E-03	--	--	--	--	2.8E-02	1.6E-03	6.3E-03	2.8E-02	6.3E-03
	95-48-7	2-Methylphenol	--	--	4.3E+03	--	--	--	4.1E-02	2.7E-03	--	--	4.1E-02	2.7E-03	1.0E+00	1.0E+00	1.0E+00
	91-57-6	2-Methylnaphthalene	--	--	3.2E+02	--	--	--	9.8E-01	5.0E-02	--	--	9.8E-01	5.0E-02	2.0E-02	9.8E-01	5.0E-02
	83-32-9	Acenaphthene	--	--	4.8E+03	2.0E+01	6.6E+01	3.3E+00	2.7E-01	1.4E-02	--	--	2.7E-01	1.4E-02	5.0E-03	2.7E-01	1.4E-02
	208-96-8	Acenaphthylene	--	--	--	--	--	--	1.1E+00	5.7E-02	--	--	1.1E+00	5.7E-02	5.0E-03	1.1E+00	5.7E-02
	120-12-7	Anthracene	--	--	2.4E+04	--	1.2E+04	6.0E+02	5.0E+00	2.5E-01	--	--	5.0E+00	2.5E-01	5.0E-03	5.0E+00	2.5E-01
	85-68-7	Butylbenzylphthalate	--	--	1.6E+04	--	3.7E+02	1.9E+01	1.5E-01	7.5E-03	--	--	1.5E-01	7.5E-03	1.0E+00	1.0E+00	1.0E+00
	132-64-9	Dibenzofuran	--	--	1.6E+02	--	--	--	2.5E-01	1.3E-02	--	--	2.5E-01	1.3E-02	5.0E-03	2.5E-01	1.3E-02
	206-44-0	Fluoranthene	--	--	3.2E+03	--	8.9E+01	4.4E+00	2.2E+00	1.1E-01	--	--	2.2E+00	1.1E-01	5.0E-03	2.2E+00	1.1E-01
	86-73-7	Fluorene	--	--	3.2E+03	3.0E+01	5.5E+02	2.8E+01	3.2E-01	1.6E-02	--	--	3.2E-01	1.6E-02	5.0E-03	3.2E-01	1.6E-02
	91-20-3	Naphthalene	--	--	1.6E+03	--	1.4E+02	7.3E+00	1.5E+00	8.0E-02	4.8E+00	2.5E-01	1.5E+00	8.0E-02	5.0E-03	1.5E+00	8.0E-02
	86-30-6	N-Nitrosodiphenylamine	--	2.0E+02	--	2.0E+01	1.8E-01	9.5E-03	5.9E-02	3.1E-03	--	--	5.9E-02	3.1E-03	2.0E-02	5.9E-02	2.0E-02
	87-86-5	Pentachlorophenol	--	8.3E+00	2.4E+03	3.0E+00	4.7E-02	2.6E-03	8.4E-02	4.7E-03	--	--	4.7E-02	2.6E-03	6.3E-03	4.7E-02	6.3E-03
	85-01-8	Phenanthrene	--	--	--	--	--	--	1.6E+00	8.2E-02	--	--	1.6E+00	8.2E-02	5.0E-03	1.6E+00	8.2E-02
	129-00-0	Pyrene	--	--	2.4E+03	--	3.5E+03	1.8E+02	2.0E+01	9.8E-01	--	--	2.0E+01	9.8E-01	5.0E-03	2.0E+01	9.8E-01
	191-24-2	Benzo(g,h,i)perylene	--	--	--	--	--	--	4.5E-01	2.3E-02	--	--	4.5E-01	2.3E-02	5.0E-03	4.5E-01	2.3E-02
cPAHs	56-55-3	Benzo(a)anthracene	--	1.4E-01	--	--	1.3E-01	6.5E-03	1.9E+00	9.3E-02	--	--	1.3E-01	6.5E-03	5.0E-03	1.3E-01	6.5E-03
	50-32-8	Benzo(a)pyrene	--	1.4E-01	--	1.2E+01	3.5E-01	1.7E-02	2.4E+00	1.2E-01	--	--	1.4E-01	1.7E-02	5.0E-03	1.4E-01	1.7E-02
	205-99-2	Benzo(b)fluoranthene	--	1.4E-01	--	--	4.3E-01	2.2E-02	6.9E-01	3.4E-02	--	--	1.4E-01	2.2E-02	5.0E-03	1.4E-01	2.2E-02
	207-08-9	Benzo(k)fluoranthene	--	1.4E-01	--	--	4.3E-01	2.2E-02	7.0E-01	3.5E-02	--	--	1.4E-01	2.2E-02	5.0E-03	1.4E-01	2.2E-02
	218-01-9	Chrysene	--	1.4E-01	--	--	1.4E-01	7.2E-03	3.7E+00	1.9E-01	--	--	1.4E-01	7.2E-03	5.0E-03	1.4E-01	7.2E-03
	193-39-5	Indeno(1,2,3-cd)pyrene	--	1.4E-01	--	--	1.3E+00	6.3E-02	8.9E-01	4.4E-02	--	--	1.4E-01	4.4E-02	5.0E-03	1.4E-01	4.4E-02
	53-70-3	Dibenz(a,h)anthracene	--	1.4E-01	--	--	6.5E-01	3.2E-02	1.6E-01	8.2E-03	--	--	1.4E-01	8.2E-03	5.0E-03	1.4E-01	8.2E-03
Total Dioxins and Furans	1746-01-6	Total Dioxins and Furans TEC (f)	5.2E-06	1.1E-05	--	2.0E-06	2.5E-08	1.3E-09	--	--	--	--	5.2E-06	5.2E-06	5.7E-07	5.2E-06	5.2E-06
Metals	7440-50-8	Copper (e)	3.6E+01	--	3.0E+03	--	1.1E+00	5.3E-02	5.5E+01	2.7E+00	N/A	N/A	3.6E+01	3.6E+01	2.0E-01	3.6E+01	3.6E+01
	7440-02-0	Nickel (e)	4.8E+01	1.6E+03	--	3.0E+01	N/A	N/A	N/A	N/A	N/A	N/A	4.8E+01	4.8E+01	5.0E-01	4.8E+01	4.8E+01
	7440-66-6	Zinc (e)	8.5E+01	--	2.4E+04	8.6E+01	N/A	N/A	N/A	N/A	N/A	N/A	8.6E+01	8.6E+01	1.0E+00	8.6E+01	8.6E+01

Notes:

(a) Metal background values, except for arsenic, based on Puget Sound Region 90th percentile values, from *Natural Background Soil Metals Concentrations in Washington State* (Ecology Publication #94-115, 1994). Natural background value for arsenic, based on the value used by Ecology to develop the MTCA Method A soil cleanup level. Total dioxins/furans TEC background value based on Department of Ecology Technical Memorandom #8, Natural Background for Dioxins/Furans in WA Soils, August 9,2010.

(b) Soil values protective of groundwater calculated using Equation 747-1 from WAC 173-340-747. Values for Kd, Koc, and Henry's Law Constant are from CLARC if available; if not, values from EPIWIN or ORNL RAIS were used.

(c) PQL is lowest available value from Analytical Resources, Inc. (Tukwilla, WA) or Frontier Analytical Laboratory (El Dorado Hills, CA)

(d) Site specific screening levels were calculated using Equation 740-3 from WAC 173-340-740 based on EPH analytical results from soil samples that contained detectable concentrations of cPAHs. The range (lowest and highest) of calculated screening levels is 1,275 to 3,390 mg/kg.

(e) These analytes are constituents of potential concern related to the Cornwall Avenue Landfill site (Landau Associates Inc, 2009 Cornwall Avenue Landfill RI/FS) but not the Haley Site, and

are included in this table because cleanup actions in the area where the Cornwall Site and the Haley Site overlap must address constituents of concern related to both sites.

(f) Dioxin/furan mixtures are evaluated using the TEQ methodology.

Shading indicated basis for preliminary revised screening level.

TEC = Toxicity equivalent concentration

BETX = Benzene, ethylbenzene, toluene, and total xylenes

SVOC = Semivolatile organic compound

cPAHs = Carcinogenic polycyclic aromatic hydrocarbons

NA = Not applicable. This analyte was not identified as a constituent of potential concern in groundwater for the Cornwall Avenue Landfill site (Landau Associates Inc, 2009 Cornwall Avenue Landfill RI/FS) so these pathways are not applicable.

-- = no value available

TABLE 2

GROUNDWATER SCREENING LEVELS FOR THE SUPPLEMENTAL INVESTIGATION

R.G. HALEY INTERNATIONAL SITE

BELLINGHAM, WASHINGTON

Analyte Group	CASRN	Constituent	Surface Water Criteria: 40 CFR Part 131.36 (a) – Protection of Aquatic Organisms – Marine Water – Acute (ug/L)	40 CFR Part 131.36 (a) – Protection of Aquatic Organisms – Marine Water – Chronic (ug/L)	40 CFR Part 131.36 (a) – Protection of Human Health For Consumption of: Organism Only (ug/L)	Section 304 of the Clean Water Act (b) – Protection of Aquatic Organisms – Marine Water – Acute (ug/L)	Section 304 of the Clean Water Act (b) – Protection of Aquatic Organisms – Marine Water – Chronic (ug/L)	Section 304 of the Clean Water Act (b) – Protection of Human Health For Consumption of: Organism Only (ug/L)	WAC 173-201A (c) – Protection of Aquatic Organisms – Marine water – Acute (ug/L)	WAC 173-201A (c) – Protection of Aquatic Organisms – Marine water – Chronic (ug/L)	WAC 173-340-730 (d) – Protection of Human Health (fish consumption) – MTCA Method B – Carcino-gen (ug/L)	WAC 173-340-730 (d) – Protection of Human Health (fish consumption) – MTCA Method B – Non-Carcinogen (ug/L)	Protection of Sediment (SQS values in 173-204 WAC) Note (e) (ug/L)	Method B Groundwater Criteria for Vapor Intrusion (f) – Carcino-gen (ug/L)	Method B Groundwater Criteria for Vapor Intrusion (f) – Non-Carcinogen (ug/L)	Preliminary Revised Screening Level (before adjustment for PQL) (ug/L)	PQL (g) (µg/L)	Selected Preliminary Revised Screening Level (after adjustment for PQL and background) (µg/L)
TPH	68334-30-5	Diesel-Range	--	--	--	--	--	--	--	PQL	--	PQL	--	--	--	--	2.5E+02	2.5E+02
	64742-65-0	Lube Oil-Range	--	--	--	--	--	--	--	PQL	--	PQL	--	--	--	--	4.0E+02	4.0E+02
BETX	71-43-2	Benzene	--	--	7.1E+01	--	--	5.1E+01	--	--	2.3E+01	2.0E+03	--	2.4E+00	1.0E+02	2.4E+00	4.5E-01	2.4E+00
	100-41-4	Ethylbenzene	--	--	2.9E+04	--	--	2.1E+03	--	--	--	6.9E+03	--	--	2.8E+03	2.1E+03	4.2E-01	2.1E+03
	108-88-3	Toluene	--	--	2.0E+05	--	--	1.5E+04	--	--	--	1.9E+04	--		1.5E+04	1.5E+04	4.8E-01	1.5E+04
	1330-20-7	Xylenes (total)	--	--	--	--	--	--	--	--	--	--	--		3.1E+02	3.1E+02	7.8E-01	3.1E+02
SVOCs	120-83-2	2,4-Dichlorophenol	--	--	7.9E+02	--	--	2.9E+02	--	--	--	1.9E+02	--	--	--	1.9E+02	5.0E+00	1.9E+02
	105-67-9	2,4-Dimethylphenol	--	--	--	--	--	8.5E+02	--	--	--	5.5E+02	2.0E+00	--	--	2.0E+00	1.0E+00	2.0E+00
	95-95-4	2,4,5-Trichlorophenol	--	--	--	--	--	3.6E+03	--	--	--	--	--	--	--	3.6E+03	5.0E+00	3.6E+03
	88-06-2	2,4,6-Trichlorophenol	--	--	6.5E+00	--	--	2.4E+00	--	--	3.9E+00	--	--	--	--	2.4E+00	2.5E-01	2.4E+00
	95-48-7	2-Methylphenol	--	--	--	--	--	--	--	--	--	--	7.1E+00	--	--	7.1E+00	1.0E+00	7.1E+00
	91-57-6	2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	1.8E+01	--	--	1.8E+01	1.0E+00	1.8E+01
	83-32-9	Acenaphthene	--	--	--	--	--	9.9E+02	--	--	--	6.4E+02	2.6E+00	--	--	2.6E+00	1.0E+00	2.6E+00
	208-96-8	Acenaphthylene	--	--	--	--	--	--	--	--	--	--	1.1E+01	--	--	1.1E+01	1.0E+00	1.1E+01
	120-12-7	Anthracene	--	--	1.1E+05	--	--	4.0E+04	--	--	--	2.6E+04	1.1E+01	--	--	1.1E+01	1.0E+00	1.1E+01
	85-68-7	Butylbenzylphthalate	--	--	--	--	--	1.9E+03	--	--		1.3E+03	5.2E-01	--	--	5.2E-01	1.0E+00	1.0E+00
	132-64-9	Dibenzofuran (see comment)	--	--	--	--	--	--	--	--	--	--	1.3E+00	--	--	1.3E+00	1.0E+00	1.3E+00
	206-44-0	Fluoranthene	--	--	3.7E+02	--	--	1.4E+02	--	--	--	9.0E+01	2.3E+00	--	--	2.3E+00	1.0E+00	2.3E+00
	86-73-7	Fluorene	--	--	1.4E+04	--	--	5.3E+03	--	--	--	3.5E+03	2.0E+00	--	--	2.0E+00	1.0E+00	2.0E+00
	91-20-3	Naphthalene	--	--	--	--	--	--	--	--	--	4.9E+03	5.4E+01	--	1.7E+02	5.4E+01	1.0E+00	5.4E+01
	86-30-6	N-Nitrosodiphenylamine	--	--	1.6E+01	--	--	6.0E+00	--	--	9.7E+00	--	2.0E+00	--	--	2.0E+00	1.0E+00	2.0E+00
	87-86-5	Pentachlorophenol	1.3E+01	7.9E+00	8.2E+00	1.3E+01	7.9E+00	3.0E+00	1.3E+01	7.9E+00	4.9E+00	7.1E+03	5.3E+00	--	--	3.0E+00	2.5E-01	3.0E+00
	85-01-8	Phenanthrene	--	--	--	--	--	--	--	--	--	--	4.8E+00	--	--	4.8E+00	1.0E+00	4.8E+00
	129-00-0	Pyrene	--	--	1.1E+04	--	--	4.0E+03	--	--	--	2.6E+03	1.4E+01	--	--	1.4E+01	1.0E+00	1.4E+01
	191-24-2	Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	1.2E-02	--	--	1.2E-02	1.0E+00	1.0E+00

Analyte Group	CASRN		Constituent	Surface Water Criteria: 40 CFR Part 131.36 (a)			Section 304 of the Clean Water Act (b)			WAC 173-201A (c)		WAC 173-340-730 (d)		Protection of Sediment (SQS values in 173-204 WAC) Note (e)	Method B Groundwater Criteria for Vapor Intrusion (f)		Preliminary Revised Screening Level (before adjustment for PQL)	PQL (g)	Selected Preliminary Revised Screening Level (after adjustment for PQL and background)
				Protection of Aquatic Organisms		Protection of Human Health For Consumption of:	Protection of Aquatic Organisms		Protection of Human Health For Consumption of:	Protection of Aquatic Organisms		Protection of Human Health (fish consumption)							
				Marine Water			Marine Water			Marine water		MTCA Method B							
				Acute (ug/L)	Chronic (ug/L)	Organism Only (ug/L)	Acute (ug/L)	Chronic (ug/L)	Organism Only (ug/L)	Acute (ug/L)	Chronic (ug/L)	Carcino-gen (ug/L)	Non-Carcinogen (ug/L)	(ug/L)	Carcino-gen (ug/L)	Non-Carcinogen (ug/L)	(ug/L)	(µg/L)	(µg/L)
SVOCs (continued)	56-55-3	cPAHs	Benzo(a)anthracene	--	--	3.1E-02	--	--	1.8E-02	--	--	3.0E-02	--	2.6E-01	--	--	1.8E-02	1.0E-02	1.80E-02
	50-32-8		Benzo(a)pyrene	--	--	3.1E-02	--	--	1.8E-02	--	--	3.0E-02	--	1.3E-01	--	--	1.8E-02	1.0E-02	1.80E-02
	205-99-2		Benzo(b)fluoranthene	--	--	3.1E-02	--	--	1.8E-02	--	--	3.0E-02	--	2.9E-01	--	--	1.8E-02	1.0E-02	1.80E-02
	207-08-9		Benzo(k)fluoranthene	--	--	3.1E-02	--	--	1.8E-02	--	--	3.0E-02	--	2.9E-01	--	--	1.8E-02	1.0E-02	1.80E-02
	218-01-9		Chrysene	--	--	3.1E-02	--	--	1.8E-02	--	--	3.0E-02	--	4.7E-01	--	--	1.8E-02	1.0E-02	1.80E-02
	193-39-5		Indeno(1,2,3-cd)pyrene	--	--	3.1E-02	--	--	1.8E-02	--	--	3.0E-02	--	1.3E-02	--	--	1.3E-02	1.0E-02	1.3E-02
	53-70-3		Dibenz(a,h)anthracene	--	--	3.1E-02	--	--	1.8E-02	--	--	3.0E-02	--	4.6E-03	--	--	4.6E-03	1.0E-02	1.0E-02
Total Dioxins and Furans	1746-01-6	2378-TCDD	TEQ Calculation	--	--	1.4E-08	--	--	5.1E-09	--	--	8.6E-09	--	--	--	--	5.1E-09	5.7E-06	5.7E-06
Dissolved Metals	7440508		Copper (h)	2.4E+00	2.4E+00	--	4.8E+00	3.1E+00	--	4.8E+00	3.1E+00	--	2.7E+03	1.2E+02	--	--	2.4E+00	5.0E-01	2.4E+00
	57-12-5		Cyanide (total) (h)	1.0E+00	1.0E+00	2.2E+05	1.0E+00	1.0E+00	1.6E+04	1.0E+00	1.0E+00	--	5.2E+04	--	--	--	1.0E+00	4.0E+00	4.0E+00
	7439-92-1		Lead (h)	2.1E+02	8.1E+00	--	2.1E+02	8.1E+00	--	2.1E+02	8.1E+00	--	--	1.1E+01	--	--	8.1E+00	1.0E+00	8.1E+00
Other	7664-41-7		Ammonia (h)	--	--	--	--	--	--	2.3E+02	3.5E+01	--	--	--	--	--	3.5E+01	1.0E+01	3.5E+01
	27323-18-9		PCBs (h)	--	3.0E-02	1.7E-04	--	3.0E-02	6.4E-05	1.0E+01	3.0E-02	1.1E-04	--	2.7E-01	--	--	6.4E-05	1.0E-02	1.0E-02

Notes:

(a) Ambient water quality criteria (AQWC) for the protection of aquatic organisms and protection of human health based on consumption of organisms from 40 CFR part 131.36 (National Toxics Rule).

(b) National recommended water quality criteria for the protection of aquatic organisms and protection of human health based on consumption of organisms from Section 304 of the Clean Water Act.

(c) Water Quality Standards for Surface Waters of the State of Washington, Chapter 173-201A WAC, amended July 1, 2003. Based on protection of aquatic organisms.

(d) MTCA Method B surface water screening levels calculated according to WAC 173-340-730(3)(b)(iii)(a) (equation 730-1) and WAC 173-340-730(3)(b)(iii)(b) (equation 730-2).

(e) Groundwater criteria considered protective of sediment (SQS criteria) using calculations developed by Ecology for the Lower Duwamish Waterway (Draft LDW CULs v12r5.xlsx)

(f) Values obtained from Ecology's draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action (Ecology Publication #09-09-047), Table B-1.

(g) PQL is lowest available value from Analytical Resources, Inc. (Tukwilla, WA) or Frontier Analytical Laboratory (El Dorado Hills, CA).

(h) These analytes are constituents of potential concern related to the Cornwall Avenue Landfill site (Landau Associates Inc, 2009 Cornwall Avenue Landfill RI/FS) but not the Haley Site, and are included in this table because cleanup actions in the area where the Cornwall site and the Haley Site overlap must address constituents of concern related to both sites.

Shading indicates basis for preliminary revised screening level

-- = no value available

TABLE 3

SEDIMENT SCREENING LEVELS FOR THE SUPPLEMENTAL INVESTIGATION

R.G. HALEY INTERNATIONAL SITE

BELLINGHAM, WASHINGTON

Analytes	SMS Criteria[1]		AET Criteria[2]	
	SQS[3]	CSL[4]	LAET[5]	2LAET[6]
Metals	mg/kg		mg/kg	
Copper[7]	390	390	390	390
Lead[7]	450	530	450	530
Mercury[8]	0.41	0.59	0.41	0.59
Silver[7]	6.1	6.1	6.1	6.1
Zinc[7]	410	960	410	960
Total LPAHs	mg/kg OC		µg/kg	
Total LPAH	370	780	5,200	5,200
Naphthalene	99	170	2,100	2,100
Acenaphthylene	66	66	1,300	1,300
Acenaphthene	16	57	500	500
Fluorene	23	79	540	540
Phenanthrene	100	480	1,500	1,500
Anthracene	220	1,200	960	960
2-Methylnaphthalene	38	64	670	670
Total HPAHs	mg/kg OC		µg/kg	
Total HPAH	960	5,300	12,000	17,000
Fluoranthene	160	1,200	1,700	2,500
Pyrene	1,000	1,400	2,600	3,300
Benzo(a)anthracene	110	270	1,300	1,600
Chrysene	110	460	1,400	2,800
Total Benzofluoranthenes	230	450	3,200	3,600
Benzo(a)pyrene	99	210	1,600	1,600
Indeno(1,2,3-cd)pyrene	34	88	600	690
Dibenzo(a,h)anthracene	12	33	230	230
Benzo(ghi)perylene	31	78	670	720
Chlorinated Hydrocarbons	mg/kg OC		µg/kg	
1,2-Dichlorobenzene	2.3	2.3	35	50
1,3-Dichlorobenzene	--	--	>170	--
1,4-Dichlorobenzene	3.1	9	110	110
1,2,4-Trichlorobenzene	0.81	1.8	31	51
Hexachlorobenzene	0.38	2.3	22	70
Phthalates	mg/kg OC		µg/kg	
Dimethyl phthalate	53	53	71	160
Diethyl phthalate	61	110	200	1,200
Dibutyl phthalate	220	1,700	1,400	5,100

Analytes	SMS Criteria[1]		AET Criteria[2]	
	SQS[3]	CSL[4]	LAET[5]	2LAET[6]
Butyl benzyl phthalate	4.9	64	63	900
Bis(2-Ethylhexyl) Phthalate[7]	47	78	1,300	3,100
Di-N-Octyl Phthalate	58	4,500	6,200	6,200
Miscellaneous Extractables	**mg/kg OC**		**µg/kg**	
Dibenzofuran	15	58	540	540
Hexachlorobutadiene	3.9	6.2	11	120
N-Nitrosodiphenylamine	11	11	28	40
Benzyl Alcohol	57	73	57	73
Benzoic Acid	650	650	650	650
PCBs	**mg/kg**		**µg/kg**	
Total PCBs[7]	12	65	130	1,000
Phenols	**µg/kg**		**µg/kg**	
Phenol[8]	420	1,200	420	1,200
2-methylphenol[8]	63	63	63	63
4-methylphenol[8]	670	670	670	670
2,4-Dimethylphenol	29	29	29	29
Pentachlorophenol	360	690	360	690
Petroleum Hydrocarbons	**mg/kg**		**mg/kg**	
Diesel-range Hydrocarbons	--	--	--	--
Heavy Oil-Range Hydrocarbons	--	--	--	--
Total TPH	200 [9]	--	--	--
Dioxins and Furans	**ng/kg**		**ng/kg**	
2,3,7,8-TCDD	--	--	--	--
1,2,3,7,8-PeCDD	--	--	--	--
1,2,3,4,7,8-HxCDD	--	--	--	--
1,2,3,6,7,8-HxCDD	--	--	--	--
1,2,3,7,8,9-HxCDD	--	--	--	--
1,2,3,4,6,7,8-HpCDD	--	--	--	--
OCDD	--	--	--	--
2,3,7,8-TCDF	--	--	--	--
1,2,3,7,8-PeCDF	--	--	--	--
2,3,4,7,8-PeCDF	--	--	--	--
1,2,3,4,7,8-HxCDF	--	--	--	--
1,2,3,6,7,8-HxCDF	--	--	--	--
1,2,3,7,8,9-HxCDF	--	--	--	--
2,3,4,6,7,8-HxCDF	--	--	--	--
1,2,3,4,6,7,8-HpCDF	--	--	--	--
1,2,3,4,7,8,9-HpCDF	--	--	--	--
OCDF	--	--	--	--
Dioxin/Furan TEQ ND=0	--	--	--	--
Dioxin/Furan TEQ ND=1/2	--	--	--	--

Notes:

[1] Sediment Management Standards (Chapter 173-204 WAC)

[2] Apparent Effects Threshold Criteria

[3] Sediment Quality Standards (Chapter 173-204-320)

[4] Cleanup Screening Level (Chapter 173-204-520)

[5] Lowest Apparent Effects Threshold Criteria (provided in an email from Peter Adolphson, Washington State Department of Ecology, dated April 18, 2011).

[6] Second Lowest Apparent Effects Threshold Criteria (provided in an email from Peter Adolphson, Washington State Department of Ecology, dated April 18, 2011).

[7] This analyte was identified as a constituent of concern related to the Cornwall Avenue Landfill site (Landau Associates Inc, 2009 Cornwall Avenue Landfill RI/FS) and is included in this table because cleanup actions in the area where the Cornwall site and the Haley Site overlap must address constituents of concern related to both sites.

[8] This analyte was identified as a constituent of concern related to the Whatcom Waterway site (RETEC, 2006, Whatcom Waterway Supplemental RI/FS) and is included in this table because cleanup actions in the area where the Whatcom Waterway site and the Haley Site overlap must address constituents of concern related to both sites.

[9] Preliminary Screening Level from *Sediment Site Characterization Evaluation of Bellingham Bay Creosote Piling and Structure Removal - Cornwell Avenue Landfill Mapping, Boulevard Park Overwater Walkway Feasibility Study and Dioxin Background Sampling and Analysi* s, June 26, 2009.

SMS = Sediment Management Standards

SQS = Sediment Quality Standards

CSL = Cleanup Screening Levels

LAET = Lowest Apparent Effects Threshold

2LAET = Second Lowest Apparent Effects Threshold

µg/kg = microgram per kilogram

ng/kg = nanogram per kilogram

mg/kg OC = milligram per kilogram

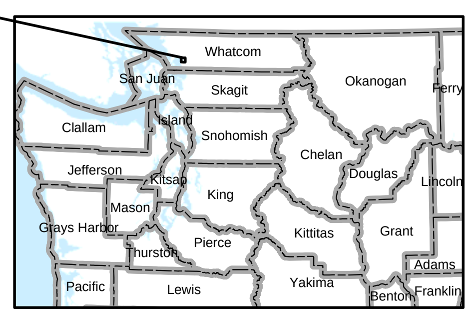
Total LPAHs are the total of Napthalene, Acenapthylene, Acenapthene, Fluorene, Phenanthrene and Anthracene; 2-Methylnapthalene is not included in the sum of LPAHs.

Total HPAHs are the total of Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzofluoranthenes, Benzo(a)pyrene, Indeno(1,2,3-c-d)pyrene, Dibenzo(a,h)anthracene and Benzo(g,h,i)perylene.

-- = No criteria is currently available for this analyte

FIGURES

Map Revised: February 24, 2006



0 1,000 2,000 Feet

N

All locations are approximate.

Lambert Conformal Conic
Washington State Plane North
North American Datum 1983

Data Sources: Interstates, state routes, and roads from TIGER 2000.
County boundaries, cities, and waterbodies from Department of Ecology.

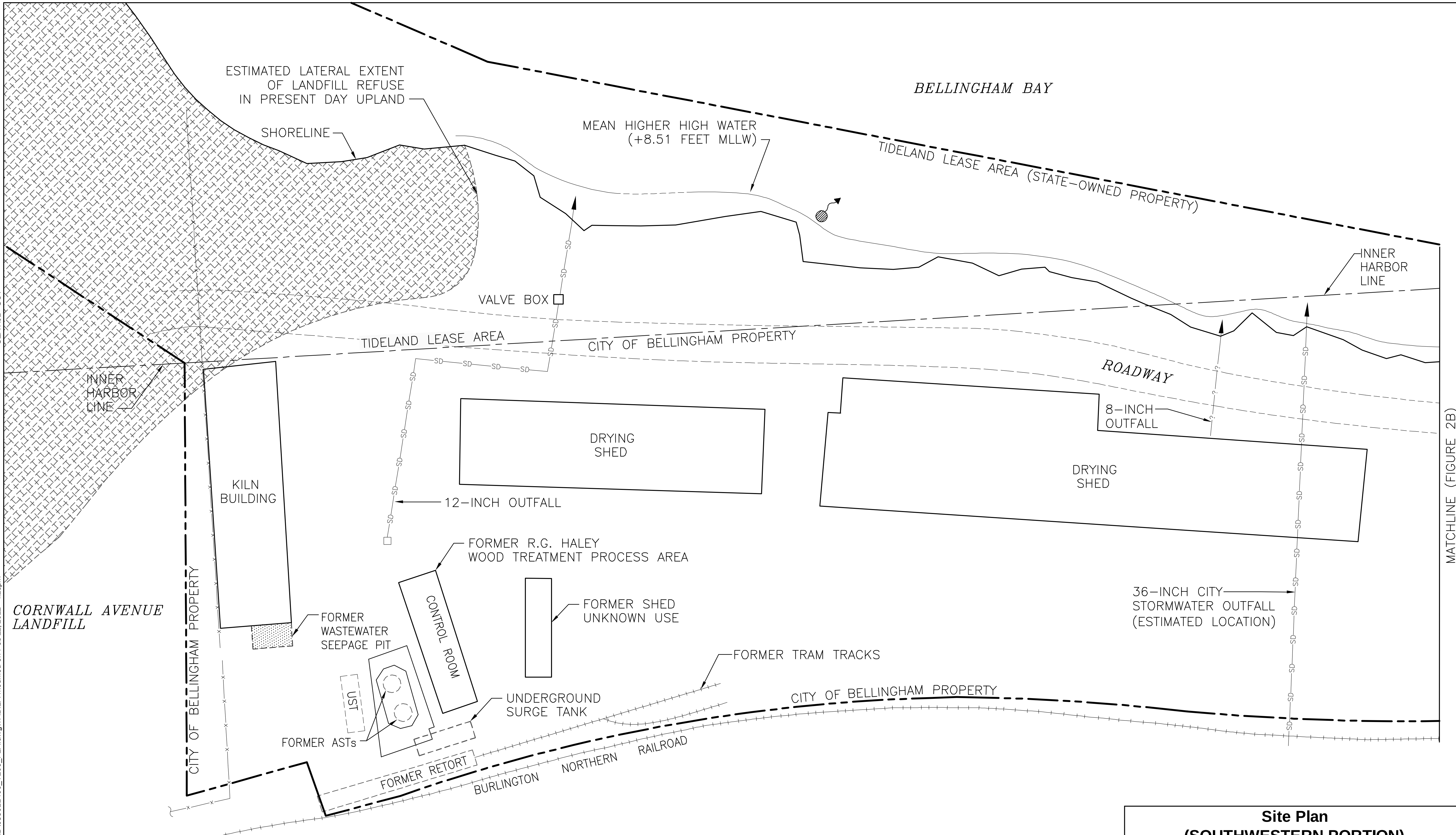
Path: P:\0\0257002\01\CAD\025700201_VM_Fig1.pdf

Office: SEA

GEOENGINEERS

VICINITY MAP

FIGURE 1



Notes: 1. The locations of all features shown are approximate.

2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

References: Ronald T. Jepson and Associates, April 1990, April 2000. Ecology and Environment, May 1986.

EXPLANATION:

LANDFILL REFUSE

FORMER OIL SEEP

AST ABOVEGROUND STORAGE TANK

UST UNDERGROUND STORAGE TANK

50 0 50

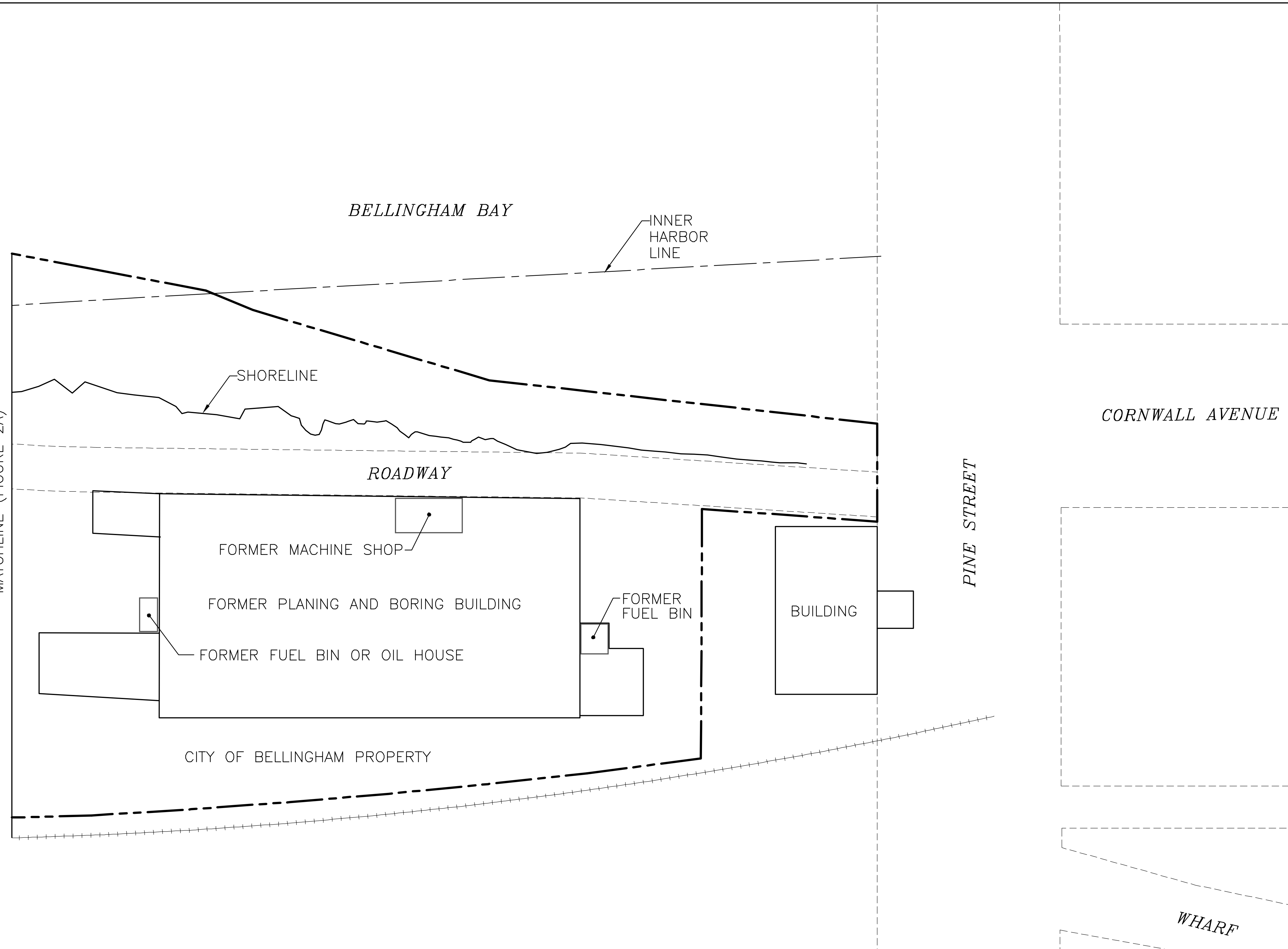
Feet

Site Plan
(SOUTHWESTERN PORTION)

R.G. Haley International Site
Bellingham, Washington

GEOENGINEERS

Figure 2A



Notes: 1. The locations of all features shown are approximate.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to thedata since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

References: Ronald T. Jepson and Associates, April 1990, April 2000. Ecology and Environment, May 1986.

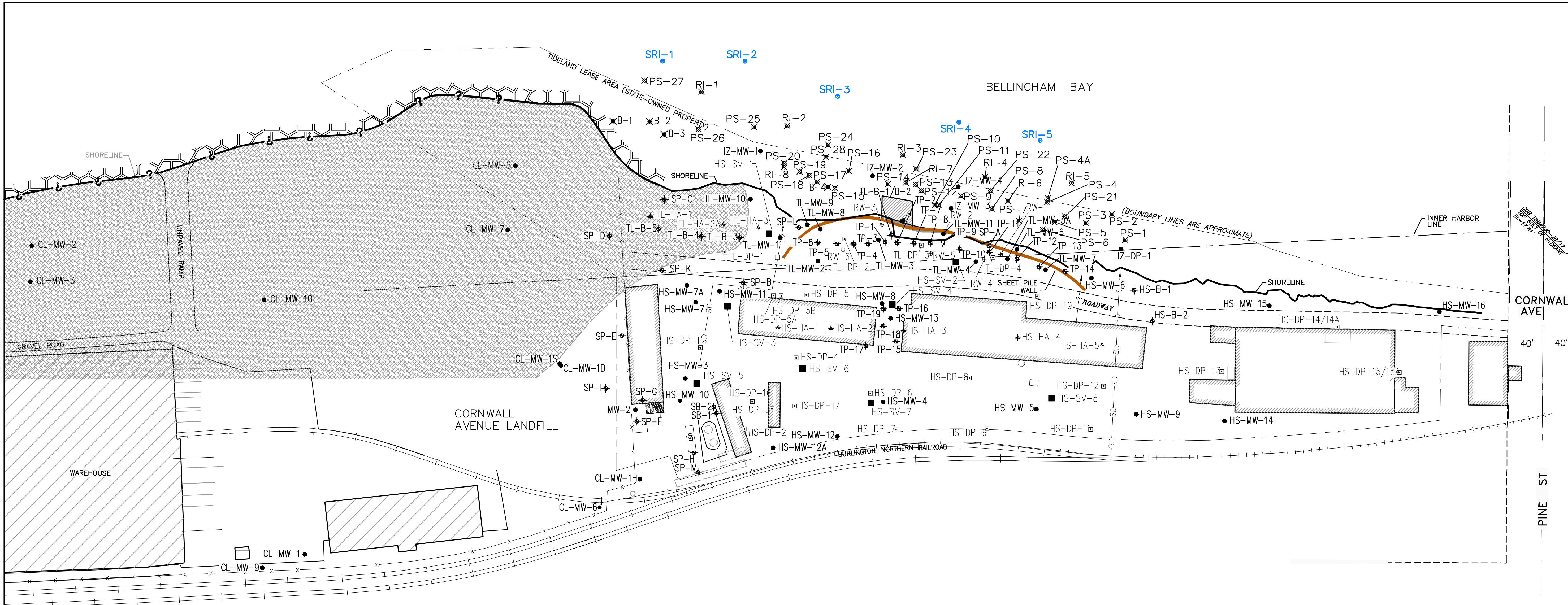
50 0 50
Feet

Site Plan
(NORTHEASTERN PORTION)

R.G. Haley International Site
Bellingham, Washington

GEOENGINEERS

Figure 2B



EXPLANATION:

SRI-1	SUPPLEMENTAL REMEDIAL SEDIMENT INVESTIGATION SAMPLING LOCATION
PS-1	PRELIMINARY SEDIMENT QUALITY ASSESSMENT SAMPLING LOCATION
RI-1	SEPTEMBER 2004 SAMPLE LOCATION
HS-MW-1	EXPLORATORY BOREHOLE FOR MONITORING WELL
HS/SB/SP	BORING
HS-DP-4	DIRECT PUSH BORING
HS-SV-1	SOIL VAPOR SAMPLE LOCATION
HS-HA-1	HAND AUGER
RW-1	RECOVERY WELL
B-1	TEMPORARY GROUNDWATER SAMPLING POINT
TP-15	TEST PIT
	FORMER OIL SEEP
UST	UNDERGROUND STORAGE TANK
	SHEETPILE BARRIER
	ESTIMATED EXTENT OF UPLAND REFUSE BASED ON LANDAU ASSOCIATES, JANUARY 27, 2003, ECOLOGY REVIEW DRAFT RI/FS CORNWALL AVENUE LANDFILL, BELLINGHAM, WASHINGTON, FIGURE 3-8
	RIPRAP SHORELINE

Notes: 1. The locations of all features shown are approximate.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

References: CAD files "R2000geoeng_haleybase50x" revised 07/28/04 by Pacific Survey & Engineering Inc., file "Fig3-8" dated August 2002 by Landau Associates, and files "027500201T1LM" and "027500201T1A" dated 03/29/04 by GeoEngineers.

120 0 120
Feet

SOIL AND GROUNDWATER EXPLORATION LOCATIONS

R.G. Haley International Site
Bellingham, Washington

GEOENGINEERS

Figure 3

SEAT:JL : SCY

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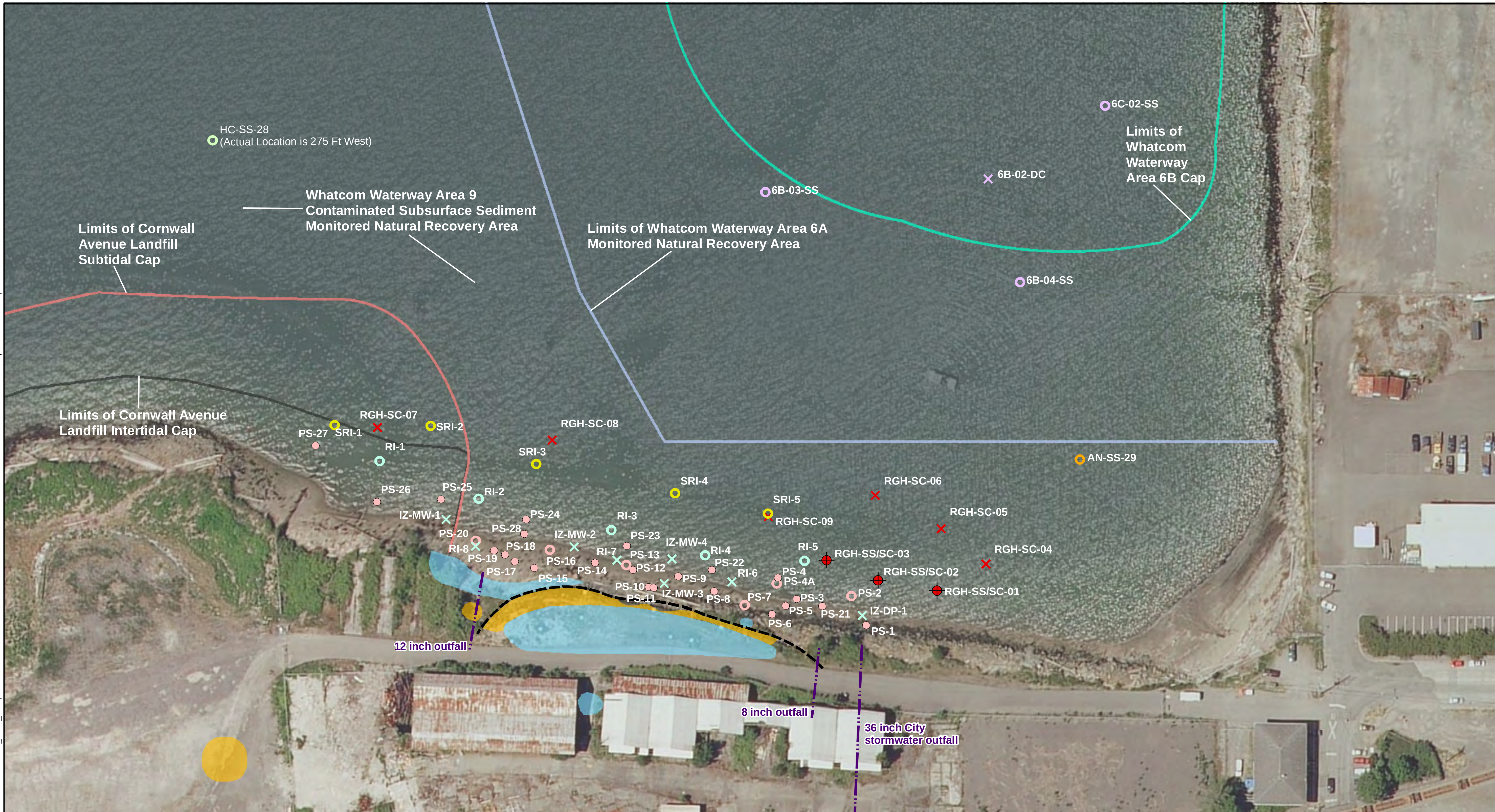

0 100
Feet

Reference: Esri World Imagery, 2009.

Notes:
1. The locations of features shown are approximate.
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Legend

- Interpolated area with past occurrence of measurable oil as light non-aqueous phase liquid (LNAPL) on groundwater
- Interpolated area with past occurrence of trace oil as LNAPL on groundwater
- Outfalls
- Sheet Pile Barrier
- Bathymetric Contour (1ft)

Sample Type

- Surface Sediment Sample Location With Sample Analysis
- Subsurface Sediment Sample Location With Sample Analysis
- Surface and Subsurface Sediment Sample Location With Sample Analysis
- Surface and/or Subsurface Sediment Sample Location With Visual Characterization

Sample Study Source

- RG Haley Preliminary Screening Study Sample Location (GeoEngineers 2003)
- RG Haley Remedial Investigation Sample Location (GeoEngineers 2004)
- RG Haley Supplemental Remedial Investigation Sample Location (GeoEngineers 2005)
- RG Haley and Bellingham Bay Piling Study Sample Location (Hart Crowser 2008)
- Whatcom Waterway Pre-Remedial Design Evaluation Sample Location (Anchor 2002)
- Whatcom Waterway Pre-remedial Design Investigation Sample Location (Anchor QEA 2010)
- Whatcom Waterway Remedial Investigation Sample Location (Anchor and Hart Crowser 1996)

Sediment Sample Locations

R. G. Haley International Site
Bellingham, Washington

GEOENGINEERS

Figure 4

Map Revised: 23 January 2012 amanza

Path: \\tac\Projects\0\0356114\GIS\035611406_T700_Proposed_Upland.mxd

Office: TAC

0 100
Feet

Data Source: Aerial from Aerials Express Seattle, 2009.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Legend

- Existing Monitoring Well
- Interpolated area with past occurrence of measurable oil as light non-aqueous phase liquid (LNAPL) on groundwater
- Interpolated area with past occurrence of trace oil as LNAPL on groundwater
- Cornwall IRM Boundary
- R.G. Haley International Property Line
- Inner Harbor Line
- Cornwall Property
- Port Owned Property
- Tideland Lease Area
- Extent of Refuse and Wood Debris
- Outfalls
- Sheet Pile Barrier

Proposed Upland Explorations

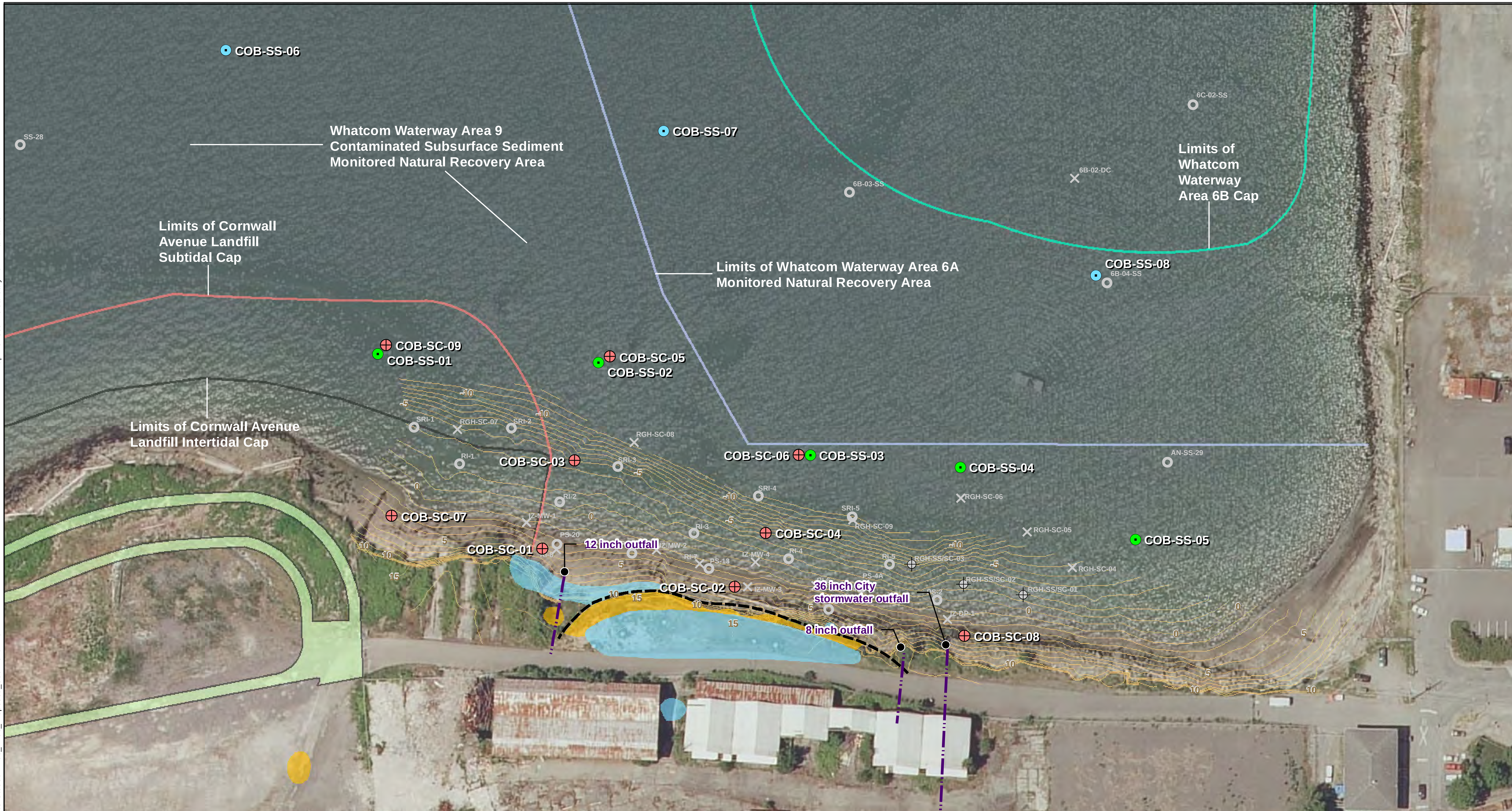
- Water Table Monitoring Well
- Deep Monitoring Well
- Surface Soil Sample
- Soil Boring

Proposed Soil and Groundwater Investigation Locations

R.G. Haley International Site
Bellingham, Washington

GEOENGINEERS

Figure 5



Map Revised: 23 January 2012 amanza

Path: \\tac\Projects\0\0356114\GIS\035611406_T700_Proposed_Sediment.mxd

Office: TACO

0 100
Feet

Reference: Esri World Imagery, 2009.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes.
It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Legend

- Interpolated area with past occurrence of measurable oil as light non-aqueous phase liquid (LNAPL) on groundwater
- Interpolated area with past occurrence of trace oil as LNAPL on groundwater
- Cornwall IRM Boundary
- Outfalls
- Sheet Pile Barrier
- Bathymetric Contour (1ft)

Proposed Sediment Sample Locations

- Proposed Surface Sediment Location: Combination of Chemical Analysis and Biological Testing
- Proposed Surface Sediment Location: Dioxin/Furan Analysis Only
- Proposed Sediment Coring Location

Previous Sample Locations

- Surface Sediment Sample Location
- Subsurface Sediment Sample Location
- Surface and Subsurface Sediment Sample

Proposed Sediment Sampling Locations

R. G. Haley International Site
Bellingham, Washington

GeoEngineers

Figure 6

APPENDICES

GeoEngineers

APPENDIX A
Soil and Groundwater Data Summary Figures

0 80
Feet

Data Source: Aerial from Aerials Express Seattle, 2009.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
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2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Concentration Relative to Screening Level:

- ≥100x
- ≥10x and <100x
- >1x and <10x
- ≤1x
- Not Sampled or Practical Quantification Limit (PQL) > Screening Level

* One sample was collected from a depth greater than 20 feet from each of these locations. The analyte was not detected or was detected at a concentration equal to or less than the screening level in these samples.

CL-MW-1 Sample Location Identification

Depth Intervals (feet below ground surface)

- 0 to 5
- 5 to 10
- 10 to 20

Site Features

- R.G. Haley International Property Line
- Former Building Footprints
- Inner Harbor Line
- Cornwall Property
- Port Owned Property
- Tideland Lease Area
- Extent of Refuse and Wood Debris
- Sheet Pile Barrier

Data Summary for Diesel in Soil

R.G. Haley International Site
Bellingham, Washington

GeoEngineers

Figure A-1

Map Revised: 01 September 2011 amanza

Path: \\tac\Projects\0\0356114\GIS\035611406_T600_Soils_Diesel.mxd

Office: TAC

0 80
Feet

Data Source: Aerial from Aerials Express Seattle, 2009.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Concentration Relative to Screening Level:

- ≥100x
- ≥10x and <100x
- >1x and <10x
- ≤1x
- Not Sampled or Practical Quantification Limit (PQL) > Screening Level

* One sample was collected from a depth greater than 20 feet from each of these locations. The analyte was not detected or was detected at a concentration equal to or less than the screening level in these samples.

CL-MW-1 Sample Location Identification

Depth Intervals (feet below ground surface)

- 0 to 5
- 5 to 10
- 10 to 20

Site Features

- R.G. Haley International Property Line
- Former Building Footprints
- Inner Harbor Line
- Cornwall Property
- Port Owned Property
- Tideland Lease Area
- Extent of Refuse and Wood Debris
- Sheet Pile Barrier

Data Summary for Lube Oil in Soil

R.G. Haley International Site
Bellingham, Washington

GEOENGINEERS

Figure A-2

Map Revised: 01 September 2011 amanza

Path: \\tac\Projects\0\0356114\GIS\0356114\06_T600_Soils_LubeOil.mxd

Office: TAC

0 160
Feet

Data Source: Aerial from Aerials Express Seattle, 2009.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Concentration Relative to Screening Level:

- ≥100x
- ≥10x and <100x
- >1x and <10x
- ≤1x
- Not Sampled or Practical Quantification Limit (PQL) > Screening Level

CL-MW-1 Sample Location Identification

Chemical Name

- Diesel
- Lube Oil

LNAPL Areas

- Interpolated area with past occurrence of measurable oil as light non-aqueous phase liquid (LNAPL) on groundwater
- Interpolated area with past occurrence of trace oil as LNAPL on groundwater

Site Features

- R.G. Haley International Property Line
- Former Building Footprints
- Inner Harbor Line
- Cornwall Property
- Port Owned Property
- Tideland Lease Area
- Extent of Refuse and Wood Debris
- Sheet Pile Barrier

Data Summary for Total Petroleum Hydrocarbons in Groundwater

R.G. Haley International Site
Bellingham, Washington

GEOENGINEERS

Figure A-3

Map Revised: 08 February 2012 amanza

Path: \\tac\Projects\0\0356114\GIS\035611406_T600_GW_TPH_rev.mxd

Office: TAC

Map Revised: 01 September 2011 amanza

Path: \\tac\Projects\0\0356114\GIS\035611406_T600_Soils_SVOC.mxd

Office: TAC

0 80
Feet

Data Source: Aerial from Aerials Express Seattle, 2009.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Concentration Relative to Screening Level:

- ≥100x
- ≥10x and <100x
- >1x and <10x
- ≤1x
- Not Sampled or Practical Quantification Limit (PQL) > Screening Level

SVOCs = semivolatile organic compunds

CL-MW-1 Sample Location Identification

Depth Intervals (feet below ground surface)

- 0 to 5
- 5 to 10
- 10 to 20

Site Features

- R.G. Haley International Property Line
- Former Building Footprints
- Inner Harbor Line
- Cornwall Property
- Port Owned Property
- Tideland Lease Area
- Extent of Refuse and Wood Debris
- Sheet Pile Barrier

Data Summary for SVOCs in Soil

R.G. Haley International Site
Bellingham, Washington

GeoEngineers

Figure A-4

Map Revised: 01 September 2011 amanza

Path: \\tac\Projects\0\0356114\GIS\0356114\06_T600_GW_SVOC.mxd

Office: TAC

0 160

Feet

Data Source: Aerial from Aerials Express Seattle, 2009.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Maximum Concentration Detected During Monitoring Events Relative to Screening Level:

- ≥100x
- ≥10x and <100x
- >1x and <10x
- ≤1x
- No Relevant Data: Not Samples or Practical Quantification Limit (PQL) > Screening Level

SVOCs = semivolatile organic compunds

CL-MW-1 Sample Location Identification

Site Features

- R.G. Haley International Property Line
- Former Building Footprints
- Inner Harbor Line
- Cornwall Property
- Port Owned Property
- Tideland Lease Area
- Extent of Refuse and Wood Debris
- Sheet Pile Barrier

Data Summary for SVOCs in Groundwater

R.G. Haley International Site
Bellingham, Washington

GeoEngineers

Figure A-5

0 80
Feet

Data Source: Aerial from Aerials Express Seattle, 2009.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Concentration Relative to Screening Level:

- ≥100x
- ≥10x and <100x
- >1x and <10x
- ≤1x
- Not Sampled or Practical Quantification Limit (PQL) > Screening Level

cPAHs = carcinogenic polycyclic aromatic hydrocarbons

CL-MW-1 Sample Location Identification

Depth Intervals (feet below ground surface)

- 0 to 5
- 5 to 10
- 10 to 20

Site Features

- R.G. Haley International Property Line
- Former Building Footprints
- Inner Harbor Line
- Cornwall Property
- Port Owned Property
- Tideland Lease Area
- Extent of Refuse and Wood Debris
- Sheet Pile Barrier

Data Summary for cPAHs in Soil

R.G. Haley International Site
Bellingham, Washington

GEOENGINEERS

Figure A-6

Map Revised: 01 September 2011 amanza

Path: \\tac\Projects\0\0356114\GIS\035611406_T600_Soils_cPAH.mxd

Office: TAC

0 160
Feet

Data Source: Aerial from Aerials Express Seattle, 2009.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Maximum Concentration Detected During Monitoring Events Relative to Screening Level:

- ≥100x
- ≥10x and <100x
- >1x and <10x
- ≤1x
- No Relevant Data: Not Samples or Practical Quantification Limit (PQL) > Screening Level

cPAHs = carcinogenic polycyclic aromatic hydrocarbons

CL-MW-1 Sample Location Identification

Site Features

- R.G. Haley International Property Line
- Former Building Footprints
- Inner Harbor Line
- Cornwall Property
- Port Owned Property
- Tideland Lease Area
- Extent of Refuse and Wood Debris
- Sheet Pile Barrier

Data Summary for cPAHs in Groundwater

R.G. Haley International Site
Bellingham, Washington

GeoEngineers

Figure A-7

Map Revised: 01 September 2011 amanza

Path: \\tac\Projects\0\0356114\GIS\0356114\06_T600_GW_cPAH.mxd

Office: TAC

0 80
Feet

Data Source: Aerial from Aerials Express Seattle, 2009.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Concentration Relative to Screening Level:

- ≥100x
- ≥10x and <100x
- >1x and <10x
- ≤1x
- Not Sampled or Practical Quantification Limit (PQL) > Screening Level

PCP = pentachlorophenol

CL-MW-1 Sample Location Identification

Depth Intervals (feet below ground surface)

- 0 to 5
- 5 to 10
- 10 to 20

Site Features

- R.G. Haley International Property Line
- Former Building Footprints
- Inner Harbor Line
- Cornwall Property
- Port Owned Property
- Tideland Lease Area
- Extent of Refuse and Wood Debris
- Sheet Pile Barrier

Data Summary for PCP in Soil

R.G. Haley International Site
Bellingham, Washington

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Figure A-8

Map Revised: 01 September 2011 amanza

Path: \\tac\Projects\0\0356114\GIS\035611406_T600_Soils_PCP.mxd

Office: TAC

0 160
Feet

Data Source: Aerial from Aerials Express Seattle, 2009.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Maximum Concentration Detected During Monitoring Events Relative to Screening Level:

- ≥100x
- ≥10x and <100x
- >1x and <10x
- ≤1x
- No Relevant Data: Not Samples or Practical Quantification Limit (PQL) > Screening Level

PCP = pentachlorophenol

CL-MW-1 Sample Location Identification

Site Features

- R.G. Haley International Property Line
- Former Building Footprints
- Inner Harbor Line
- Cornwall Property
- Port Owned Property
- Tideland Lease Area
- Extent of Refuse and Wood Debris
- Sheet Pile Barrier

Data Summary for PCP in Groundwater

R.G. Haley International Site
Bellingham, Washington

GeoEngineers

Figure A-9

Map Revised: 01 September 2011 amanza

Path: \\tac\Projects\0\0356114\GIS\0356114\06_T600_GW_PCP.mxd

Office: TAC

0 80
Feet

Data Source: Aerial from Aerials Express Seattle, 2009.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
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Concentration Relative to Screening Level:

- ≥100x
- ≥10x and <100x
- >1x and <10x
- ≤1x
- Not Sampled or Practical Quantification Limit (PQL) > Screening Level

Total toxicity equivalent concentration for dioxins/furans calculated according to chapter 173-340-708(8)(d) of the Washington State Model Toxic Control Act Cleanup Regulation (MTCA).

CL-MW-1 Sample Location Identification

Depth Intervals (feet below ground surface)

- 0 to 5
- 5 to 10
- 10 to 20

Site Features

- R.G. Haley International Property Line
- Former Building Footprints
- Inner Harbor Line
- Cornwall Property
- Port Owned Property
- Tideland Lease Area
- Extent of Refuse and Wood Debris
- Sheet Pile Barrier

Data Summary for Dioxins/Furans in Soil

R.G. Haley International Site
Bellingham, Washington

GeoEngineers

Figure A-10

Map Revised: 01 September 2011 amanza

Path: \\tac\Projects\0\0356114\GIS\035611406_T600_Soils_DioxinTEQ.mxd

Office: TAC

0 160
Feet

Data Source: Aerial from Aerials Express Seattle, 2009.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Maximum Concentration Detected During Monitoring Events Relative to Screening Level:

- ≥100x
- ≥10x and <100x
- >1x and <10x
- ≤1x
- No Relevant Data: Not Samples or Practical Quantification Limit (PQL) > Screening Level

Total toxicity equivalent concentration for dioxins/furans calculated according to chapter 173-340-708(8)(d) of the Washington State Model Toxic Control Act Cleanup Regulation (MTCA).

CL-MW-1 Sample Location Identification

Site Features

- R.G. Haley International Property Line
- Former Building Footprints
- Inner Harbor Line
- Cornwall Property
- Port Owned Property
- Tideland Lease Area
- Extent of Refuse and Wood Debris
- Sheet Pile Barrier

Data Summary for Dioxins/Furans in Groundwater

R.G. Haley International Site
Bellingham, Washington

GeoEngineers

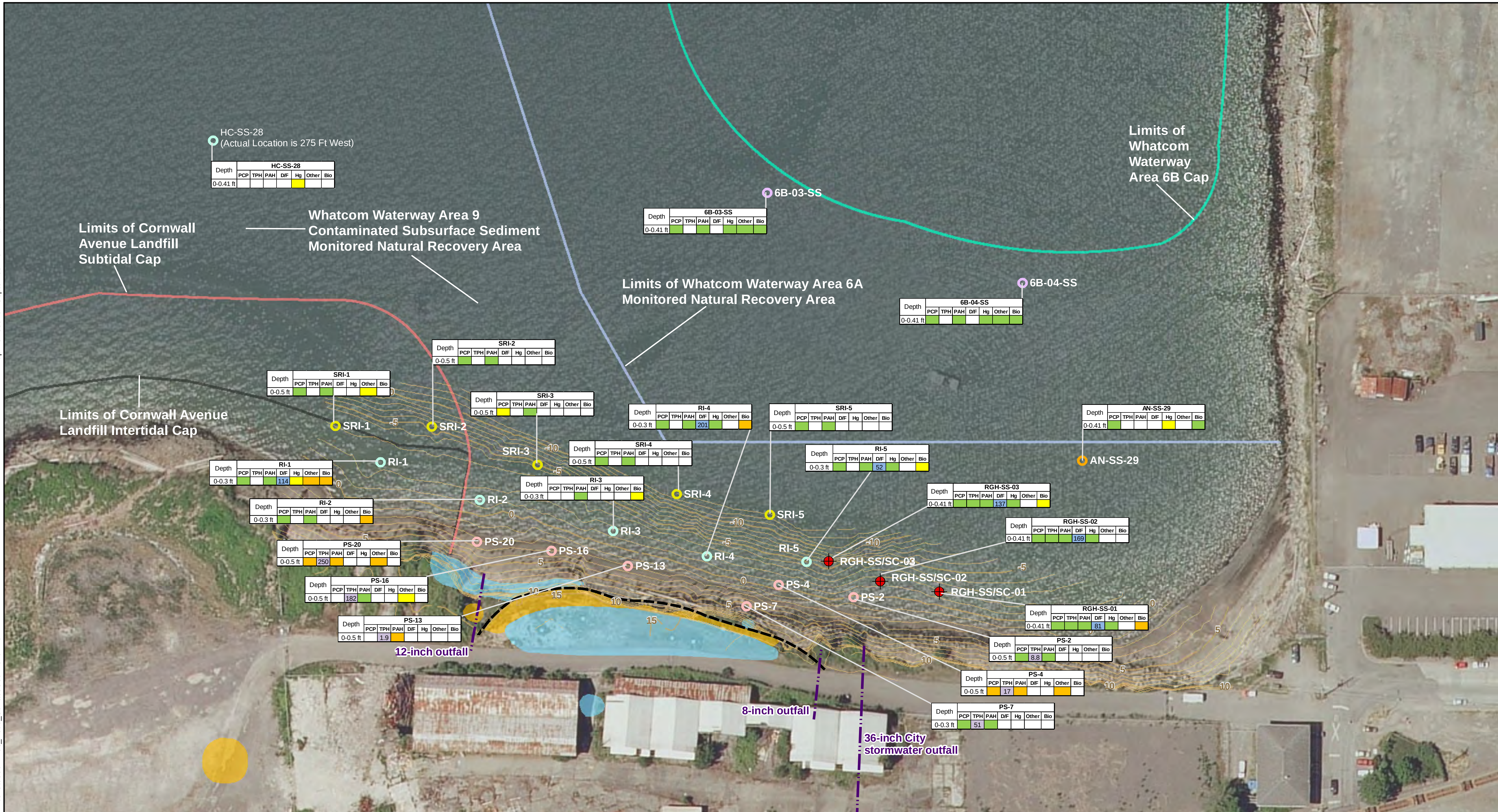
Figure A-11

Map Revised: 01 September 2011 amanza

Path: \\tac\Projects\0\0356114\GIS\035611406_T600_GW_DioxinTEQ.mxd

Office: TAC

APPENDIX B
Sediment Data Summary Figures



Map Revised: 01 September 2011 amanza

Path: \\tac\Projects\0\0356114\GIS\0356114 06_T600_SurfaceSediment.mxd

Office: TACO

0 100

Feet

Reference: Esri World Imagery, 2009.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes.
It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Legend

- Interpolated area with past occurrence of measurable oil as light non-aqueous phase liquid (LNAPL) on groundwater
- Interpolated area with past occurrence of trace oil as LNAPL on groundwater
- Outfalls
- Sheet Pile Barrier
- Bathymetric Contour (1ft)

Sample Type

- Surface Sediment Sample Location
- Surface and Subsurface Sediment Sample

Note: Sample location symbols and designations are gray for locations where the sediment sample type presented in the figure has not been collected.

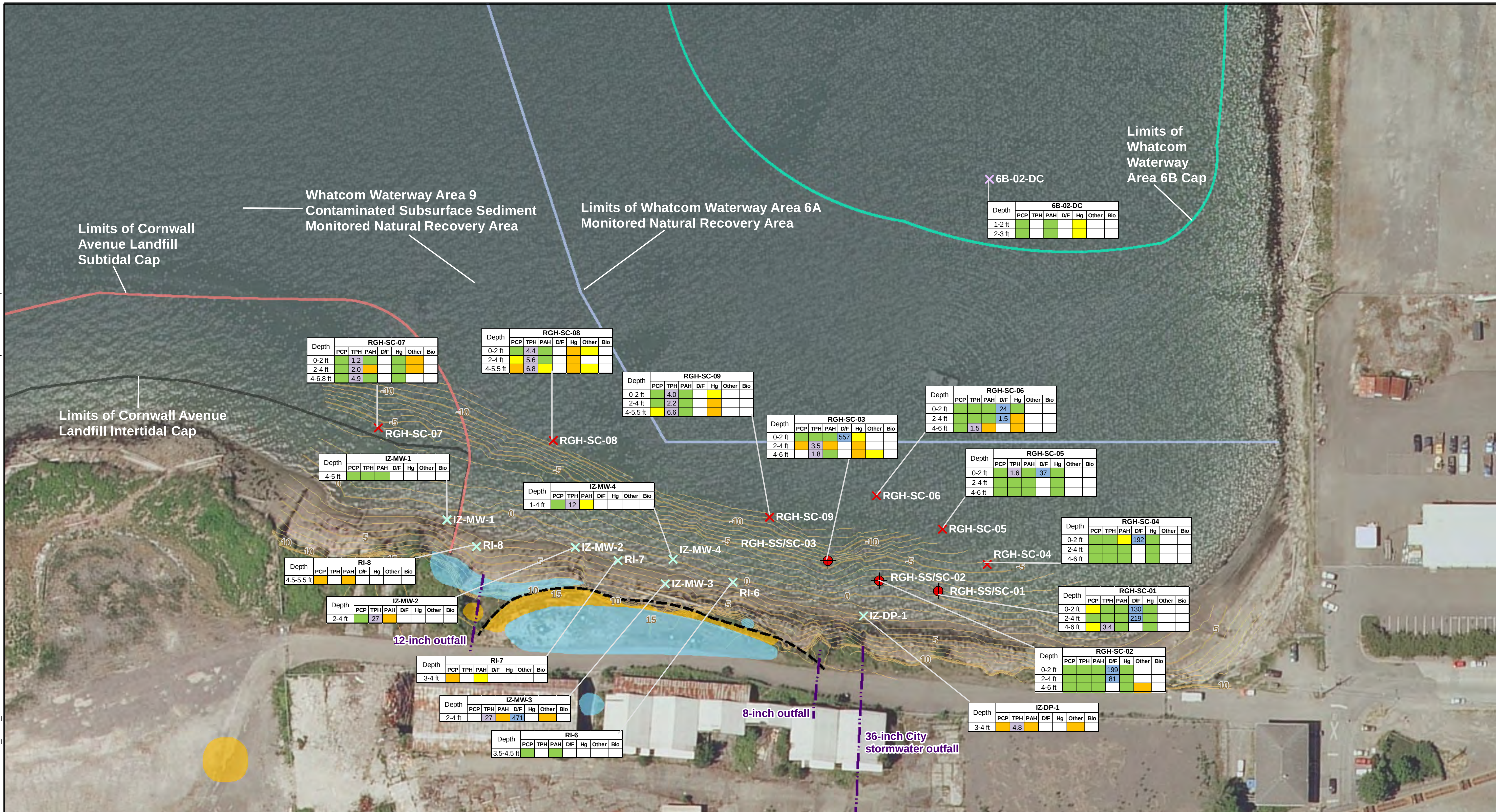
See Figure B-3 for legend description.

Data Summary for Surface Sediment

R. G. Haley International Site
Bellingham, Washington

GeoEngineers

Figure B-1



Map Revised: 01 September 2011 amanza

Path: \\tac\Projects\0\0356114\GIS\035611406_T600_SubSurfaceSediment.mxd

Office: TACO

0 100 Feet

Reference: Esri World Imagery, 2009.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Legend

- Interpolated area with past occurrence of measurable oil as light non-aqueous phase liquid (LNAPL) on groundwater
- Interpolated area with past occurrence of trace oil as LNAPL on groundwater
- Outfalls
- Sheet Pile Barrier
- Bathymetric Contour (1ft)

Sample Type

- × Subsurface Sediment Sample Location
- ⌖ Surface and Subsurface Sediment Sample

Note: Sample location symbols and designations are gray for locations where the sediment sample type presented in the figure has not been collected.

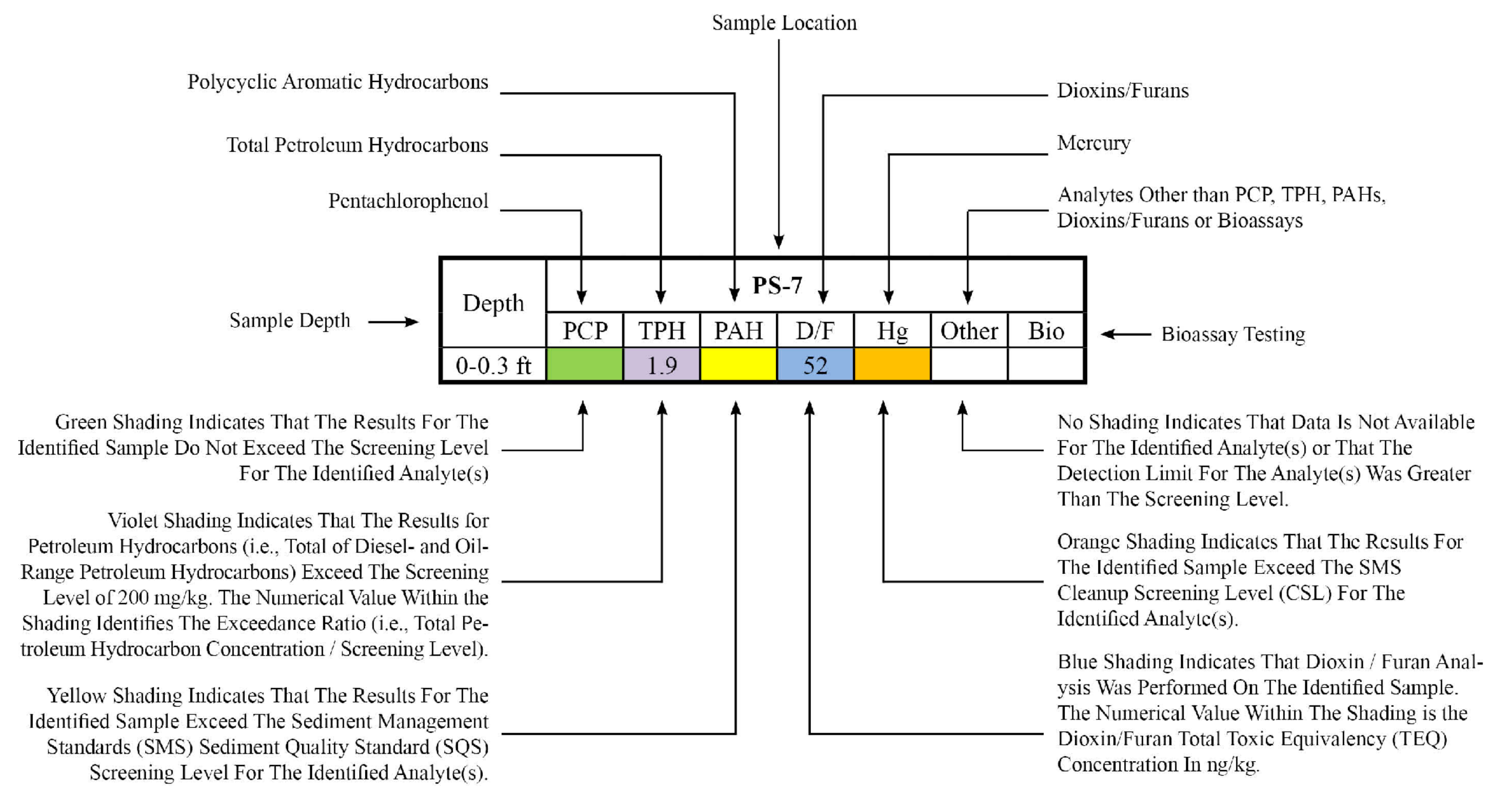
See Figure B-3 for legend description.

Data Summary for Near-Surface and Subsurface Sediment

R. G. Haley International Site
Bellingham, Washington

GeoEngineers

Figure B-2



Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Sediment Results Summary Legend

R.G. Haley International Site
Bellingham, Washington

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Figure B-3

APPENDIX C
Upland Sampling and Analysis Plan

Final Upland Sampling and Analysis Plan

R.G. Haley International Site
Bellingham, Washington

for
City of Bellingham

February 23, 2012

GeoEngineers

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Final Upland Sampling and Analysis Plan

R.G. Haley International Site
Bellingham, Washington

File No. 0356-114-06

February 23, 2012

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1.0 INTRODUCTION

This Upland Sampling and Analysis Plan (SAP) describes the sample collection, handling and analysis procedures for soil and groundwater that will be used to implement the actions outlined in the Work Plan for Supplemental Investigation (Work Plan) for the R.G. Haley International Site (herein referred to as the Haley Site). The Haley Site includes portions of the Haley property, adjacent aquatic lands, and adjacent portions of the Cornwall Avenue Landfill property (Cornwall) and the Whatcom Waterway site (Whatcom Waterway). The full extent of contamination associated with historical operations on the Haley property has not been fully evaluated; therefore, the boundaries of the Site as defined by the Washington State Model Toxics Control Act (MTCA) Cleanup Regulation have not been determined.

The objective of the supplemental investigation is to address data gaps to meet the requirements of MTCA for a remedial investigation and collect sufficient information to allow for a feasibility study of cleanup action alternatives. The Upland SAP has been prepared in general accordance with MTCA, specifically, Chapter 173-340-820 of the Washington Administrative Code (WAC 173-340-820). The supplemental investigation will be conducted in accordance with the Work Plan, this Upland SAP, and the Sediment Sampling and Analysis Plan, and the Quality Assurance Project Plan (QAPP) contained in Appendices D and E, respectively, of the Work Plan.

1.1. Purpose

The purpose of the Upland SAP is to define the specific requirements for sample collection and analytical activities for soil and groundwater to ensure that they are conducted in accordance with technically acceptable protocols and that the results meet the data quality objectives (DQOs). The Upland SAP presents the protocols pertaining to sampling equipment and procedures, and sample handling and analysis that will be implemented during the supplemental investigation of the Haley Site. Sampling objectives and locations are also described. The Upland SAP provides a basis for conducting upland field activities and a mechanism for complying with quality assurance requirements.

1.2. Project Organization and Responsibilities

The key personnel involved in the implementation of the Work Plan are summarized below. Each of these key personnel will ensure that the sampling and analysis activities are conducted in a manner sufficient to meet the project-specific DQOs presented in the QAPP (Appendix E of the Work Plan).

1.2.1. Principal-in-Charge and Project Manager

The Principal-in-Charge has overall responsibility for executing the project in accordance with contractual requirements. Steve Woodward is the Principal-in-Charge. The Project Manager is responsible for coordinating and scheduling project activities, implementing the terms and conditions of this QAPP, interfacing with Washington State Department of Ecology (Ecology) and other agency personnel, selecting project team members, assigning and coordinating project tasks, determining subcontractor participation, establishing and adhering to budgets and schedules, providing technical oversight, and coordinating production and review of project deliverables. Jay Lucas is the Project Manager.

1.2.2. Field Coordinator

The Field Coordinator is responsible for the daily management of activities in the field. Specific responsibilities include:

- Provides technical direction to the field staff.
- Develops schedules and allocates resources for field tasks.
- Coordinates data collection activities to be consistent with information requirements.
- Supervises the compilation of field data and laboratory analytical results.
- Assures that data are correctly and completely reported.
- Implements and oversees field sampling in accordance with project plans.
- Supervises field personnel.
- Coordinates work with on-site subcontractors.
- Schedules sample shipment with the analytical laboratory.
- Monitors that appropriate sampling, testing, and measurement procedures are followed.
- Coordinates the transfer of field data, sample tracking forms, and log books to the Project Manager for data reduction and validation.
- Participates in quality assurance (QA) corrective actions as required.

Robert Miyahira or an alternate designee will be the Field Coordinator.

1.2.3. Quality Assurance Leader

The QA Leader is responsible for coordinating quality assurance/quality control (QA/QC) activities as they relate to the acquisition of field data. Specific responsibilities include the following:

- Serves as the official contact for laboratory data QA concerns.
- Reviews and approves the laboratory QA Plan.
- Responds to laboratory data QA needs, answers laboratory requests for guidance and assistance, and resolves issues.
- Monitors laboratory compliance with data quality requirements.
- Ensures that appropriate sampling, testing, and analysis procedures are followed and that proper QC checks are implemented.
- Reviews the implementation of the QAPP and the overall quality of the analytical data generated.
- Maintains the authority to implement corrective actions as necessary.
- Ensures proper implementation of the QAPP.

- Ensures that GeoEngineers and subcontractor personnel have been properly trained as applicable.
- Reviews project policies, procedures, and guidelines and reviews the project activities to ensure the QA program is being properly implemented.
- Responsible for project-related quality aspects related to the collection and chemical analysis of samples, as delegated by the Project Manager.
- Provides oversight of the data development and review process and of subcontracting laboratories.
- Develops detailed scopes of work for the subcontracting laboratories that incorporate the DQOs described in Section 2.0 of the QAPP.
- Conducts laboratory audits, as necessary, and data validation activities.
- Enters data into Ecology's Environmental Information Management (EIM) system.

Mark Lybeer is the QA Leader.

1.2.4. Laboratory Management

The subcontracted laboratories conducting sample analyses for this project are required to obtain approval from the QA Leader before the initiation of sample analysis to assure that the laboratory QA Plan complies with the project QA objectives. The Laboratory QA Coordinator administers the Laboratory QA Plan and is responsible for QC. Specific responsibilities of the Laboratory QA Coordinator include:

- Ensure implementation of the Laboratory QA Plan.
- Serve as the laboratory point of contact.
- Activate corrective action as necessary when analytical control limits are exceeded.
- Issue the final laboratory QA/QC report.
- Administer QA sample analysis.
- Comply with the specifications established in the project plans as related to laboratory services.
- Participate in QA audits and compliance inspections.

The Laboratory's QA Coordinator will be determined once an Ecology-accredited laboratory is chosen.

1.3. Supplemental Investigation Work Elements

This Upland SAP presents the sampling and analysis details for the upland portion of the supplemental investigation, which will be conducted to assess data gaps identified with respect to soil and groundwater at the Haley Site. The elements of the upland portion of the supplemental investigation are presented in the Work Plan. All of the sampling completed for the upland portion of the supplemental investigation will be conducted in general accordance with Ecology Publication Number 94-49, *Guidance on Sampling and Data Analysis Methods* dated January 1995. The supplemental investigation will also include an investigation of sediment; the SAP for the sediment sampling is provided under separate cover as Appendix D to the work plan.

2.0 SAMPLE LOCATIONS, FREQUENCY AND DESIGNATION

Soil and groundwater will be sampled as part of the upland activities for the supplemental investigation. The objectives and rationale for the proposed sampling locations is presented in the Work Plan. The sampling locations are depicted on Figure 5 of the Work Plan. Table 1 presents a summary of the supplemental investigation work elements, sample locations and frequency. A brief summary is presented below.

2.1. Soil Sample Locations

Soil samples will be collected for laboratory analysis from locations across the upland portion of the Haley property and portions of Cornwall to meet the objectives of the supplemental investigation. Soil samples will be collected from nine soil borings completed using hollow stem auger drill methods, ten soil borings completed using direct-push drill methods and four surface sample locations completed using a hand auger

2.2. Soil Sample Designation

The soil samples collected from direct-push and hand auger borings will be assigned a unique sample identifier that will include the four components listed below.

- A prefix of CL or HS for borings advanced on Cornwall or Haley, respectively;
- A qualifier of SB for soil samples collected from soil borings (subsurface soil) or SS for soil samples collected from hand auger borings (surface soil);
- A sequentially numbered boring identification; and
- The sample depth.

For example, a soil sample collected from a depth of 4 to 8 feet below ground surface (bgs) at direct push boring location 101 on Cornwall would be numbered CL-SB-101-4-8. The sample identification will be placed on the sample label, Field Report form, and Chain of Custody form.

The soil samples collected from hollow stem auger borings will be assigned a unique sample identifier that will include the four components listed below.

- The monitoring well prefix followed by an "S", which will consist of HS-MWS for monitoring wells on the Haley property, CL-MWS for monitoring wells on the Cornwall property, and TL-MWS for monitoring wells located on the northwest side of the Inner Harbor Line;
- The boring identification number; and
- The sample depth.

For example, a soil sample collected from monitoring well location HS-MW-18 at a depth of 20 to 22 feet would be numbered HS-MWS-18-20-22. The sample identification will be placed on the sample label, Field Report form, and Chain of Custody form.

2.3. Groundwater Sample Locations

Groundwater samples will be collected for laboratory analysis from existing monitoring wells and from monitoring wells installed as part of the supplemental investigation. In addition to collecting groundwater samples for chemical analysis, select groundwater monitoring wells will be used for slug testing, LNAPL bail-down testing and a tidal study.

2.4. Groundwater Sample Designation

The groundwater samples collected from monitoring wells will be assigned a unique sample identifier that will include the three components listed below.

- The monitoring well prefix, which will consist of HS-MW for monitoring wells on the Haley property, CL-MW for monitoring wells on Cornwall property, and TL-MW for monitoring wells located in the vicinity of the shoreline;
- The boring identification, which will consist of a sequential number assigned to each location at the time of installation; and
- The date.

For example, the sample collected from monitoring well MW-7 on the Haley Site (HS-MW-7) on October 10, 2011 would be numbered HS-MW-7-10102011. The sample identification will be recorded in the field notes, on the sample label and on the Chain of Custody form.

3.0 SAMPLING EQUIPMENT AND PROCEDURES

The following sections summarize sample collection procedures for soil and groundwater. Table 1 provides details regarding the planned sampling and analytical program.

3.1. Underground Utilities Clearance

Prior to the start of any intrusive activities (i.e., drilling/well installation), exploration locations will be marked in the field using stakes, white marking paint or similar techniques. The following general procedures will be followed for utility clearances. First, the locations of proposed explorations will be visually inspected to determine whether debris or other objects may need to be removed prior to drilling. Next, the location coordinates of the proposed explorations will be determined using a portable global positioning system (GPS) unit. A commercial utility locating service will then inspect the proposed exploration locations and mark any underground utilities in the vicinity. In addition, a call will be placed to the Utilities Underground Location Center (1-800-424-5555) at least 48 hours prior to intrusive activities to arrange for location of underground utilities that may be present. The exploration locations may be modified if necessary to stay clear of utilities.

3.2. Borehole Drilling and Logging

Drilling activities will conform to State and local regulations including WAC 173-160, *Minimum Standards for Construction and Maintenance of Wells*. The planned drilling activities to complete the supplemental investigation include hand auger, direct-push and hollow stem auger drilling methods.

3.2.1. Hand Auger Borings

Four surface soil samples will be collected on the upland portion of the Haley property using a stainless steel hand auger. The hand auger will be used to collect a soil sample between the ground surface and 12 inches bgs. The soil collected from each hand auger boring will be mixed in a dedicated vessel or decontaminated stainless steel bowl to create a homogenous sample prior to collecting in a laboratory-supplied sample container.

3.2.2. Direct-Push Borings

Soil borings will be advanced using direct-push methods to hydraulically drive a probe from the ground surface to bedrock. It is anticipated that bedrock will be encountered in the direct-push borings at depths ranging from 6 to 18 feet bgs except in TL-SB-101. Bedrock is anticipated at a depth of 30 feet bgs in TL-SB-101. The direct-push borings will be terminated once bedrock has been encountered at each location. Soil samples will be collected continuously throughout the total depth of the boring by driving a 4-foot long probe rod through the desired sample interval. The probe rod will be lined with a disposable acetate sleeve which will be removed and opened to reveal the sample after each 4-foot sample interval is driven.

3.2.3. Hollow Stem Auger Borings

Soil borings will be advanced using hollow-stem auger drilling methods to advance a split-spoon sampler from the ground surface to bedrock, estimated to be encountered at depths ranging from 10 feet bgs on the southeast side of the Haley Site to 35 feet bgs on the northwest (shoreline) side of the Haley Site, for lithologic logging and soil sample collection, with the exception of boring TL-MW-12. Boring TL-MW-12 will be completed at a total depth of 13 feet bgs. Monitoring wells will be constructed in the hollow-stem auger borings as described in Section 3.4; for monitoring wells that are not constructed at the total depth of a boring, the boring will be drilled to bedrock and then backfilled to the desired depth for monitoring well construction.

The sampler will consist of an 18-inch split-spoon which will be removed and opened to reveal each sample collected. The soil sample rationale for each hollow-stem auger boring location is as follows:

- CL-MW-101 and CL-MW-102: Soil cores will be collected continuously for field screening and lithologic description. Soil samples will be collected for potential chemical analysis at 5-foot intervals from the ground surface to the total depth of each borings. These borings will terminate at bedrock, which is estimated to be approximately 15 feet bgs.
- HS-MW-17: Soil cores will be collected continuously from the ground surface to the total depth of the boring for field screening and lithologic description. Soil samples will be collected at 5-foot intervals from the ground surface to the total depth of the boring for chemical analysis.

Previous borings completed in the vicinity of HS-MW-17 encountered bedrock at depths ranging from 14 to 16 feet bgs. The boring for HS-MW-17 will be terminated once bedrock has been encountered.

- HS-MW-18: Soil samples will be collected at 5-foot intervals from the ground surface to the total depth of the boring for field screening, lithologic description and chemical analysis. Previous borings completed in the vicinity of HS-MW-18 encountered bedrock at depths of approximately 20 feet bgs. The boring will be terminated once bedrock has been encountered.
- TL-MW-12 and TL-MW-13: Soil cores will be collected continuously for field screening and lithologic description. Soil samples will be collected at 5-foot intervals from the ground surface to the total depth of boring TL-MW-13, which will be completed to bedrock at an estimated depth of 25 feet bgs, for chemical analysis. Soil samples will not be collected from TL-MW-12 because of its proximity to TL-MW-13. Soil samples will not be collected if landfill waste is encountered in boring TL-MW-13.
- TL-MW-14: Soil cores will be collected continuously for field screening and lithologic description. Soil samples will be collected at 5-foot intervals starting at the base of the smear zone and continuing to bedrock, which is estimated to be encountered at approximately 30 feet bgs, for chemical analysis.
- TL-MW-15 and TL-MW-16: Soil samples will be collected at 5-foot intervals from the ground surface to 25-feet bgs for field screening, lithologic description and chemical analysis. Soil cores will be collected continuously from 25-feet bgs to the total depth of each boring for lithologic description and chemical analysis; soil samples will be collected at 5 foot intervals between 25-feet bgs and the total depth of each boring for chemical analysis. Bedrock is anticipated to be located at depths of 35 to 40 feet bgs. The borings will be terminated once bedrock has been encountered.
- Two borings will be completed immediately adjacent to borings TL-MW-15 and -16 for the collection of continuous core samples across the smear zone, as described in Section 3.3.1 below. The core samples will be collected for ultraviolet light photography and petrophysical testing.

Borings TL-MW-14 and -15 will be completed on the upgradient side of the sheetpile wall, where LNAPL is present on groundwater. The borings will be advanced through the LNAPL zone and continue until bedrock is encountered. To reduce the potential for LNAPL and heavily-contaminated soils to be transported deeper into the subsurface during drilling, a temporary conductor casing will be installed from ground surface through the smear zone prior to advancing the boring to bedrock. The conductor casing will be removed once the monitoring wells have been constructed and a seal has been emplaced across the LNAPL smear zone.

3.2.4. Field Logging

The lithology/stratigraphy encountered in drilled borings will be logged by the field geologist or engineer on field forms. Information on the boring logs will include the exploration location; general information about drilling field activities; sampling information such as sample intervals/ depths, sample recoveries and drilling hammer blow counts (when available); and sample description information. Lithologies encountered will generally be described in accordance with ASTM International (ASTM) D 2488 Standard Practice for Description and Identification of Soils

(Visual-Manual Procedure). In addition, identification of the Unified Soil Classification System (United State Geological Survey [USCS]) group symbol will be recorded on the field logs.

Besides the information noted above, additional information to be recorded on field logs includes depth to groundwater/saturated soil, the presence of heaving sand, changes in drilling rate, and other noteworthy observations or conditions, such as the presence or absences of stratification, depth of apparent lithologic contacts and anthropogenic materials in fill.

Management of investigation-derived waste (IDW) generated during drilling (e.g., soil cuttings) is discussed in Section 3.13.

3.2.5. Field Screening

Soil samples will be field-screened for evidence of possible contamination. Field screening results will be recorded on the field logs. The following field screening methods will be used: 1) visual screening, 2) water sheen screening, and 3) headspace vapor screening.

3.2.5.1. VISUAL SCREENING

The soil will be observed for unusual color or staining that may be indicative of contamination.

3.2.5.2. WATER SHEEN SCREENING

This is a qualitative field screening method that can help identify the presence or absence of petroleum hydrocarbons. A portion of the soil sample will be placed in a pan containing distilled water. The water surface will be observed for signs of sheen. The following sheen classifications will be used:

Classification	Identifier	Description
No Sheen	(NS)	No visible sheen on the water surface
Slight Sheen	(SS)	Light, colorless, dull sheen; spread is irregular, not rapid; sheen dissipates rapidly
Moderate Sheen	(MS)	Light to heavy sheen; may have some color/iridescence; spread is irregular to flowing, may be rapid; few remaining areas of no sheen on the water surface
Heavy Sheen	(HS)	Heavy sheen with color/iridescence; spread is rapid; entire water surface may be covered with sheen

3.2.5.3. HEADSPACE VAPOR SCREENING

This is a semi-quantitative field screening method that can help identify the presence or absence of volatile chemicals. As soon as possible after collecting a soil sample, a portion of the sample is placed in a resealable plastic bag for headspace vapor screening. Ambient air is captured in the bag; the bag is sealed and then shaken gently for approximately 10 seconds to expose the soil to the air trapped in the bag. Vapors present within the sample bag headspace are measured by inserting the probe of a photoionization detector (PID) through a small opening in the bag. A PID measures the concentration of organic vapors ionizable by a 10.6 electron volt lamp (standard) in parts per million (ppm) and quantifies organic vapor concentrations in the range between 0.1 ppm and 2,000 ppm (isobutylene-equivalent) with an accuracy of 1 ppm between 0 ppm and 100 ppm.

The maximum ppm value will be recorded on the field report for each sample. The PID will be calibrated to 100 ppm isobutylene.

3.3. Soil Sampling

Soil samples will be collected from borings for lithologic logging and chemical analysis using a decontaminated split-barrel sampler or dedicated acetate liner. Soil samples to be submitted for chemical analysis will be removed from the sampler/liner, placed into laboratory-supplied containers, lightly packed and capped with a plastic lid. The sand-sized and finer fractions of the soil will be targeted for collection. Samples will be selected for analysis based on field screening results and/or sample depth relative to the ground surface or depth of groundwater. The sample containers will be retained on ice and delivered under chain-of-custody (COC) to the analytical laboratory.

Subsurface debris or structures may be encountered in the subsurface, resulting in drilling refusal. Based upon the initial field inspection of planned boring locations, if it is impractical to relocate a boring because of observed or expected obstructions, special sampling equipment may be required to complete the boring at the planned location. This may include a concrete coring device, special drill rig, or excavator equipped with a breaker bar. Procedures for these operations are typically equipment-specific, and will be incorporated into the plan as necessary. In no case should foreign material (such as surface asphalt residue or concrete coring cuttings) be included in a collected sample that is not obviously a part of the in situ soil matrix.

Reusable equipment used to obtain soil samples (e.g., split-barrel samplers) will be decontaminated prior to each use using an aqueous Alconox® or Liqui-Nox® solution and a distilled water rinse as described in Section 3.10.

3.3.1. Samples for Digital Photography and Petrophysical Testing

Core samples to be submitted to PTS Laboratories for digital imaging, including white light (visible light) photography and ultraviolet photography (UV), and petrophysical testing will be undisturbed cores that are immediately frozen by placing on dry ice. Prior to obtaining the cores PTS laboratories will be contacted to arrange for shipping and confirm collection procedures. The core samples will be obtained across the smear zone with a continuous core to be collected beginning 1-foot above the top of the smear zone and extending to 1-foot below the smear zone. The depth interval of the smear zone will be determined during the observation and lithologic description of soil cores collected from borings completed adjacent to TL-MW-15 and TL-MW-16; which will be advanced solely to determine the thickness of the smear zone in these locations.

Cores will be collected using a decontaminated split-barrel sampler with sleeves. Cores will be removed from the sampler as soon as possible and any void space in a sleeve should be covered by saran wrap. The sleeves should be wrapped with saran wrap, secured with clear box tape and each sleeve labeled with boring name, and start and end depth to the tenth of a foot accuracy. The cores will immediately be placed in a cooler containing dry ice. Cores will be shipped at the end of each day to the extent practicable. Additionally, two samples consisting of 1-liter each of groundwater and LNAPL will be obtained and submitted to PTS laboratories. Tests to be conducted by PTS laboratories will likely include:

- Digital core photography using UV light based on core photography methods listed in ASTM D 5079-90 and API RP40. The UV photography will indicate relative hydrocarbon distribution in the soil cores.
- Free product mobility by centrifugal method based on modified ASTM Method D425. The samples for this test will be selected by GeoEngineers based on the results from the UV photography, to represent different lithologies and represent vadose and saturated conditions, as observed at the time of sample collection. Companion centrifuge samples will be centrifuged up to a pressure approximately equal to gravity drainage conditions, removed from the centrifuge and submitted for chemical analyses of petroleum hydrocarbons.
- LNAPL from the site will be tested for density, specific gravity, and kinematic viscosity based on ASTM D1217, D1481, and D445 methods respectively. The groundwater and LNAPL samples will also be analyzed for relative permeability.

3.4. Monitoring Well Construction

Monitoring wells will be installed using hollow-stem auger drilling methods. Monitoring well construction details will be recorded on field forms/logs. Well construction elements are discussed below.

3.4.1. Well Casing

The monitoring wells will be constructed using 2-inch diameter, Schedule 40, threaded, polyvinyl chloride (PVC) casing that meets the following requirements: 1) casing will be new (unused); 2) glue will not be used to join casing sections; casing sections will be joined only by tightening the threaded sections; and 3) casing will be straight and plumb.

3.4.2. Well Screen

Monitoring wells will generally be screened across two zones:

- Water table wells TL-MW-12, HS-MW-17, TL-MW-12, CL-MW-101, and CL-MW-102 will be constructed with screens set across the top of the water table. The screened interval of these wells will not exceed 5 to 10 feet in length.

Deep wells HS-MW-18, TL-MW-13, -14, -15, and -16 will be constructed with 3-foot screen lengths, with the screened intervals to be determined at the time of drilling based on the observed lithologies at those locations.

Well screens will consist of 2-inch diameter, Schedule 40, 0.010-inch or 0.020-inch machine-slotted, PVC well screens. PVC end caps will be installed on the bottom of the well screens.

3.4.3. Filter Pack

The filter pack for the wells will consist of silica sand with the appropriate grain size distribution to limit entry of fine-grained particulates from the surrounding formation into the wells (e.g., 10-20 or 20-40 sand). The filter pack will extend from the bottom of the well screen to at least 1 foot above the top of the well screen. In areas where groundwater is less than 4 feet bgs, the filter pack may be installed flush with the top of the well screen. The top of the sand pack will be sounded to verify its depth during placement.

3.4.4. Annular Seal

The annular seal will consist of a minimum 1-foot thick layer of hydrated bentonite pellets or chips installed between the filter pack and the concrete surface seal.

3.4.5. Surface Completion

Depending on well location, each well will be completed using either flush or aboveground monuments. These two types of surface completions are described below.

For flush completions, the well casing will be cut approximately 3 inches bgs, and a locking j-plug (compression) or similar well cap will be installed to prevent surface water from entering the well. The well monument will be installed in a concrete surface seal. The well number will be marked on the well monument lid and/or the well cap. Where vehicular traffic may pass over the well, the concrete surface seal and well monument will be constructed to meet the strength requirements of surrounding surfaces.

Aboveground monuments will consist of steel or aluminum protective casing installed in a concrete surface seal and extending at least 4 inches above the top of the PVC well casing. A lockable monument cap will be installed on top of the protective casing. A weep hole will be drilled in the side of the protective casing, several inches above the ground surface, to allow for water drainage. Three steel protective posts (3 inches minimum diameter) will be placed in a triangular pattern around the protective casing. The posts will be installed at least 2 feet away from the protective casing and will extend at least 3 feet above and below the ground surface.

Monitoring wells will be secured with locks as soon as possible after drilling. Corrosion-resistant locks will be used. Wherever possible, keyed-alike locks will be used.

3.5. Monitoring Well Development

The new monitoring wells will be developed no sooner than 24 hours after installation to allow the bentonite annular seals to cure. In addition, prior to the preliminary groundwater monitoring and sampling event, existing wells may be redeveloped using the methods described to remove accumulated sediment. At least 48 hours will be allowed to pass after well development before the first round of sampling is conducted to allow the surrounding water-bearing zone to recover from well installation and development.

Before each well is developed, the depth to water in the well and the total well depth will be measured, and the well will be checked for the presence of LNAPL. Monitoring wells with a measureable thickness of LNAPL will not be developed. The new and existing monitoring wells will be developed using a combination of surging and purging. The wells will be purged until at least five well casing volumes have been removed and turbidity has stabilized. The target turbidity is less than 10 nephelometric turbidity units (NTU). (Note that this is only a target, and may not be achieved in all wells.) Water quality parameters (e.g., temperature, pH, conductivity, turbidity) will be measured and recorded on field logs during well purging.

3.6. Groundwater Monitoring

During the preliminary groundwater evaluation, each of the viable monitoring wells in the existing monitoring well network will be sampled for the analytes shown on Table 1. Table 1 also shows the planned analyses for groundwater samples to be collected from new monitoring wells. The monitoring wells that will be evaluated for sampling, and sampled if viable, are shown on Figure 1 of this Upland SAP.

Prior to sampling, each of the monitoring wells will be inspected for signs of tampering or other damage. If tampering is suspected (i.e., casing is damaged, lock or cap is missing), this will be recorded in the field report and on the well sampling form and reported to the Project Manager. Wells that are suspected to have been tampered with will not be sampled until the Field Geologist/ Engineer has discussed the matter with the Project Manager.

Groundwater monitoring activities will be recorded in field reports, and well purging/sampling data will be recorded on groundwater sampling forms.

The following sections describe the activities to be conducted during each groundwater monitoring event.

3.6.1. LNAPL Thickness/Groundwater Level Measurement

LNAPL thickness and groundwater levels will be measured and recorded during each groundwater monitoring event. Standing water inside the outer protective casing or monument around each well casing will be removed prior to opening the well. Wells will be opened and allowed to vent for at least 10 minutes prior to water level measurement.

A decontaminated interface probe will be used to check for the presence of LNAPL in each well. The groundwater level and thickness of any LNAPL in the well will then be measured to the nearest 0.01 feet using the interface probe. Water levels will be measured from a permanent mark located at the top of the well casing.

If LNAPL is encountered in a well, the thickness of the LNAPL will be calculated by subtracting the depth to LNAPL from the depth to groundwater. The water level measurements (and LNAPL thickness, if applicable) will be recorded on the groundwater sampling form.

Following water level measurement, the total depth of the well from the top of the casing will be measured using a weighted measuring tape or electronic sounding device and recorded on the groundwater sampling form. The depth to groundwater will then be subtracted from the total depth of the well to determine the height of the water column present in the well casing.

During each groundwater monitoring event, water level measurements will be taken at all monitoring wells at least once within a one-hour period to determine the elevation of the groundwater table and provide the data needed to prepare groundwater contour (potentiometric) maps for each monitoring event. Any known conditions (e.g., unusually low or high barometric pressure) that may affect groundwater levels will be recorded in the field report. Additionally, the tidal conditions at the time of water level measurement and groundwater sampling will be recorded in the field report.

LNAPL thickness and water level measuring equipment will be decontaminated between each well according to the procedures described in Section 3.10.

3.6.2. Conductivity Vertical Profiling

The objective of this monitoring is to evaluate if conductivity profiling in monitoring wells can distinguish a salt water-freshwater boundary and, if present, the nature and location of the boundary. This method will be most successful in monitoring wells with the longest screens located within the anticipated tidal influence area and do not have LNAPL present. The wells that satisfy these criteria are monitoring wells are HS-MW-6, HS-MW-7, HS-MW-8, TL-MW-1 and TL-MW-9. These wells have 15 feet long screens (other wells have five foot or shorter screens), except for TL-MW-9, which has a screen length of 10 feet. Measurements in these wells will be obtained in-situ through the water column within the well screen interval in approximately two foot increments using a downhole water quality meter in the field. These measurements will be obtained within a time period two hours before and after a high tide. Conductivity will also be measured in a sample of seawater from the Site for comparison purposes.

3.6.3. Well Purging Prior to Sampling

Monitoring wells will be purged prior to sampling using low-flow methods to evacuate standing water in the well that may not be representative of groundwater in the surrounding formation. Before the start of purging/sampling activities, plastic sheeting will be placed on the ground surrounding the well, if necessary, to provide a clean working area around the well and to reduce the possibility of soil contaminants contacting groundwater sampling equipment.

Well purging will be accomplished using new dedicated tubing and a portable peristaltic pump, submersible pump, or bladder pump. The pump intake will be placed near the middle of the well screen interval, and the well will be purged at a target rate of 250 to 500 milliliters (mL) per minute. A flow-through cell and portable water quality meter(s) will be used to monitor water quality parameters during purging. The wells will be purged until water quality parameters have stabilized. Stabilization goals are as follows:

- Temperature ± 1°C
- pH ± 0.1 pH units
- Salinity and/or conductivity/specific conductance ± 3 percent
- Dissolved oxygen ± 0.3 milligrams per liter
- Redox potential (Eh) ± 10 mV
- Turbidity <10 NTU (if 10 NTU cannot be achieved, then ± 10 percent)

The portable water quality meter will be calibrated in accordance with manufacturer specifications prior to use.

3.6.4. Groundwater Sample Collection

Groundwater samples will be collected after water quality parameters have stabilized as discussed above.

Groundwater samples will be collected from each well using a peristaltic pump, submersible pump, or bladder pump and analyzed for the constituents listed in Table 1. The groundwater samples collected for laboratory analysis of dissolved copper will be collected in the field as unfiltered samples and submitted to the analytical laboratory for filtering prior to analysis. Groundwater samples will be collected directly from the pump discharge tubing after disconnecting the tubing from the flow-through cell. Samples for dissolved metals will be field-filtered by attaching a 0.45 micron filter directly in-line with the discharge tubing. Groundwater samples will be collected in labeled, pre-cleaned sample bottles provided by the analytical laboratory. The sample containers will be retained on ice and delivered under COC to the analytical laboratory.

Required sample containers, preservation methods, volumes, and holding times are summarized in Table 5 of the QAPP.

Reusable sampling equipment will be decontaminated prior to commencing sampling activities, and between each well, as discussed in Section 3.10.

3.7. Aquifer Testing

3.7.1. Slug Tests

Slug tests will be performed at a select subset of monitoring wells to evaluate the hydraulic conductivity of distinct, water-bearing geologic units. The slug tests will include a falling head and/or rising head test at each monitoring well. An electronic pressure transducer will be deployed into each slug test well to measure and record pressure, which corresponds to the height of water above the transducer and will be used to calculate rising or falling water level in response to the introduction or removal of the slug in the well. Additionally, the depth to groundwater in each slug test well will be measured manually using an electronic water level meter before, during and after each slug test.

Slug tests will be performed at select monitoring wells screened at different depths and across different geologic units. The slug test wells will be selected following installation of the new monitoring wells (Section 3.4) but are likely to include HS-MW-2, HS-MW-5, HS-MW-6, HS-MW-7, HS-MW-8, HS-MW-9, HS-MW-17, HS-MW-18, TL-MW-7, TL-MW-13, TL-MW-14 and CL-MW-101.

3.7.2. LNAPL Bail-Down Tests

LNAPL bail-down tests will be performed at a subset of monitoring wells located in the vicinity of the sheetpile barrier to evaluate the volume of recoverable LNAPL, or LNAPL transmissivity. Monitoring wells with at least 1-foot of free product, as measured during the preliminary groundwater monitoring and sampling event, will be selected for the LNAPL bail-down test. These wells will likely include TL-MW-2, TL-MW-4, TL-MW-5A, and TL-MW-6. The 10-inch diameter recovery wells will not be used for the LNAPL bail-down test because of their large diameter and the subsequent volume of LNAPL that will require handling, storage and disposal.

Each LNAPL bail-down test will be completed using either a decontaminated, stainless steel or dedicated bailer or peristaltic pump with dedicated polyethylene tubing to remove approximately one well volume of LNAPL, calculated based on the well diameter and measured thickness of LNAPL in the well. Care will be taken to minimize the volume of water removed from the monitoring well during the LNAPL bail-down test. After LNAPL has been removed from the monitoring well to the maximum extent practicable, an electronic oil-water interface probe will be used to measure the depth to water and product thickness in regular intervals until at least 80 percent of the initial thickness of LNAPL measured in the well has recovered or a time period of 6 hours has elapsed. The recovery data will be used to calculate LNAPL transmissivity and recovery rates.

3.8. Tidal Study

A tidal study will be conducted to evaluate the influence of tidal fluctuations on groundwater conditions at the Haley Site Monitoring well pairs that are screened across different vertical intervals and located at varying distances from the shoreline will be chosen for the tidal study to evaluate lateral and vertical tidal influences on groundwater at the Haley Site. The monitoring wells for the tidal study will be selected following the preliminary groundwater monitoring and sampling event and additional monitoring well installation and sampling. The monitoring wells anticipated for inclusion in the tidal study include HS-MW-7, HS-MW-8, HS-MW-15, HS-MW-17, HS-MW-18, TL-MW-10, TL-MW-12, TL-MW-13, TL-MW-14, TL-MW-15, and TL-MW-16.

The tidal study will include monitoring of groundwater levels in at least nine monitoring wells using pressure transducers, programmed to record pressure head in the monitoring wells at regular intervals for at least 72 hours during an extreme tidal cycle. The tidal study will also include measurement of groundwater levels in other monitoring wells on the Haley Site at regular intervals and measurement of tidal fluctuations throughout the duration of the tidal study.

3.9. Stormwater System Evaluation

The purpose of the stormwater system evaluation is to:

- Confirm that the historical stormwater outfalls, including the 12-inch outfall and the 8-inch outfall (see Figure 2A in Work Plan), are inactive; and
- Evaluate whether these two outfalls or the active 36-inch city stormwater outfall (see Figure 2A in Work Plan), may be acting as a preferential migration pathway for Haley Site contaminants to reach sediment.

3.9.1. Site Reconnaissance

A site reconnaissance will be conducted during a substantial rain event to observe the 12-inch outfall and 8-inch outfall. If stormwater discharge is observed, the layout and function of these utilities will be evaluated, including the source of water (if any) that discharges from them, followed by actions to eliminate the discharge.

3.9.2. Evaluation of Stormwater Utilities as Preferential Migration Pathways

An evaluation of all three outfalls will be conducted to determine the potential for contaminated groundwater to preferentially migrate through the backfill material surrounding the pipes or to infiltrate through breaks, cracks or leaks in the pipes and discharge through the outfalls. A preliminary evaluation will consist of a comparison of the elevation of the pipes and the seasonal high groundwater elevations to assess the potential for groundwater infiltration into the pipes or backfill material. Additional details pertaining to the evaluation of the City stormwater outfall are provided in the following section:

3.9.2.1. CITY STORMWATER OUTFALL

The City has already conducted a video survey of a portion of the 36-inch City stormwater outfall pipe to assess its integrity. The scope of work for the supplemental investigation will include a video survey of the remaining portions of the stormwater line, if possible, on the Haley Site to verify the integrity of the pipe and ensure that contaminated soil on the Haley Site is not entering the pipe through cracks, breaks or leaks. The video survey will also identify whether solids are present in the pipe. If the video survey and other site reconnaissance do not identify potential routes for impacted soil on the Haley Site to enter the stormwater pipe, solids in the line (if any) will not be sampled. Alternatively, if potential pathways are identified for impacted soil on the Haley Site to enter the pipe, and solids are present in the pipe, solids will be sampled downgradient of the potential entry point and submitted for laboratory analysis of petroleum hydrocarbons and semivolatile organic compounds (SVOCs), including carcinogenic polycyclic aromatic hydrocarbons (cPAHs) and pentachlorophenol (PCP). If solids are present in a location that cannot be sampled, an alternative approach will be developed to evaluate this potential transport pathway based upon conditions observed in the field.

Based on the results of the groundwater evaluation described above, stormwater from the City stormwater outfall will be sampled for laboratory analysis as part of the supplemental investigation. If the results of the evaluation indicate that groundwater historically has risen above the any part of the line. Stormwater from the line will not be sampled if groundwater has not risen above the line. If collected, the stormwater sample will be submitted for chemical analysis of semivolatile organic compounds, including pentachlorophenol and carcinogenic polycyclic aromatic hydrocarbons, and diesel- and heavy oil-range hydrocarbons. These are the majority of, and most mobile, constituents of concern at the Haley Site.

3.10. Decontamination Procedures

To prevent cross-contamination of collected samples, reusable equipment used to collect samples will be decontaminated prior to sample collection using the following procedures. Deviations from these procedures, if any, will be documented in field notes/logs.

3.10.1. Drilling Equipment

For large pieces of drilling equipment (such as augers, drill rods, drill bits, and those portions of the drill rig that may be positioned directly over a boring location), the following procedure will be used to decontaminate the equipment between borings and upon completion of drilling activities. The equipment will be pressure-washed and, if necessary, scrubbed to remove visible dirt, grime, grease, oil, loose paint, rust flakes, etc. The equipment will then be rinsed with potable water.

Sampling devices will be cleaned using an aqueous Alconox® or Liqui-Nox® solution and a distilled water rinse before each sample is collected.

3.10.2. Reusable Sampling Equipment

Whenever possible, disposable sampling equipment will be used to minimize the need for decontaminating equipment. Prior to and between sample collection, reusable sampling equipment that comes in contact with soil or groundwater will be decontaminated. Reusable sampling equipment may include split-barrel soil samplers, groundwater sampling pumps, interface probes, sounding tapes, trowels, spoons, and other hand tools or sampling/measuring devices.

For soil sampling equipment, excess soil will first be removed from the equipment. The equipment will then be pressure-washed or washed using an aqueous Alconox® or Liqui-Nox® detergent solution and a brush. Detergent will be used to clean surfaces of sampling tools that directly contact samples (e.g., split-barrel core sampler); equipment that does not directly contact samples (e.g., augers) will be pressure-washed and rinsed. Decontaminated equipment will be temporarily staged on clean plastic sheeting, wrapped or covered with aluminum foil, and/or stored in a clean, dry place.

Oil-water interface probes and electronic water level indicators/well sounders used for well gauging will be decontaminated before and after use at each well. Decontamination will be performed as follows:

1. Wipe off any visible LNAPL with disposable towels.
2. Clean measurement probe and tape with an aqueous Alconox® or Liqui-Nox® solution.
3. Rinse with distilled water.
4. If necessary to ensure complete removal of residual LNAPL, measuring devices may also be cleaned with acetone or isopropyl alcohol (IPA) at this stage and rinsed with hexane. If acetone or IPA is used, steps 2 and 3 (with fresh solutions) will be repeated.

If submersible (centrifugal) or bladder-type groundwater purging and sampling pumps are used, they will be decontaminated before and after each use by washing the exterior with an aqueous Alconox® or Liqui-Nox® solution and a brush. The interior of the pump and may be cleaned by first pumping an aqueous Alconox® or Liqui-Nox® solution through the system, followed by distilled water.

3.10.3. Monitoring Well Casing/Screen and Well Development Equipment

Unless brought to the work site in sealed plastic wrappers, new, visually clean well casings and screens will be pressure-washed before they are installed. Additionally, well development equipment (surge block, development pump) will be pressure-washed before use at each well.

3.10.4. Sample Containers

Pre-cleaned sample bottles and jars will be supplied by the subcontracted analytical laboratory. The sample containers will be protected from contact with dust, dirt, and other potential sources of cross-contamination. Sample containers will not be reused.

3.10.5. Used Decontamination Water

Used decontamination water, which may include acetone, IPA and hexane, will be stored on-property in labeled 55-gallon drums for subsequent characterization and off-property disposal at a permitted facility. Investigation Derived Waste (IDW) management is discussed in Section 3.13.

3.11. Field Documentation

Three primary types of field documentation will used for this project: field reports and field forms, sample container labels, and COC forms. A description of each of these documentation methods is provided in the following sections.

3.11.1. Field Reports

Field reports are intended to provide a sufficient record of observations and data to enable participants to reconstruct events that occur during project field activities. They contain factual, detailed and objective information.

Field reports will be used to document the field and sampling activities performed at the project site for each day of field work. Field reports will include the date, time, description of field activities performed, names of personnel and site visitors, weather conditions, areas where photographs were taken (if applicable), and any other data pertinent to the project. Field reports will also contain sample collection and identification information and (if appropriate) a drawing of each area sampled, along with the locations (coordinates) where samples were collected. Sample data recorded in field reports will include the sample date, time, location, identification number, matrix, collection method, analyses to be performed, any comments and the sampler's name. Locations and unique identification of soil samples collected from excavations or stockpiles will be recorded in the field report or an attached site map, and/or other appropriate form. Field reports will also document any safety issues; quality control samples collected (e.g., duplicate samples, equipment rinsate blanks); calibration checks of field monitoring/measuring instruments (e.g., PID, water quality meter); field measurements; and IDW disposition (e.g., number of drums generated and their contents and location).

Soil boring and well installation information will be recorded on boring logs and well logs attached to the field report. A groundwater/well sampling and/or development record will be used for each well to record the information collected during water sampling and/or well development.

Following review by the project manager, the original field records will be kept in the project file.

3.11.2. Sample Labels

Sample containers will be clearly labeled with waterproof black ink at the time of sampling. Sample labels will include the following information:

- Project/site name;
- Sampling date;
- Sampling time;
- Sample identification number;
- Preservation used, if any; and
- Initials of sampler.

The same information entered on the sample label will be recorded on the COC form and in the field report.

3.11.3. Chain-of-Custody Forms

Samples will be retained in the field crew's custody until samples are delivered to the analytical laboratory. After samples have been collected and labeled, they will be maintained under COC procedures. These procedures document the transfer of custody of samples from the field to the laboratory. Each sample sent to the laboratory for analysis will be recorded on a COC form.

The COC form documents sample names, dates, times, and analyses to be performed for each sample, as well as all transfers of sample custody from the field to the analytical laboratory. The COC form will be completed using waterproof ink. Any corrections will be made by drawing a line through and initialing and dating the change, then entering the correct information.

When transferring custody of samples, the individuals relinquishing and receiving them will sign, date, and note the time on the COC form. Sample coolers shipped by common carrier will have the COC form enclosed in a resealable plastic bag and placed in the sample cooler prior to sealing the cooler for shipping. Custody seals will be used on sample coolers that are shipped by common carrier or delivered by courier to the laboratory. The sample shipping receipt will be retained in the project files as part of the COC documentation. The shipping company will not sign the COC forms as a receiver; instead the laboratory will sign as a receiver when the samples are received. Internal laboratory records will document custody of the samples from the time they are received through final disposition.

3.12. Surveying

Exploration locations will be surveyed by GeoEngineers field crews or a professional land surveyor.

3.12.1. Surveying by Field Crews

3.12.1.1. VERTICAL CONTROLS – LASER LEVEL SURVEYING

Each exploration location or monitoring well casing rim and ground surface elevation will be surveyed by GeoEngineers field personnel using a laser level. Elevations will be referenced to a known elevation, such as a permanent survey benchmark or a nearby well that has been surveyed. The vertical survey will have an accuracy of 0.01 feet.

3.12.1.2. HORIZONTAL CONTROLS – GPS

The horizontal coordinates of exploration locations will be determined using a hand-held Trimble GeoXT® GPS unit or similar equipment. GeoEngineers field personnel will log the exploration location names and coordinates in the GPS unit for subsequent downloading to a computer. GPS data collected in the field will be processed in the office using measurements from the nearest reference station to each data collection point.

3.12.2. Surveying by Professional Land Surveyor

The exploration locations will be marked using stakes and/or flagging to allow surveying of the locations by a Washington-licensed professional land surveyor. The surveyors will measure and record the vertical and horizontal coordinates or each exploration location. Elevations will be measured to the nearest 0.01 feet relative the North American Vertical Datum of 1988 (NAVD88) which is the vertical datum used by Ecology and the City of Bellingham. Horizontal coordinates will be referenced to the Washington State Plane North coordinate system. The horizontal survey will have an accuracy of 0.10 feet.

3.13. Investigation Derived Waste

IDW will be placed in labeled storage containers or placed on visqueen and covered with visqueen and will be staged on the upland portion of the Haley property in the designated containment area located within the area bounded by Ecology blocks, which is located within a fenced portion of the Site. Each waste container will be labeled, secured and properly stored on Site and managed and disposed according to applicable local, State, and Federal regulations.

3.13.1. Soil

Soil cuttings from borings will be placed in 55-gallon drums marked with the contents, date, and contact information and placed in the containment area. Soil cuttings from known impacted areas may be placed on visqueen and covered with visqueen.

3.13.2. Groundwater and Decontamination Water

Well development and purge water removed from monitoring wells and decontamination water generated during sampling activities, will be placed in 55-gallon drums marked with the contents, date and contact information. The drums will be placed in the containment area.

3.13.3. Incidental Waste

Incidental waste generated during field activities includes items such as disposable personal protective clothing, gloves, and sampling supplies such as aluminum foil, paper towels, plastic bags/sheeting, and similar discarded materials. These materials will be placed in plastic garbage bags or other appropriate containers. These containers will be removed from sampling areas daily and placed in a central staging area on the upland portion of the Haley property. At the completion of the field investigation, incidental waste will be removed from the staging area and disposed of as municipal waste at a local trash receptacle or county disposal facility.

4.0 SAMPLE HANDLING

4.1. Sample Containers and Preservation

Requirements for sample containers, sample preservation, and sample holding times for the planned laboratory analyses are discussed in the QAPP (Appendix E of the Work Plan).

4.2. Sample Packaging and Shipping

Each sample submitted for laboratory analysis will be assigned a unique identification number, and will be labeled and recorded on field forms and the COC form, as discussed in Section 3.11. Labels for sample containers will be filled out completely with all appropriate information. Samples will then be packed on ice in a cooler for delivery to the analytical laboratory. The samples will be either hand-delivered to the laboratory by field personnel or courier, or shipped via a commercial carrier. Custody seals will be used on sample coolers that are not hand-delivered by field personnel. Samples submitted for digital photography and petrophysical testing will be frozen soon after collection and kept frozen until received by PTS Laboratories. These samples will be shipped by commercial carrier.

Upon receipt of the sample coolers at the laboratory, the custody seals (if present) will be broken, the condition and temperature of the samples will be recorded, and the COC forms will be signed to document transfer of sample custody. The COC forms will be used internally in the laboratory to track sample handling and final disposition.

5.0 LABORATORY ANALYTICAL METHODS

The analytical methods to be used for sample analysis are listed in Table 1. Details regarding analytical methods, sample containers, sample preservatives, and sample holding times are discussed in the QAPP (Appendix E of the Work Plan).

6.0 QUALITY ASSURANCE AND QUALITY CONTROL REQUIREMENTS

The QAPP (Appendix E of the Work Plan) discusses quality assurance and quality control (QA/QC) requirements in detail.

TABLE 1

FIELD INVESTIGATION SUMMARY
SOIL AND GROUNDWATER INVESTIGATION

R.G. HALEY INTERNATIONAL SITE

BELLINGHAM, WASHINGTON

Data Gap		Location	Purpose	Scope/Rationale	Soil Sampling and Analysis Details		Chemical Analysis[1]						
					Field Screening and Sample Collection Intervals (feet below ground surface)	Chemical Analysis Intervals (feet below ground surface)	TPH-Dx	SVOCs	cPAHs	PCP	Copper	BTEX	Dioxins/ Furans
							Ecology NWTPH-Dx with silica gel cleanup	EPA 8270/8270-SIM (Standard & Low-Level), EPA 8041			EPA 6010/6020 /7271	EPA 8260B-Low Level	EPA 1613 Modified-Low level
1	Subsurface Geology and Hydrogeology	HS-MW-17 and HS-MW-18	Evaluate the nature of the fill material and the presence of native soil and discrete permeable zone between the fill material and bedrock, characterize vertical lithology.	These are new borings/wells, Advance five borings through the fill and native soil, if present. Borings will terminate where bedrock (GMD or Chuckanut Formation) is encountered.	5-foot intervals from ground surface to bedrock plus one just above bedrock	Physical characterization only, see details for Data Gap 3 for chemical analysis of soil samples collected from these borings	Physical characterization only, see details for Data Gap 3 for chemical analysis of soil samples collected from these borings.						
		TL-SB-101											
		TL-MW-13 through TL-MW-16											
		HS-MW-2	Evaluate hydraulic characteristics of fill and native soil.	Complete slug tests at monitoring wells screened across the different lithologic units. Slug tests are planned for monitoring wells HS-MW-2, HS-MW-5 HS-MW-6, HS-MW-7, HS-MW-8, HS-MW-9 , TL-MW-7 and new wells HS-MW-17 and 18 and TL-MW-12 and 13, if these wells do not contain LNAPL.	NA	NA							
		HS-MW-5 through HS-MW-9											
		HS-MW-17 and HS-MW-18											
		TL-MW-7, TL-MW-12 and TL-MW-13											
		CL-MW-101											
		HS-MW-7 and HS-MW-8, HS-MW-15, HS-MW-17 and HS-MW-18, TL-MW-10, TL-MW-12, TL-MW-13 and TL-MW-14	Evaluate vertical and horizontal groundwater gradients, lateral and vertical tidal influence and hydraulic properties of screened units.	Deploy transducers into wells for a minimum 72-hour period to record hydraulic heads during complete tidal cycle.	NA	NA							
2A	Preliminary Groundwater Evaluation	All existing and viable (accessible and useable) monitoring wells on Haley property and selected wells on Cornwall.	Evaluate LNAPL and groundwater conditions at existing monitoring wells. Conduct LNAPL bail down tests selected wells.	Collect groundwater level measurements and gauge LNAPL thickness to evaluate current groundwater and LNAPL conditions. LNAPL bail down tests will be conducted on some monitorong wells with greater than one-foot thickness of LNAPL to develop estimates of LNAPL transmissivity. These wells will likely include TL-MW-2, TL-MW-4, TL-MW-5A, and TL-MW-6.	NA	NA	NA						
			Evaluate current nature and extent of COPCs in groundwater at existing monitoring wells.	Sample monitoring wells with no measurable thickness of LNAPL to evaluate current groundwater quality.	NA		G	G	G	G	G [2]	G [3]	G [4]
2B	Install Additional Monitoring Wells and Collect Groundwater Samples for Chemical Analysis	TL-MW-12	Evaluate the lateral extent of LNAPL.	Install monitoring well screened across the water table, estimated screened interval is 3 to 13 feet bgs, and gauge monitoring well for the presence of LNAPL.	No soil samples collected during drilling because of proximity to monitoring well TL-MW-13, which will be sampled continuously	No chemical analysis							
		HS-MW-17	Evaluate the lateral extent of COPCs in groundwater.	Install monitoring wells screened across the water table, estimated screened interval for each well is 4 to 9 feet bgs, and sample the wells for dissolved-phase COPCs.	NA	NA	G	G	G	G	G		
		CL-MW-101					G	G	G	G			
		CL-MW-102					G	G	G	G			
		HS-MW-18	Evaluate the vertical extent of COPCs in groundwater.	Install monitoring wells screened within a water-bearing native soil between the fill and the GMD or bedrock, estimated screened interval is 3 feet. If a permeable layer of sufficient thickness to screen is not encountered above bedrock the well will not be constructed. TL-MW-13 is located in refuse area on Cornwall: a well will be constructed only if native soil is encountered below the refuse.	NA	NA	G	G	G	G	G		G
		TL-MW-13					G	G	G	G		G	
		TL-MW-14					G	G	G	G			G
		TL-MW-15					G	G	G	G	G		
		TL-MW-16					G	G	G	G			

Data Gap		Location	Purpose	Scope/Rationale	Soil Sampling and Analysis Details		Chemical Analysis[1]						
					Field Screening and Sample Collection Intervals (feet below ground surface)	Chemical Analysis Intervals (feet below ground surface)	TPH-Dx	SVOCs	cPAHs	PCP	Copper	BTEX	Dioxins/ Furans
							Ecology NWTPH-Dx with silica gel cleanup	EPA 8270/8270-SIM (Standard & Low-Level), EPA 8041			EPA 6010/6020 /7271	EPA 8260B-Low Level	EPA 1613 Modified-Low level
3	Evaluate the extent of COPCs in soil	HS-MW-17 (bedrock at approximately 16 feeet bgs)	Evaluate the vertical extent of COPCs in soil.	Collect and analyze soil samples from the ground surface to the total depth of each boring, including one sample collected immediately above bedrock at the base of each boring.	5-foot intervals from ground surface to bedrock plus one just above bedrock	All samples collected	S-3	S-3	S-3	S-3			
		HS-MW-18 (bedrock at approximately 20 feet bgs)				All samples collected	S-4	S-4	S-4	S-4			
		TL-SB-101 (bedrock estimated at 30 feet bgs)				All samples collected	S-6	S-6	S-6	S-6			
		TL-MW-13 (bedrock estimated at 30 feet bgs)				All samples collected	S-6	S-6	S-6	S-6			
		TL-MW-14 (bedrock estimated at 35 feet bgs)		Collect soil cores for ultraviolet fluorescent screening and petrophysical testing between 5 and 15 feet bgs	Continuously from the ground surface to 15 feet bgs; 5-foot intervals from 15 feet bgs to bedrock plus one just above bedrock	5-foot intervals beginning at the base of the smear zone (estimated to be 20 feet bgs) to bedrock plus one just above bedrock	S-4	S-4	S-4	S-4			S-4
		TL-MW-15 (bedrock estimated at 35 feet bgs)					S-4	S-4	S-4	S-4			
		TL-MW-16 (bedrock estimated at 40 feet bgs)					S-5	S-5	S-5	S-5			
		HS-SB-101 (bedrock at approximately 16 feet bgs)		Evaluate COPCs in soil beneath the former building	5-foot intervals from ground surface to bedrock plus one just above bedrock	All samples collected	S-3	S-3	S-3	S-3			
		HS-SB-102 (bedrock at approximately 11 feet bgs)		Evaluate vertical extent of COPCs between the deepest sample analyzed from HS-MW-4 at 7 feet bgs and bedrock at 11 feet bgs		One sample just above bedrock, estimated 10 feet bgs	S-1	S-1	S-1	S-1			
		HS-SB-103 (bedrock at approximately 13 feet bgs)		Evaluate vertical extent of COPCs between the deepest sample analyzed from HS-MW-3 at 6.5 feet bgs and bedrock at 13 feet bgs		Samples collected at 10 feet bgs and just above bedrock	S-2	S-2	S-2	S-2			
		HS-SB-104 (bedrock at approximately 16 feet bgs)		Evaluate COPCs in soil beneath the former building		All samples collected	S-3	S-3	S-3	S-3			
		HS-SB-105 (bedrock at approximately 10 feet bgs)		Define extent of PCP in soil above bedrock, which is estimated to be at 10 feet bgs		All samples collected	S-2	S-2	S-2	S-2			
		CL-SB-101 (bedrock at approximately 10 feet bgs)	Evaluate the lateral extent of COPCs in soil exceeding the screening levels. These borings are located on Cornwall.	Collect and analyze soil samples from the ground surface to the total depth of each boring, including one sample collected immediately above bedrock at the base of each boring.	5-foot intervals from ground surface to bedrock plus one just above bedrock	All samples collected	S-2	S-2	S-2	S-2			
		CL-SB-102 (bedrock at approximately 15 feet bgs)				All samples collected	S-2	S-2	S-2	S-2			
		CL-SB-103 (bedrock at approximately 15 feet bgs)				All samples collected	S-2	S-2	S-2	S-2			
		CL-SB-104 (bedrock at approximately 15 feet bgs)				All samples collected	S-2	S-2	S-2	S-2			
		CL-MW-101	Evaluate COPC concentrations at well-screened interval	Collect and analyze one soil sample corresponding to the depth of the monitoring well screeed interval	5-foot intervals from the ground surface to bedrock	One sample collected between 4 and 9 feet	S-1	S-1	S-1	S-1			
		CL-MW-102				One sample collected between 4 and 9 feet	S-1	S-1	S-1	S-1			
		HS-SS-101 through HS-SS-104	Evaluate the lateral extent of dioxins/furans in shallow soil exceeding the screening levels.	Collect one surface soil sample at each location for laboratory analysis.	Composite soil sample collected from ground surface to 12 inches bgs.	One composite sample from each location							S-4

Notes

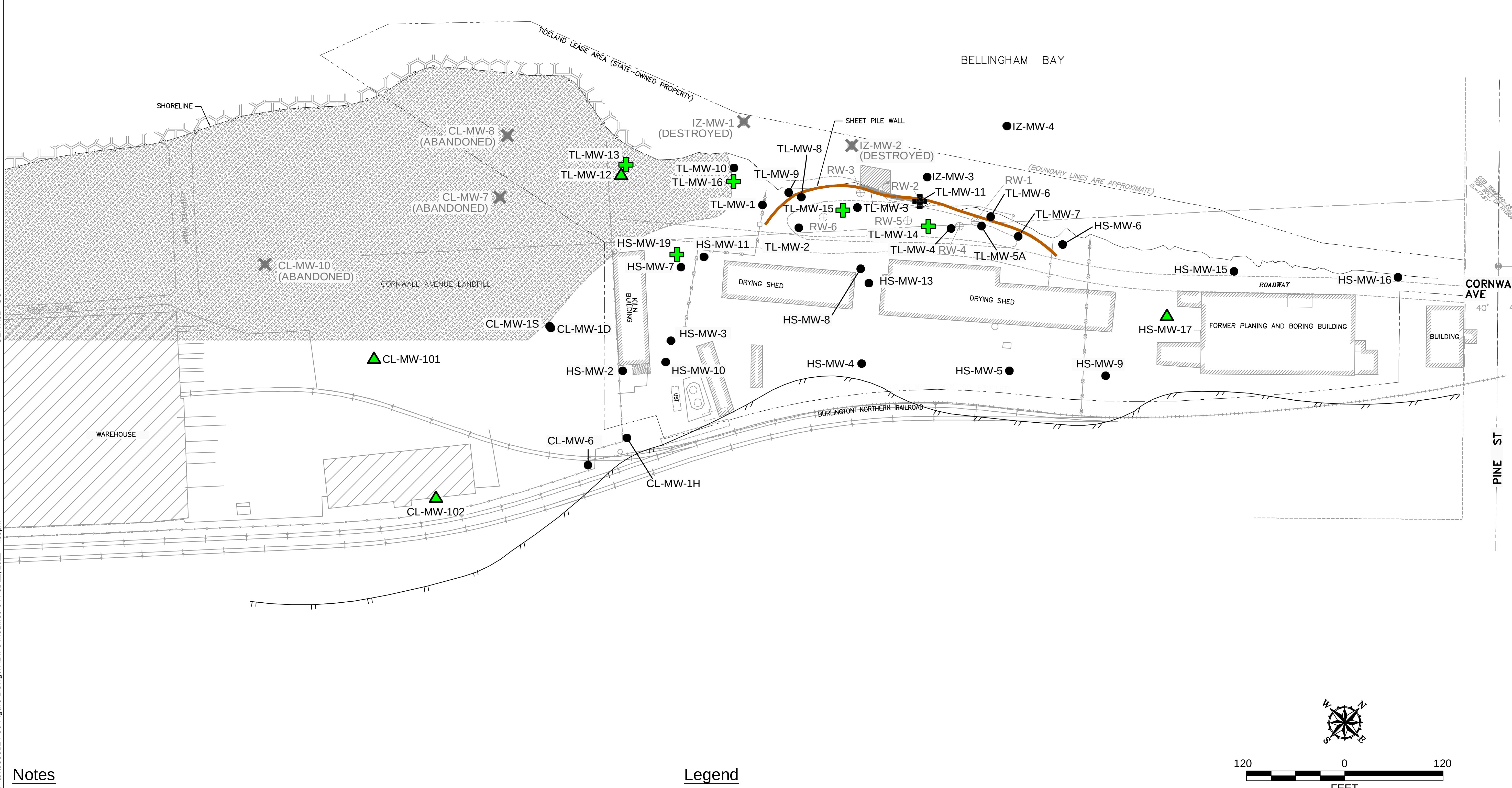
[1] Planned chemical analysis are identified with a "G" for groundwater and "S" for soil. The anticipated number of soil samples submitted for chemical analysis from each exploration is denoted by a number following the "S".

[2] Groundwater samples will be collected from the following monitoring wells for laboratory analysis of copper: HS-MW-11, HS-MW-13, TL-MW-10

[3] Groundwater samples will be collected from the following monitoring wells for laboratory analysis of BTEX: HS-MW-11, HS-MW-13 and TL-MW-10

[4] Groundwater samples will be collected from the following monitoring wells for laboratory analysis of dioxins/furans: HS-MW-13, HS-MW-15, TL-MW-11 and CL-MW-1S

bgs = below ground surface
BTEX = benzene, toluene, ethylbenzene and xylenes
COPCs = constituents of potential concern
EPA = U.S. Environmental Protection Agency
LNAPL = light non-aqueous phase liquid
NA = not applicable
PAHs = polycyclic aromatic hydrocarbons
PCP = pentachlorophenol
TPH = total petroleum hydrocarbons



SEAT:JL : SCY

\\Sea\Projects\0\0356114\06\CAD\Revised Work Plan\0356114-06 Figure 1.dwg\TAB:F6 modified on Feb 22, 2012 - 4:35pm

Notes

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: CAD files "R2000geoeng_haleybase50x" revised 07/28/04 by Pacific Survey & Engineering Inc., file "Fig3-8" dated August 2002 by Landau Associates, and files "027500201T1LM" and "027500201T1A" dated 03/29/04 by GeoEngineers.

Legend

- TL-MW-13 (green cross): Proposed Deep Monitoring Well
- TL-MW-11 (black cross): Existing Deep Monitoring Well
- CL-MW-101 (green triangle): Proposed Shallow Monitoring Well
- HS-MW-4 (black dot): Existing Shallow Monitoring Well
- RW-1 ⊕: Recovery Well (will not be sampled)
- UST: Underground Storage Tank
- Upgradient Extent of Shallow Aquifer
- Sheetpile Barrier
- Estimated extent of upland refuse based on Landau Associates, January 27, 2003, Ecology Review Draft RI/FS Cornwall Avenue landfill, Bellingham, Washington, Figure 3-8
- Riprap Shoreline

Proposed and Existing Monitoring Wells

R.G. Haley International Site
Bellingham, Washington

GeoEngineers

Figure 1

Appendix D
Sediment Sampling and Analysis Plan

Final Sediment Sampling and Analysis Plan

R.G. Haley International Site
Bellingham, Washington

for
City of Bellingham

February 23, 2012

GeoEngineers

Plaza 600 Building
600 Stewart Street, Suite 1700
Seattle, Washington 98101
206.728.2674

Final Sediment Sampling and Analysis Plan

R.G. Haley International Site
Bellingham, Washington

File No. 0356-114-06

February 23, 2012

Prepared for:

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Attention: Sam Shipp, PE

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GRL:IHW:SCW:csv

GeoEngineers

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1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) summarizes field procedures for conducting Site investigation activities at the R.G. Haley Site (Site), generally located at 500 Cornwall Avenue in Bellingham, Washington (Figure 1). Objectives of the sediment investigation are discussed in the Work Plan. The purpose of the sampling is to further delineate the extent of sediment contamination at the Site and to fill data gaps identified from a review of data from previous investigations. The SAP will be used in conjunction with the Work Plan, project Quality Assurance Project Plan (QAPP) and Health and Safety Plan (HASP).

Detailed descriptions of sediment sampling procedures are provided in this document. Soil and groundwater sampling procedures are described in a separate SAP, and procedures for an aquatic habitat survey are described in a separate Dive Plan. Site conditions may make it necessary to modify the procedures described in this SAP. Substantial variations or modifications that become necessary during the investigation will be communicated with the City of Bellingham, the Washington State Department of Ecology (Ecology), and other involved parties as appropriate. Variations or modifications implemented during the investigation and the reason for the modification will be documented in field records.

The purpose of this SAP is to describe field activities, sampling equipment, sampling locations and procedures that will be used during this investigation. The QAPP identifies quality assurance/ quality control (QA/QC) procedures that will be implemented during sampling activities and laboratory analyses.

2.0 SAMPLING OBJECTIVE AND GENERAL APPROACH

The objective of sediment sampling at the Site is to further characterize the nature and extent of contaminants and biological impacts resulting from site contaminants in surface, near-surface and subsurface sediment, defined as follows:

- Surface sediment – samples collected from the sediment surface (mudline) to a depth of 12 centimeters (cm).
- Near-surface sediment – samples collected from the mudline to a depth of approximately 2 feet.
- Subsurface sediment – samples collected from depths greater than 2 feet below the mudline.

Contaminants identified in Site sediment during previous investigations that are to be further characterized using the procedures specified in this SAP include:

- Diesel- and oil-range petroleum hydrocarbons;
- SVOCs including pentachlorophenol (PCP) and polycyclic aromatic hydrocarbons (PAHs);
- Dioxins and furans; and
- Mercury.

The sediment investigation will be conducted in intertidal and subtidal areas that may make it necessary to alter the sampling approach (i.e., sample collection methodology) due to tide elevation at the time of sampling and sediment surface conditions. Certain samples are anticipated to be collected from land using a track-mounted sonic drill rig if the low tide duration is adequate when sampling is scheduled to be performed. Other sediment samples will be collected over water using sampling equipment (including a Van Veen sampler and sonic drill rig) deployed from a sampling vessel (i.e., boat and/or barge).

A phased approach will be used for sediment sampling and analysis, as described below. Table 1 contains a summary of the sampling and analysis approach and rationale. The sampling locations at the Site are shown on Figure 2.

2.1. Phase I:

- Collection of surface sediment samples from the mudline to 12 centimeters (cm) below the mudline at eight locations (COB-SS-01 through COB-SS-08) at the Site. These samples will be collected from a sampling vessel (i.e., boat, etc.) using a Van Veen or modified Van Veen sampler. Samples collected from five locations (COB-SS-01 through COB-SS-05) will undergo a combination of chemical analysis and bioassay testing as identified in Table 1. Additionally, surface sediment samples will be collected from the Samish Bay reference area and will undergo a combination of conventional analyses and bioassay testing (Table 1). Samples collected from three locations (COB-SS-06 through COB-SS-08) will be archived at the analytical laboratory for possible future analysis of dioxin/furan (Table 1).
- Collection of sediment cores from five locations (COB-SC-01 through COB-SC-09) using a sonic drill rig. The sonic drill rig will be operated from land or a sampling vessel (i.e., barge) depending on the sampling location. Continuous sediment cores will be collected and logged from the mudline through sediment/fill containing anthropogenic material and into underlying native sediment deposits. Selected sediment core samples will be analyzed for a combination of chemical and conventional parameters including diesel- and oil-range petroleum hydrocarbons, SVOCs, dioxins/furans, mercury, total solids, total organic carbon (TOC), and grain size.

2.2. Phase II:

Based on the results of Phase I sampling, an additional Phase II sampling event may be performed consisting of the following:

- Collection of additional surface sediment samples from a sampling vessel using a Van Veen or modified Van Veen sampler. The number of samples to be collected and the analyses to be performed will be based on the results of Phase I sampling.

The proposed coring is anticipated to provide sufficient information to develop cleanup alternatives for sediment at the RG Haley Site. It is anticipated that additional coring may be warranted to further refine remedial activities to be performed at the Site. If additional coring is warranted, it is anticipated that the coring would be associated with pre-remedial design studies performed to support development of the selected remedial design for the Site. Any additional coring that is performed will be coordinated with Ecology.

Sediment Management Standards (SMS) criteria and project screening levels, recommended sample preparation and analytical methods, sediment sample volumes and containers for conventional and chemical analyses, and storage temperatures and holding times are presented in the QAPP.

3.0 PERSONNEL AND RESPONSIBILITIES

The following GeoEngineers personnel will have key roles and responsibilities for sediment sampling and analysis activities:

Project Management: Iain Wingard of GeoEngineers will be the project manager for sediment sampling and analysis tasks and will have overall responsibility for implementation of the sediment sampling and analysis program and data evaluation. As Project Manager he will be responsible for the overall quality assurance for sediment sampling and analysis on this project to ensure that it meets technical requirements.

A portion of the sediment sample collection field work and analysis may be performed by a party contracted to the United States Environmental Protection Agency (EPA), under a Targeted Brownfileds Assessment Grant. If this occurs, Iain Wingard of GeoEngineers will coordinate with the EPA personnel and EPA's subcontractor(s) for collection and analysis of the sediment samples and communication of project quality assurance requirements during Phase I and Phase II sampling.

Field Coordinator: The Field Coordinator will be Garrett Leque of GeoEngineers. Garrett will be responsible for performing sediment sample collection in accordance with the methods and procedures described in this SAP. His duties will include coordination of field sampling efforts and interaction with the laboratory, in addition to interpretation of analytical data. Responsibilities will also include complying with the site-specific HASP.

As stated above, a portion of the sediment sample collection field work and analysis may be performed by a party contracted to the EPA, under a Targeted Brownfileds Assessment Grant. If this occurs, Garrett Leque of GeoEngineers will assist the EPA personnel with collection of sediment samples and analysis during Phase I and Phase II sampling.

Quality Assurance Leader: Mark Lybeer of GeoEngineers will be the GeoEngineers QA Leader. The QA Leader is responsible for coordinating GeoEngineers QA/QC activities as they relate to the acquisition of field data.

Specific responsibilities include the following:

- Serves as GeoEngineers official contact for laboratory data QA concerns.
- Reviews and approves the laboratory QA Plan for laboratories subcontracted to GeoEngineers.
- Responds to laboratory data QA needs, answers laboratory requests for guidance and assistance, and assists in resolving issues.
- Monitors laboratory compliance with data quality requirements.

- Ensures that appropriate sampling, testing, and analysis procedures are followed and that proper QC checks are implemented.
- Reviews the implementation of the QAPP and the overall quality of the analytical data generated.
- Maintains the authority to implement corrective actions as necessary.
- Ensures proper implementation of the QAPP.
- Provides oversight of the data development and review process and of subcontracting laboratories.
- Conducts laboratory audits, as necessary, and data validation activities.
- Enters data into Ecology's Environmental Information Management (EIM) system.

As stated above, a portion of the sediment sample collection field work and analysis may be performed by a party contracted to the EPA, under a Targeted Brownfileds Assessment Grant. If this occurs, EPA will identify a Quality Assurance Leader to perform the specific responsibilities identified above. The EPA Quality Assurance Leader will coordinate with the GeoEngineers Project Manager for collection and analysis of the sediment samples and compliance with the project quality assurance requirements during Phase I and Phase II sampling.

Laboratory Manager: The subcontracted laboratories conducting sample analyses for this project are required to obtain approval from the QA Leader before the initiation of sample analysis to assure that the laboratory QA plan complies with the project QA objectives. The Laboratory Manager administers the Laboratory QA Plan and is responsible for QC. Specific responsibilities of the Laboratory Manager include:

- Ensure implementation of the laboratory QA plan.
- Serve as the laboratory point of contact.
- Activate corrective action as necessary when analytical control limits are exceeded.
- Issue the final laboratory QA/QC report.
- Administer QA sample analysis.
- Comply with the specifications established in the project plans as related to laboratory services.
- Participate in QA audits and compliance inspections.

The Laboratory's QA Manager will be determined once an Ecology-accredited laboratory is chosen.

4.0 SITE AND SAMPLE DESCRIPTIONS

4.1. Summary of Previous Investigations

The Work Plan describes previous investigations conducted on and near the Site. Several phases of investigation have been performed at the Haley Site to support development of the draft

Remedial Investigation (RI). Other sediment investigations have been performed to support the development and design of remedial alternatives for the adjacent Cornwall Avenue Landfill Site (Cornwall Landfill Site) and Whatcom Waterway sites. Some of these other studies evaluated sediment quality throughout the broader Bellingham Bay.

The previous investigations have identified that constituents of concern or potential concern associated with the Cornwall, Whatcom Waterway and R.G. Haley Sites are comingled. In addition, landfill refuse from the Cornwall site overlaps with the area impacted by Haley chemical constituents. As a result, the proposed remedial action areas for the Cornwall and Whatcom Waterway sites overlap with the Haley Site.

The aerial extent of surface, near-surface and/or subsurface sediment with concentrations of Haley COCs greater than screening levels is not bounded northeast, northwest and southwest of existing exceedances at the R.G. Haley Site. The vertical (depth) extent of screening level exceedances also has not been delineated at multiple locations where these constituents exceed screening levels.

4.2. Area of Interest

The area of interest for the present study is shown on Figure 2, and is generally the area between the Cornwall Landfill Site and Whatcom Waterway Site, bay-ward of the Haley shoreline into adjacent intertidal and subtidal portions of Bellingham Bay. An R.G. Haley upland investigation is also being conducted and is detailed in the Work Plan and a separate SAP.

The elevation of mean higher high water (MHHW) is approximately 8.51 feet above mean lower low water (MLLW). The boundary between the intertidal and subtidal zones is approximately -4 feet MLLW. The shoreline bank is steep and generally covered with shoreline armoring including rip rap.

Surface sediment in the intertidal portion of the Site consists predominantly of gravel and sand with varying amounts of cobbles and silt. This sediment frequently contains debris that includes wood, brick fragments, and glass fragments. An area predominantly comprised of wood debris is exposed at the surface in the upper intertidal zone on the southwest portion of the Site. Horizons comprised predominantly of wood debris also were identified at depths ranging from approximately 1 to 4 feet below the mudline in intertidal zone cores. The wood debris present in the intertidal zone is predominantly comprised of sawdust, wood chips and wood fragments.

Numerous remnant untreated timber pilings are also generally located in the upper intertidal portion of the Site (i.e., at or above +3 feet MLLW). The remnant timber pilings located in this area are the remains of a former wharf structure that supported historic lumber mill operations (see Figure 3 in the Data Gaps Assessment Report; GeoEngineers, 2011).

The grain size of surface sediment in the shallow subtidal zone (i.e., from about -4 feet MLLW to -13 feet MLLW) predominantly ranges from silty sand to sandy silt. Debris was also observed in this area primarily consisting of wood fragments (wood pieces and chips, sticks and sawdust). The vertical sediment profile in the subtidal zone includes some limited horizons comprised predominantly of wood debris, however, sand and silt is the predominant sediment matrix at most locations and depths. Additionally, landfill debris was identified at depth in cores advanced on the southwestern portion of the Site. Items of landfill origin also have been noted in sediment cores completed outside (northeast) of the proposed remedial action (capping) boundary of the Cornwall Site. Based on existing core logs, it is does not appear that any sediment cores previously advanced in the aquatic portion of the Haley site have contacted undisturbed native sediment.

4.3. Sampling Location Rationale

The sampling location rationale is described in Table 1. Sampling locations and target depths for subsurface sediment sampling were chosen to delineate the horizontal and vertical extent of Haley COCs, and to investigate the full vertical profile of fill above the underlying native, undisturbed sediment.

4.4. Sediment Sample Intervals of Interest

The compliance interval for surface sediment (i.e., the "biologically active zone") has been determined to be 0 to 12 cm below mudline in Bellingham Bay. Surface samples will be collected from this interval. Sediment cores collected using sonic drilling techniques are intended to extend from the mudline to several feet into native, undisturbed sediment. This depth is estimated to be approximately 20 feet below mudline.

5.0 SAMPLE COLLECTION AND HANDLING

5.1. Navigation and Positioning

Sample locations will be determined in the field to the nearest 0.1 second (North American Datum 83) using a hand-held or boat-mounted differential global positioning system (DGPS) unit. Location control accuracy for the samples is to be within +/- 3 meters (approximately 10 feet) of the planned sampling locations. The location where samples are collected will be recorded either on the field logs or using the GPS software to the nearest 0.1 second. Where over-water sampling is performed, the sampling vessel operator shall provide a means of steadying the sampling vessel so as to ensure proper collection of samples.

Where over-water sampling is performed, water depths at sediment sampling locations will be measured directly using a lead-line and converted to mudline elevations using National Oceanic and Atmospheric Administration (NOAA) tide information. Lead-line measurements also serve as a check on location positioning as the actual water depth at the sample location coordinates should match the predicted depth at the location based on a previously completed hydrographic survey.

5.2. Collection Methods

Prior to sample collection, individuals collecting sediment samples must read and become familiar with the sediment SAP and QAPP.

5.2.1. Surface Sediment

Surface sediment samples are anticipated to be collected using a Van Veen or modified Van Veen sediment sampler deployed from a vessel designed for such purposes. All equipment must be decontaminated before sampling. The general procedure for collecting surface sediment samples is as follows:

1. Maneuver the sampling vessel to the proposed sampling location, steady the vessel, and verify location control using the GPS.
2. Record the location of the sample.
3. Prepare the sampler for deployment.
4. Deploy the sampler through the water column to the mudline at approximately 1 foot per second (fps). Verify that the sampler cable is plumb.
5. Record the sampling time and the depth to mudline below the water surface (using the lead-line).
6. Release the sampler and raise it to the vessel at approximately 1 fps.
7. Place the sampler on the work surface of the vessel. Avoid jostling the sampler and/or disturbing the sample.
8. Examine the sample for the following sediment acceptance criteria:
   - The sampler jaw is closed.
   - The sampler is not overfilled so that the sediment surface presses against the top of the sampler.
   - Minimal leakage has occurred, as evidenced by overlying water on the sediment surface.
   - Minimal sample disturbance has occurred, as evidenced by limited turbidity in the overlying water.
   - A penetration of at least 13 cm has been achieved. 13 cm shall be the target penetration depth in order to sample sediment that has not come into contact with the side of the sampler.
   - If any of the sediment acceptance criteria are not achieved, the sample will be rejected and the location resampled. If the proposed sampling location cannot be achieved after four deployments, notify the Project Manager to determine an appropriate alternative location.
9. Siphon off standing water from the surface of the sediment using a hose primed with Site saltwater. Do not disturb the surface of the sediment.
10. Visually classify sediment in accordance with ASTM International (ASTM) D 2488 methods and the Unified Soil Classification System (ASTM D 2487) and record on the field form. In addition to the visual classification, sediment samples shall be field screened (see Section 5.3). Qualitative descriptive parameters including biota, debris, and presence of petroleum product/staining shall also be recorded.
11. Photograph the sediment. Include in the camera's field of view a sheet of paper or white board with the sample name written in large black print; use care not to touch the sediment with the paper/whiteboard.
12. Collect the upper 12 cm of sediment from the sampler using a decontaminated stainless steel spoon. Do not collect sediment that has been in contact with the side of the sampler. Place the sediment into a decontaminated stainless steel homogenization bowl. Cover the container with a new sheet of aluminum foil and dispose after use.

13. Thoroughly rinse the interior of the sampler until all loose sediment has been washed off. Excess sediment will be returned to the water surface in the approximate location where the sample was collected.
14. If sufficient sample volume was not collected, repeat the sampling process until sufficient volume is achieved. Successive deployments should be within an approximate 10-foot radius of the initial deployment.
15. Homogenize the sediment (from one deployment if adequate sediment volume was achieved, or from multiple deployments if multiple deployments were required) in the stainless steel bowl using the stainless steel spoon until the sediment appears generally uniform in color and texture.
16. Distribute the sample to appropriate sample containers identified in the QAPP and ensure that the samples are properly labeled and tightly closed.
17. Clean the exterior of the sample containers and store them in a cooler with ice.
18. Decontaminate all equipment as described in Section 5.4.
19. Double check that field collection forms are completely filled out.

5.2.2. Near-Surface and Subsurface Sediment

Near-surface and subsurface sediment samples are anticipated to be collected using sonic drilling techniques. The sonic drill rig will utilize a five-foot-long, 3-inch-diameter core barrel containing dedicated (disposable) acetate liners. Investigation locations in the intertidal zone (i.e., COB-SC-01, COB-SC-02, COB-SC-07, and COB-SC-08 in Figure 2) are anticipated to be collected from land using a track-mounted sonic drill rig during low tide. The remaining locations (i.e., COB-SC-03, COB-SC-04, COB-SC-05, COB-SC-06, and COB-SC-09) are anticipated to be collected using the sonic drill rig located on a vessel (i.e., barge). Sample collection methodology may have to be adjusted based on the tide schedule at the time of sampling.

The general procedure for collecting near-surface and subsurface samples is as follows:

1. Maneuver the track rig or sampling vessel to the proposed sampling location, steady the vessel (for over-water sampling), and verify location control using the GPS.
2. Record the location of the sample.
3. Record the sampling time and depth to mudline below the water surface (using the lead-line) for over-water sampling.
4. Drive the sampler into the sediment surface in five foot intervals or until refusal.
5. Collect a continuous subsurface sample to the target depth (see Table 1) or until refusal.
6. For each sample interval, record the penetration depth on the field form.
7. Extract the core barrel, extract the acetate liner, cap the liner, and examine the sample relative to the following acceptance criteria:
   - Overlying water is present and the surface is intact (for the first five-foot run only);
   - Calculated compaction is not greater than 25 percent; and/or

- The sampling device appears intact without obstructions or blocking.

If inspection of the sample recovery meets the criteria then proceed with sample processing. Ideally samples will be processed in the field. If sample processing is not performed in the field, label the samples and keep the samples at approximately 4° C during storage and shipment.

Subsurface samples should be processed in the field or within 24 hours of collection by the Field Sampler. All equipment will be decontaminated prior to initiating sample processing. The general procedure is as follows:

1. Measure and record the recovered length of sediment in the core (and compare to field records if sample is not being processed in the field).
2. Calculate sediment compaction and establish compaction-corrected depths for the entire length of the sample.
3. Visually classify sediment in accordance with ASTM D 2488 methods and the Unified Soil Classification System (ASTM D 2487) and record on the field form. In addition to the visual classification, sediment samples shall be field screened (see Section 5.3). Qualitative descriptive parameters including biota, debris, and presence of product/staining shall also be recorded.
4. Photograph the sediment. Include in the camera's field of view a sheet of paper or white board with the sample name written in large black print; use care not to touch the sediment with the paper/whiteboard. It is likely several photos will be necessary to record the entire length. Include the length interval on the paper/whiteboard.
5. Collect sediment from the liner using a decontaminated stainless steel spoon. Do not collect sediment that has been in contact with the side of the liner. Place the sediment into a decontaminated stainless steel homogenization bowl. Cover the container with a new sheet of aluminum foil and dispose after use.
6. Homogenize the sediment in the stainless steel bowl using the stainless steel spoon until the sediment appears generally uniform in color and texture.
7. Distribute the sample to appropriate sample containers identified in the QAPP and ensure that the samples are properly labeled and tightly closed.
8. Clean the exterior of the sample containers and store them in a cooler with ice.
9. Decontaminate all equipment as described in Section 5.4.
10. Double check that field collection forms are completely filled out.

If adequate sample volume cannot be obtained in a particular interval(s) in cores, an adjacent core will be attempted within a 10-foot radius of the original core.

5.3. Field Screening

Sediment samples will be field-screened for evidence of possible contamination. Field screening results will be recorded on the field logs. The following field screening methods will be used: (1) visual/olfactory screening, (2) water sheen screening, and (3) headspace vapor screening.

5.3.1. Visual/Olfactory Screening

The sediment will be observed for unusual colors, staining or odor that may be indicative of contamination.

5.3.2. Water Sheen Screening

This is a qualitative field screening method that can help identify the presence or absence of petroleum hydrocarbons. A portion of the sediment sample will be placed in a pan containing distilled water. The water surface will be observed for signs of sheen. The following sheen classifications will be used:

No Sheen (NS) - No visible sheen on the water surface

Slight Sheen (SS) - Light, colorless, dull sheen; spread is irregular, not rapid; sheen dissipates rapidly

Moderate Sheen (MS) - Light to heavy sheen; may have some color/iridescence; spread is irregular to flowing, may be rapid; few remaining areas of no sheen on the water surface

Heavy Sheen (HS) - Heavy sheen with color/iridescence; spread is rapid; entire water surface may be covered with sheen

5.3.3. Headspace Vapor Screening

This is a semi-quantitative field screening method that can help identify the presence or absence of volatile chemicals. As soon as possible after collecting a sediment sample, a portion of the sediment remaining in the sampler is placed in a resealable plastic bag for headspace vapor screening. Ambient air is captured in the bag; the bag is sealed and then shaken gently for approximately five seconds to expose the sediment to the air trapped in the bag. Vapors present within the sample bag headspace are measured by inserting the probe of a photoionization detector (PID) through a small opening in the bag. A PID measures the concentration of organic vapors ionizable by a 10.6 electron volt lamp (standard) in parts per million (ppm) and quantifies organic vapor concentrations in the range between 0.1 ppm and 2,000 ppm (isobutylene-equivalent) with an accuracy of 1 ppm between 0 ppm and 100 ppm. The maximum ppm value will be recorded on the field report for each sample. The PID will be calibrated to 100 ppm isobutylene.

5.4. Equipment Decontamination

Field sampling equipment, including the sediment samplers (i.e., Van Veen sampler, core barrel and drive head) as well as stainless steel bowls and spoons, will be cleaned prior to sampling and between each sampling location. Equipment for reuse will be decontaminated according to the procedure below:

1. Seawater will be sprayed over equipment to dislodge and remove any sediment (deionized water will be used for the samples collected on land).
2. Surfaces of equipment contacting sample material will be scrubbed with a brush using an Alconox solution.

3. Scrubbed equipment will be rinsed and scrubbed with deionized water.
4. Equipment will undergo a final spray rinse of deionized water.

Solvents (i.e., acetone and hexane) may be used during sample collection activities performed on land; however, they will not be used aboard the vessel because the use of solvents on the congested deck of a vessel may pose a safety hazard to the crew. In addition, disposal and spillage of solvents during field activities aboard the vessel pose an environmental concern. For the on-land activities, if solvents are used, they will be used after step 3 above and then steps 3 and 4 will be repeated.

Decontamination water from steps 2 through 4 will be collected and stored on Site in labeled, secure drums for proper disposal.

Field personnel will limit cross contamination by changing gloves between sampling events.

5.5. Field Documentation

Sample documentation will be recorded on sample forms. In addition, field reports will be completed on field report forms. Field sample forms and reports will become part of the project files at the conclusion of this field exploration.

At a minimum, the following information will be recorded during the collection of each sample:

- Sample location.
- Sampler's name(s).
- Date and time of sample collection.
- Water depth (for over-water samples).
- Sampling equipment penetration, sample material recovery depth, and sample interval.
- Gross characteristics of the sediment including:
  - Presence or absence of stratification,
  - Texture,
  - Color,
  - Presence of biota or biological structures,
  - Presence of debris including wood
  - Field screening results (see Section 5.3)
- Description of wood presence, type, and quantity of wood, if observed, including:
  - Type of wood (e.g., sawdust, bark, processed lumber, stick)
  - Location of wood (e.g., on the surface, beneath the surface, in a layer, mixed throughout)
- Visually based volumetric estimate of wood (i.e., <25%, between 25% and 50%, and greater than 50%) in the sediment and/or in discernible sediment horizons (preferably using percentage diagrams available on soil classification charts).

- Gross characteristics of the vertical profile including:
    - Presence of a redox layer and redox layer thickness, if present
    - Changes in material characteristics.

The following information also will be recorded in the field log for each day of sampling:

- Deviations from the SAP, HASP or QAPP.
- Decontamination procedures (i.e., whether solvents were used and where).
- Calibration readings for any equipment used.

The handling, use and maintenance of field log books are the field coordinator's responsibilities.

5.6. Sample containers and labeling

Sediment samples obtained during this study will be placed in appropriate laboratory-prepared containers. Sample containers and preservatives are listed in the QAPP.

Sample containers will be labeled with the following information at the time of collection:

- Project name and/or number;
- Sample name, which will include a reference to depth interval if appropriate; and
- Date and time of collection.

Sample naming conventions will be as follows:

Surface Samples:

COB-SS-##, where COB indicates City of Bellingham, SS indicates "surface sediment", and ## indicates a two-digit location code as shown on Figure 2.

Near-surface and subsurface samples:

COB-SC-##-beginning depth-ending depth, COB indicates City of Bellingham, where SC indicates "sediment core," ## indicates the two-digit location code as shown on Figure 2, followed by the top and bottom depths of the sample interval.

The sample collection activities will be noted on the field forms. The Field Coordinator will monitor consistency between the SAP, sample containers/labels, field log books and the chain-of-custody

5.7. Sample Storage and Shipping

Samples will be placed in a cooler with wet ice or "blue ice" immediately after they are collected. Holding times will be observed during sample storage. Holding times for the project analyses are summarized in the QAPP.

The samples will be transported and delivered to the analytical laboratories in coolers. Transport and delivery may be performed by one of the following methods:

- Field personnel may transport and deliver samples that are being submitted to a local laboratory for analysis.
- Field personnel may transfer the samples to a courier service. Custody seals will be attached to coolers.
- Field personnel may have the samples shipped to the laboratory via a commercial express mailing service. Custody seals will be attached to coolers.

Regardless of the transport method, the shipping containers (coolers) will be properly secured using ice, packaging material and clear plastic tape as necessary.

5.8. Field Instrumentation

Proper calibration of equipment and instrumentation facilitates accurate and reliable field measurements. Field and laboratory equipment used on the project will be calibrated and adjusted in general accordance with the manufacturer's recommendations. Methods and intervals of calibration and maintenance will be based on the type of equipment, stability characteristics, required accuracy, intended use, and environmental conditions

5.9. Field Measurement Evaluation

Field data will be reviewed at the end of each day by following the quality control checks outlined below and procedures in the QAPP. Field data documentation will be checked against the applicable criteria as follows:

- Correct sample collection information.
- Correct field instrumentation and calibration.
- Correct sample collection protocol.
- Correct sample containers, preservation and volume.
- Field Quality Control (QC) samples collected at the frequency specified.
- Sample documentation and chain-of-custody protocols performed correctly.

5.10. Disposal of IDW

All disposable sampling material and personal protective equipment (i.e., disposable coveralls, gloves, and paper towels) used in sample processing will be placed in garbage bags or other appropriate containers. Disposal supplies will be removed from the site by sampling personnel and placed in a normal refuse container for disposal at a solid waste landfill. Sediment remaining after surface sample collection will be returned to the water surface or collected in drums (for core samples). Decontamination water and/or solvents will be stored in (separate) drums. All drums will be labeled, secured and properly stored on Site for proper off-site disposal.

6.0 SAMPLE ANALYSES

Sample analyses are outlined in the QAPP and consist of a combination of the following:

- Diesel- and oil-range petroleum hydrocarbons by NWTPH-Dx with silica acid gel cleanup;

- SVOCs by EPA Method 8270 (SMS list including PCP);
- Dioxins and furans by EPA Method 1613;
- Conventionals (Total organic carbon [Plumb, 1981], Total solids [PSEP, 1986], and grain size [PSEP, 1986]);
- Mercury by EPA Method EPA 7471; and
- Bioassays (i.e. 10-day amphipod, 20-day juvenile infaunal growth test, and sediment larval test).

Reporting limits and detection limit goals are presented in the QAPP.

7.0 HEALTH AND SAFETY

A Site-specific Health and Safety Plan (HASP) is presented in Appendix D of the Work Plan. GeoEngineers field staff will conduct a safety meeting each morning before beginning daily field activities. The field staff will terminate any work activities that do not comply with the HASP.

8.0 REFERENCES

GeoEngineers, Inc., "Data Gaps Assessment, R.G. Haley International Site, Bellingham, Washington, for City of Bellingham." GEI File No. 0356-114-06, April 26, 2011.

TABLE 1

SEDIMENT SAMPLING APPROACH AND RATIONALE

R.G. HALEY INTERNATIONAL SITE
BELLINGHAM, WASHINGTON

Sample Type	Station ID	Purpose of Sediment Sample Collection and Analysis	Expected Exploration Depth	Estimated Number of Samples to be Analyzed						Methodology for Sample Collection and Analyses/Testing
				TPH	SVOCs	D/F	Mercury	Conven-tionals	Bio-assays	
Phase I Surface Sediment Samples	COB-SS-01	Characterize horizontal extent of sediment impacts exceeding SMS chemical criteria within the compliance interval. Characterize petroleum hydrocarbon concentrations within the compliance interval west of where near-surface sediment exceeded the screening level at RGH-SC-07. Characterize concentrations of dioxins/furans within the compliance interval west of RI-1 where elevated dioxon/furan concentrations were previously detected.	0-12 cm	1	1	1	1	1	0	Sample Collection - Van Veen sample collected from a vessel (i.e. boat). Sample Analyses/Testing - Chemical analyses being performed to assess extent/overlap of Site contaminants and evaluation of cleanup remedy(ies). Sample will be analyzed for dioxins/furans to provide additional data concerning dioxin/furan concentration gradient in surface sediment. Bioassay testing is not proposed as Cornwall Avenue Landfill investigation/remedy approach acknowledges likely biological impacts within limits of Cornwall Avenue Landfill cleanup remedy (i.e., capping) boundary.
	COB-SS-02	Characterize horizontal extent of sediment impacts exceeding SMS chemical and biological criteria within the compliance interval including PCP which exceeded SMS chemical criteria at SRI-3. Characterize petroleum hydrocarbon concentrations within the compliance interval northwest of where near-surface sediment exceeded the screening level at RGH-SC-08. Characterize extent of biological effects (i.e., SMS bioassay criteria exceedances) northwest of previous bioassay exceedances at RI-1, RI-2, and RI-3. Characterize concentrations of dioxins/furans within the compliance interval north/west of RI-1 and RI-4 where elevated dioxon/furan concentrations were previously detected.	0-12 cm	1	1	1	1	1	1	Sample Collection - Van Veen sample collected from a vessel (i.e. boat). Sample Analyses / Testing - Chemical analyses and bioassay testing will be performed simultaneously as previous investigation results have indicated bioassay exceedances where chemicals meet SMS chemical criteria. Sample will be analyzed for dioxins/furans to provide additional data concerning dioxin/furan concentration gradient in surface sediment.
	COB-SS-03	Characterize horizontal extent of sediment impacts exceeding SMS chemical and biological criteria within the compliance interval including PCP which exceeded SMS chemical criteria at SRI-3. Characterize petroleum hydrocarbon concentrations within the compliance interval northwest of where near-surface sediment exceeded the screening level at RGH-SC-08 and RGH-SC-09. Characterize extent of biological effects (i.e., SMS bioassay criteria exceedances) northwest of previous bioassay exceedances at RI-2, RI-3, and RI-4. Collect and archive sample from compliance interval for potential future dioxins/furans analysis northwest of RI-4 where elevated dioxin/furan concentration was previously detected.	0-12 cm	1	1	A	1	1	1	Sample Collection - Van Veen sample collected from a vessel (i.e. boat). Sample Analyses / Testing - Chemical analyses and bioassay testing will be performed simultaneously as previous investigation results have indicated bioassay exceedances where chemicals meet SMS chemical criteria. Analysis for dioxins/furans may be performed on sample from this location based on the results of other surface sediment sample analyses.
	COB-SS-04	Characterize horizontal extent of sediment impacts exceeding SMS chemical and biological criteria within the compliance interval. Characterize petroleum hydrocarbon concentrations within the compliance interval northwest of where near-surface sediment exceeded the screening level at RGH-SC-05 and RGH-SC-09. Characterize extent of biological effects (i.e., SMS bioassay criteria exceedances) northwest of previous bioassay exceedances at RI-4, RI-5, and RGH-SS-03. Characterize concentrations of dioxins/furans within the compliance interval north/west of RI-4, RI-5, RGH-SS-03 where elevated dioxon/furan concentrations were previously detected.	0-12 cm	1	1	1	1	1	1	Sample Collection - Van Veen sample collected from a vessel (i.e. boat). Sample Analyses / Testing - Chemical analyses and bioassay testing will be performed simultaneously as previous investigation results have indicated bioassay exceedances where chemicals meet SMS chemical criteria. Sample will be analyzed for dioxins/furans to provide additional data concerning dioxin/furan concentration gradient in surface sediment.

Sample Type	Station ID	Purpose of Sediment Sample Collection and Analysis	Expected Exploration Depth	Estimated Number of Samples to be Analyzed						Methodology for Sample Collection and Analyses/Testing
				TPH	SVOCs	D/F	Mercury	Conven-tionals	Bio-assays	
Phase I Surface Sediment Samples	COB-SS-05	Characterize horizontal extent of sediment impacts exceeding SMS chemical and biological criteria within the compliance interval. Characterize petroleum hydrocarbon concentrations within the compliance interval northwest of where near-surface sediment exceeded the screening level at RGH-SC-05. Characterize extent of biological effects (i.e., SMS bioassay criteria exceedances) northwest of previous bioassay exceedance at RGH-SS-01 and RGH-SS-03. Collect and archive sample from compliance interval for potential future dioxins/furans analysis north of surface and nearsurface locations where elevated dioxin/furan concentration were previously detected.	0-12 cm	1	1	A	1	1	1	Sample Collection - Van Veen sample collected from a vessel (i.e. boat). Sample Analyses / Testing - Chemical analyses and bioassay testing will be performed simultaneously as previous investigation results have indicated bioassay exceedances where chemicals meet SMS chemical criteria. Analysis for dioxins/furans may be performed on sample from this location based on the results of other surface sediment sample analyses.
	COB-SS-06	Collect and archive sample for potential future dioxins/furan analysis.	0-12 cm	0	0	A	0	A	0	Sample Collection - Van Veen sample collected from a vessel (i.e. boat). Sample Analyses/Testing - Analysis for dioxins/furans may be performed on sample from this location based on the results of other surface sediment sample analyses.
	COB-SS-07	Collect and archive sample for potential future dioxins/furan analysis.	0-12 cm	0	0	A	0	A	0	Sample Collection - Van Veen sample collected from a vessel (i.e. boat). Sample Analyses/Testing - Analysis for dioxins/furans may be performed on sample from this location based on the results of other surface sediment sample analyses.
	COB-SS-08	Collect and archive sample for potential future dioxins/furan analysis.	0-12 cm	0	0	A	0	A	0	Sample Collection - Van Veen sample collected from a vessel (i.e. boat). Sample Analyses/Testing - Analysis for dioxins/furans may be performed on sample from this location based on the results of other surface sediment sample analyses.
	Samish Bay Reference Area	Provide a bioassay reference sample(s) for comparison to bioassay tests performed on Site samples.	0-12 cm	0	0	0	0	1	1	Sample Collection - Van Veen sample collected from a boat. Sample Analyses/Testing - Wet sieving will be performed on Site samples and reference area sample(s) to obtain equivalent grain size distribution.
Near-Surface and Subsurface Sediment Cores	COB-SC-01	Characterize sediment stratigraphy upper intertidal zone to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical profile of constituent concentrations to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical limits / extent of Haley constituents that exceed SMS numerical criteria as well as petroleum hydrocarbons that exceed the screening level.	10-20 ft	2-3	2-3	2	1	2-3	0	Sample Collection - Sediment core samples collected using a sonic drill rig operated from land. Core will be advanced from sediment surface through sediment / fill containing anthropogenic material and into underlying native sediment deposits. A continuous sediment core will be collected and logged. Samples will be collected at two (2) foot sample intervals from surface to depth of 6 feet (i.e., 0-2, 2-4, and 4-6 feet) and from selected sediment horizons below a depth of six (6) feet. Sample Analyses / Testing - Samples collected from 0-2 feet will be analyzed for petroleum hydrocarbons, SVOCs, dioxins/furans, mercury, and conventional parameters. One or more additional samples will be selected for analysis based on observations during sample collection and sediment core investigation objectives.

Sample Type	Station ID	Purpose of Sediment Sample Collection and Analysis	Expected Exploration Depth	Estimated Number of Samples to be Analyzed						Methodology for Sample Collection and Analyses/Testing
				TPH	SVOCs	D/F	Mercury	Conven-tionals	Bio-assays	
Near-Surface and Subsurface Sediment Cores (continued)	COB-SC-02	Characterize sediment stratigraphy upper intertidal zone to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical profile of constituent concentrations to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical limits / extent of Haley constituents that exceed SMS numerical criteria as well as petroleum hydrocarbons that exceed the screening level.	10-20 ft	2-3	2-3	1	1	2-3	0	Sample Collection - Sediment core samples collected using a sonic drill rig operated from land. Core will be advanced from sediment surface through sediment / fill containing anthropogenic material and into underlying native sediment deposits. A continuous sediment core will be collected and logged. Samples will be collected at two (2) foot sample intervals from surface to depth of 6 feet (i.e., 0-2, 2-4, and 4-6 feet) and from selected sediment horizons below a depth of six (6) feet. Sample Analyses / Testing - Samples collected from 0-2 feet will be analyzed for petroleum hydrocarbons, SVOCs, dioxins/furans, mercury, and conventional parameters. One or more additional samples will be selected for analysis based on observations during sample collection and sediment core investigation objectives.
Near-Surface and Subsurface Sediment Cores	COB-SC-03	Characterize sediment stratigraphy lower intertidal zone to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical profile of constituent concentrations to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical limits / extent of Haley constituents that exceed SMS numerical criteria as well as petroleum hydrocarbons that exceed the screening level.	10-20 ft	2-3	2-3	2	1	2-3	0	Sample Collection - Sediment core samples collected using a sonic drill rig operated from a vessel (i.e., barge). Core will be advanced from sediment surface through sediment / fill containing anthropogenic material and into underlying native sediment deposits. A continuous sediment core will be collected and logged. Samples will be collected at two (2) foot sample intervals from surface to depth of 6 feet (i.e., 0-2, 2-4, and 4-6 feet) and from selected sediment horizons below a depth of six (6) feet. Sample Analyses / Testing - Samples collected from 0-2 feet will be analyzed for petroleum hydrocarbons, SVOCs, dioxins/furans, mercury, and conventional parameters. One or more additional samples will be selected for analysis based on observations during sample collection and sediment core investigation objectives.
	COB-SC-04	Characterize sediment stratigraphy lower intertidal zone to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical profile of constituent concentrations to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical limits / extent of Haley constituents that exceed SMS numerical criteria as well as petroleum hydrocarbons that exceed the screening level.	10-20 ft	2-3	2-3	1	1	2-3	0	Sample Collection - Sediment core samples collected using a sonic drill rig operated from a vessel (i.e., barge). Core will be advanced from sediment surface through sediment/fill containing anthropogenic material and into underlying native sediment deposits. A continuous sediment core will be collected and logged. Samples will be collected at two (2) foot sample intervals from surface to depth of 6 feet (i.e., 0-2, 2-4, and 4-6 feet) and from selected sediment horizons below a depth of six (6) feet. Sample Analyses/Testing - Samples collected from 0-2 feet will be analyzed for petroleum hydrocarbons, SVOCs, dioxins/furans, mercury, and conventional parameters. One or more additional samples will be selected for analysis based on observations during sample collection and sediment core investigation objectives.
	COB-SC-05	Characterize sediment stratigraphy in the subtidal zone to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical profile of constituent concentrations to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical limits / extent of Haley constituents that exceed SMS numerical criteria as well as petroleum hydrocarbons that exceed the screening level.	10-20 ft	2-3	2-3	1	1	2-3	0	Sample Collection - Sediment core samples collected using a sonic drill rig operated from a vessel (i.e., barge). Core will be advanced from sediment surface through sediment / fill containing anthropogenic material and into underlying native sediment deposits. A continuous sediment core will be collected and logged. Samples will be collected at two (2) foot sample intervals from surface to depth of 6 feet (i.e., 0-2, 2-4, and 4-6 feet) and from selected sediment horizons below a depth of six (6) feet. Sample Analyses / Testing - Samples collected from 0-2 feet will be analyzed for petroleum hydrocarbons, SVOCs, dioxins/furans, mercury, and conventional parameters. One or more additional samples will be selected for analysis based on observations during sample collection and sediment core investigation objectives.

Sample Type	Station ID	Purpose of Sediment Sample Collection and Analysis	Expected Exploration Depth	Estimated Number of Samples to be Analyzed						Methodology for Sample Collection and Analyses/Testing
				TPH	SVOCs	D/F	Mercury	Conven-tionals	Bio-assays	
Near-Surface and Subsurface Sediment Cores (continued)	COB-SC-06	Characterize sediment stratigraphy in the subtidal zone to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical profile of constituent concentrations to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical limits / extent of Haley constituents that exceed SMS numerical criteria as well as petroleum hydrocarbons that exceed the screening level.	10-20 ft	2-3	2-3	2-3	1	2-3	0	Sample Collection - Sediment core samples collected using a sonic drill rig operated from a vessel (i.e., barge). Core will be advanced from sediment surface through sediment / fill containing anthropogenic material and into underlying native sediment deposits. A continuous sediment core will be collected and logged. Samples will be collected at two (2) foot sample intervals from surface to depth of 6 feet (i.e., 0-2, 2-4, and 4-6 feet) and from selected sediment horizons below a depth of six (6) feet. Sample Analyses / Testing - Samples collected from 0-2 feet will be analyzed for petroleum hydrocarbons, SVOCs, dioxins/furans, mercury, and conventional parameters. One or more additional samples will be selected for analysis based on observations during sample collection and sediment core investigation objectives.
	COB-SC-07	Characterize sediment stratigraphy upper intertidal zone to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical profile of constituent concentrations to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical limits / extent of Haley constituents that exceed SMS numerical criteria as well as petroleum hydrocarbons that exceed the screening level.	10-20 ft	2-3	2-3	2-3	1	2-3	0	Sample Collection - Sediment core samples collected using a sonic drill rig operated from land. Core will be advanced from sediment surface through sediment / fill containing anthropogenic material and into underlying native sediment deposits. A continuous sediment core will be collected and logged. Samples will be collected at two (2) foot sample intervals from surface to depth of 6 feet (i.e., 0-2, 2-4, and 4-6 feet) and from selected sediment horizons below a depth of six (6) feet. Sample Analyses / Testing - Samples collected from 0-2 feet will be analyzed for petroleum hydrocarbons, SVOCs, dioxins/furans, mercury, and conventional parameters. One or more additional samples will be selected for analysis based on observations during sample collection and sediment core investigation objectives.
	COB-SC-08	Characterize sediment stratigraphy upper intertidal zone to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical profile of constituent concentrations to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical limits / extent of Haley constituents that exceed SMS numerical criteria as well as petroleum hydrocarbons that exceed the screening level.	10-20 ft	2-3	2-3	2-3	1	2-3	0	Sample Collection - Sediment core samples collected using a sonic drill rig operated from land. Core will be advanced from sediment surface through sediment / fill containing anthropogenic material and into underlying native sediment deposits. A continuous sediment core will be collected and logged. Samples will be collected at two (2) foot sample intervals from surface to depth of 6 feet (i.e., 0-2, 2-4, and 4-6 feet) and from selected sediment horizons below a depth of six (6) feet. Sample Analyses / Testing - Samples collected from 0-2 feet will be analyzed for petroleum hydrocarbons, SVOCs, dioxins/furans, mercury, and conventional parameters. One or more additional samples will be selected for analysis based on observations during sample collection and sediment core investigation objectives.
	COB-SC-09	Characterize sediment stratigraphy in the subtidal zone to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical profile of constituent concentrations to further refine the CSM and support evaluation and design of remedial alternatives. Characterize the vertical limits / extent of Haley constituents that exceed SMS numerical criteria as well as petroleum hydrocarbons that exceed the screening level.	6 ft	1-2	1-2	1-2	1	1-2	0	Sample Collection - Sediment core samples collected using a sonic drill rig operated from a vessel (i.e., barge). Core will be advanced from sediment surface through sediment / fill containing anthropogenic material. A continuous sediment core will be collected and logged. Samples will be collected at two (2) foot sample intervals from surface to depth of 6 feet (i.e., 0-2, 2-4, and 4-6 feet). Sample Analyses / Testing - Samples collected from COB-SC-09 will be archived for potential analysis. Analyses will be performed on selected core samples if the concentration of one or more chemicals is greater than the SMS chemical criteria or the concentration of petroleum hydrocarbons or dioxins/furans is greater than the screening levels in the surface sample collected from COB-SS-01. The selected core samples will be analyzed for the chemicals that are present at concentrations greater than SMS criteria and Site screening levels in COB-SS-01.

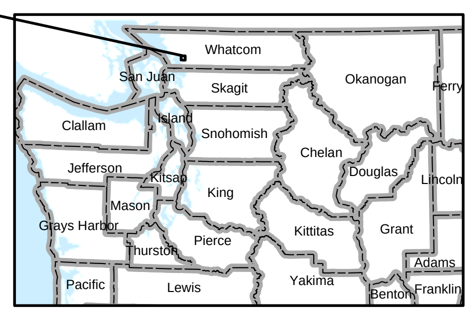
0 1,000 2,000
Feet

All locations are approximate.

Lambert Conformal Conic
Washington State Plane North
North American Datum 1983

Data Sources: Interstates, state routes, and roads from TIGER 2000.
County boundaries, cities, and waterbodies from Department of Ecology.

N



Map Revised: February 24, 2006

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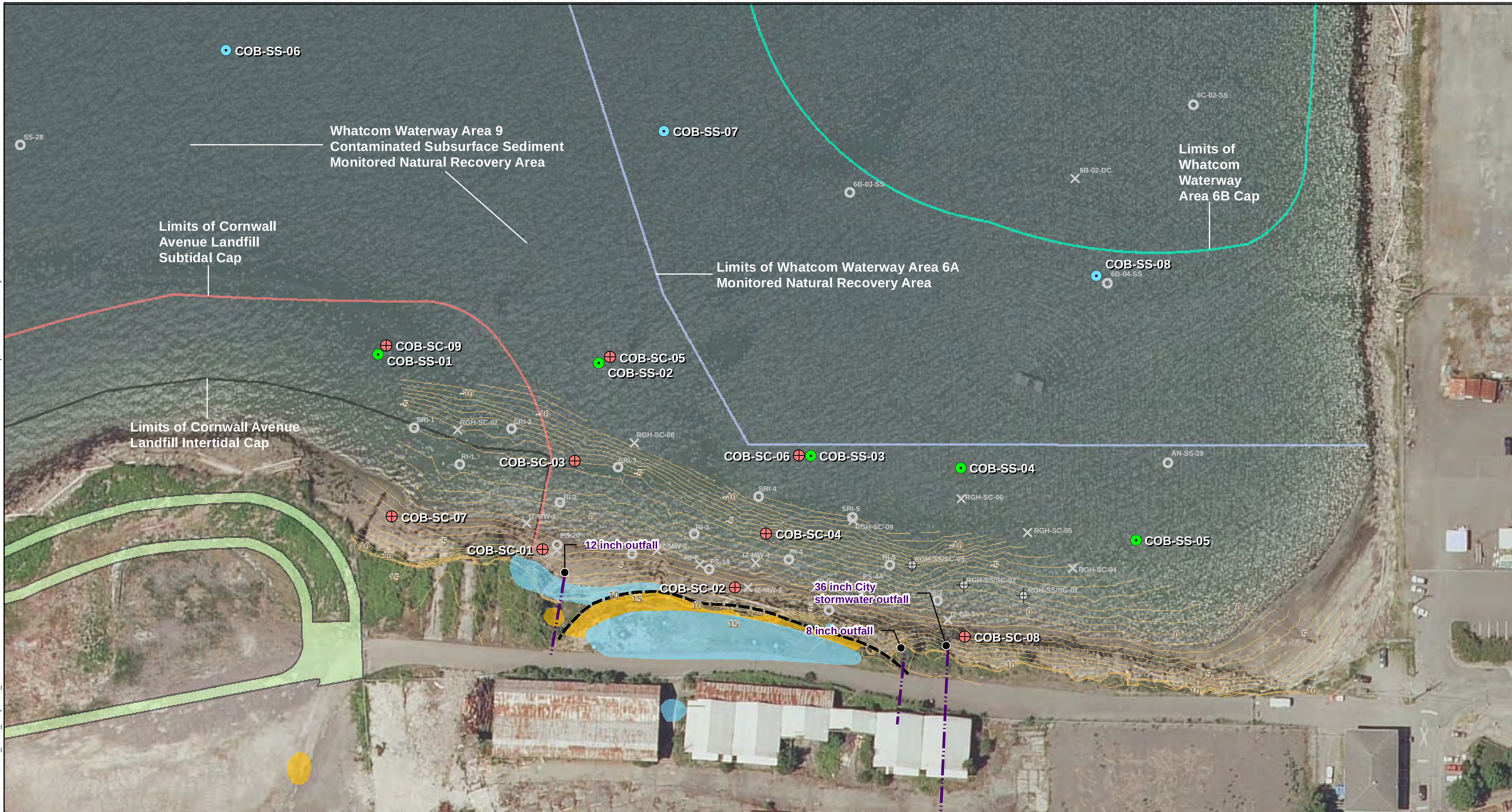
Office: SEA

GEOENGINEERS

VICINITY MAP

FIGURE 1



Office: TACO Path: \\tac\Projects\0\0356114\GIS\0356114\06_T700_Proposed_Sediment.mxd

Map Revised: 25 January 2012 amanza

0 100
Feet

Reference: Esri World Imagery, 2009.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes.
It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Legend

- Interpolated area with past occurrence of measurable oil as light non-aqueous phase liquid (LNAPL) on groundwater
- Interpolated area with past occurrence of trace oil as LNAPL on groundwater
- Cornwall IRM Boundary
- Outfalls
- Sheet Pile Barrier
- Bathymetric Contour (1ft)

Proposed Sediment Sample Locations

- Proposed Surface Sediment Location: Combination of Chemical Analysis and Biological Testing
- Proposed Surface Sediment Location: Dioxin/Furan Analysis Only
- Proposed Sediment Coring Location

Previous Sample Locations

- Surface Sediment Sample Location
- Subsurface Sediment Sample Location
- Surface and Subsurface Sediment Sample

Proposed Sediment Sampling Locations

R. G. Haley International Site
Bellingham, Washington

GEOENGINEERS

Figure 2

APPENDIX E
Quality Assurance Project Plan

Final Quality Assurance Project Plan

R.G. Haley International Site
Bellingham, Washington

for
City of Bellingham

February 23, 2012

GeoEngineers

Plaza 600 Building
600 Stewart Street, Suite 1700
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206.728.2674

Final Quality Assurance Project Plan

R.G. Haley International Site
Bellingham, Washington

File No. 0356-114-06

February 23, 2012

Prepared for:

City of Bellingham
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Attention: Sam Shipp, PE

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GeoEngineers

Table of Contents

LIST OF TABLES

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared for the R.G. Haley International Site (herein referred to as the Haley Site) as Appendix E of the Supplemental Investigation Work Plan (Work Plan) to present the objectives, procedures, organization, function activities, and specific quality assurance/quality control (QA/QC) activities designed to achieve the data quality objectives (DQOs) established for the project. The QAPP has been developed based on guidelines specified in the Washington State Model Toxics Control Act Cleanup Regulation (Chapter 173-340 of the Washington Administrative Code [WAC 173-340[) and Ecology guidance contained in Ecology Publication #04-03-030, *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies* (Ecology 2004). The QAPP also has been developed in general accordance with the sediment management standards (SMS) portion of the WAC 173, Chapter 204-100 to 204-620 and the *Sediment Sampling Analysis Plan Appendix, Guidance on the Development of Sediment Sampling and Analysis Plans Meeting the Requirements of the Sediment Management Standards — Chapter 173-204 WAC* (SAPA).

Throughout the project, environmental measurements will be conducted to produce data that are scientifically valid, of known and acceptable quality, and meet established objectives. QA/QC procedures will be implemented so that the precision, accuracy, representativeness, completeness, and comparability (PARCC) of the data generated meet the specified DQOs to the maximum extent possible.

2.0 DATA QUALITY OBJECTIVES

The overall DQO for the project is to collect environmental sampling data of known, acceptable, and documentable quality. The specific objectives established for the project are:

- Implement the procedures outlined herein for field sampling, sample custody, equipment operation and calibration, laboratory analysis, and data reporting to ensure consistency and thoroughness of data generated.
- Achieve the level of QA/QC required to produce scientifically valid analytical data of known and documented quality. This will be accomplished by establishing criteria for data precision, accuracy, representativeness, completeness, and comparability, and by evaluating project data against these criteria.

The sampling design, field procedures, useable laboratory procedures, and QC procedures established for this project were developed to provide defensible data. Specific data quality factors that may affect data usability include quantitative factors (precision, bias, accuracy, completeness, and reporting limits) and qualitative factors such as representativeness and comparability. The specific DQOs associated with these data quality factors are discussed below. Method-specific DQOs for chemical laboratory analyses are presented in Tables 1 through 3.

2.1. Analytes and Matrices of Concern

Samples of soil, LNAPL, groundwater, sediment, and stormwater solids will be collected during field activities. Tables 1 through 3 summarize the chemical analyses that may be performed for these media.

The constituents of potential concern (COPCs) for this project include:

- Total petroleum hydrocarbons (TPH), analyzed by Ecology Method Northwest Total Petroleum Hydrocarbons – Diesel Extended (NWTPH-Dx) with and without silica gel cleanup;
- Semivolatile organic compounds (SVOCs), analyzed by EPA Methods 8270, 8270 (low level), 8270-SIM, 8270-SIM (low level), and 8041;
- Copper, analyzed by EPA Method 6010/6020/7210;
- Benzene, toluene, ethylbenzene and total xylenes (BTEX), analyzed by EPA Method 8260B (low level); and
- Dioxins/furans (17 congeners), analyzed by EPA Method 1613 Modified (low level).

Other analyses may include:

- Nitrate by EPA Method 353.2
- Sulfate by EPA Method 300.0
- Dissolved Inorganic Carbon/Total Organic Carbon by EPA Method 415.1 and SW-846 9060

2.2. Analytical Detection Limits

Analytical methods have quantitative limitations at a given statistical level of confidence that are often expressed as the method detection limit (MDL). Individual instruments often can detect but not accurately quantify compounds at limits lower than the MDL, referred to as the instrument detection limit (IDL). When compounds are positively identified (i.e., detected) at concentrations below the MDL, the detected concentration is identified as being estimated (i.e., "J flagged). The contract laboratory will provide numerical results for all analytes that are positively identified and report them as detected above the PQL or detected below the PQL but above the IDL.

Achieving a stated detection limit for a given analyte is helpful in providing statistically useful data. Intended data uses, such as comparison to numerical criteria or risk assessments, typically dictate specific project target reporting limits (TRLs) necessary to fulfill stated objectives. The TRLs for Site COPCs are presented in Tables 1 through 3 for soil, water, and sediment, respectively. These TRLs will serve as the target laboratory PQLs for this project. It may be possible to achieve PQLs less than the TRLs under ideal conditions. However, the TRLs presented in Tables 1 through 3 are considered targets because several factors may influence final PQLs. First, moisture and other physical conditions of soil/sediment samples can affect PQLs. Second, analytical procedures may require sample dilutions or other practices to accurately quantify a particular analyte at concentrations above the range of the instrument. The effect of this is that other analytes could be reported as not detected, but at a PQL significantly higher than a specified TRL. Data users must be aware that elevated PQLs can bias statistical data summaries, and careful interpretation is required when using data sets with PQLs exceeding TRLs.

2.3. Precision

Precision is the measure of mutual agreement among replicate or duplicate measurements of an analyte from the same sample and applies to field duplicate or split samples, replicate analyses, and duplicate spiked environmental samples (matrix spike duplicates). The closer the measured values are to each other, the more precise the measurement process. Precision error may affect data usefulness. Good precision is indicative of relative consistency and comparability between different samples. Precision will be expressed as the relative percent difference (RPD) for spike sample and field duplicate comparisons of various matrices. The RPD is calculated as:

$$RPD\,(\%) = \frac{|D_1 - D_2|}{(D_1 + D_2)/2}\ X\ 100,$$

Where

D_1 = Concentration of analyte in primary sample.

D_2 = Concentration of analyte in duplicate sample.

The RPD will be calculated for samples and compared to the project RPD QC control limits. Project RPD QC control limits are listed in Tables 1 and 2 (sediment, Table 3, RPD's are as shown in Table 1). The RPD QC control limits listed in Tables 1 and 2 are only applicable if the primary and duplicate sample concentrations are greater than five times the PQL. For results less than five times the PQL, the difference between the primary and duplicate samples should be less than two times the PQL for soil/sediment samples and one times the PQL for water samples.

2.4. Accuracy

Accuracy is a measure of bias in the analytical process. The closer the measurement value is to the true value, the greater the accuracy. Accuracy is typically evaluated by adding a known spike concentration of a target or surrogate compound to a sample prior to analysis. The detected concentration or percent recovery (%R) of the spiked compound reported in the sample provides a quantitative measure of analytical accuracy. Since most environmental data collected represent single points spatially and temporally rather than an average of values, accuracy is generally more important than precision in assessing the data. In general, if %R values are low, non-detect results may be reported for compounds of interest when in fact these compounds are present (i.e., false negative results), and results for detected compounds may be biased low. The reverse is true when %R values are high. In this case, non-detect values are considered accurate, whereas detected values may be higher than true values.

For this project, accuracy will be expressed as the %R of a known surrogate spike, matrix spike, or laboratory control sample (blank spike), concentration:

$$Recovery\,(\%R) = \frac{Spiked\ Result - Unspiked\ Result}{Known\ Spike\ Concentration}\ X\ 100$$

Accuracy (%R) criteria for surrogate spikes, matrix spikes, and laboratory control samples (blank spikes) are presented in Tables 1 and 2 (sediment, Table 3, %R criteria are as shown in Table 1 for soil).

2.5. Representativeness, Completeness, and Comparability

Representativeness expresses the degree to which data accurately and precisely represent the actual site conditions. Representativeness of the data will be evaluated by:

- Comparing actual sampling procedures to those specified in this QAPP.
- Reviewing analytical results for field duplicates to determine the variability in the analytical results.
- Invalidating non-representative data or identifying data to be classified as questionable or qualitative in nature. Only representative data will be used in subsequent data reduction, validation, and reporting activities.

Completeness establishes whether a sufficient amount of valid measurements were obtained to meet project objectives. The number of samples and results expected establishes the comparative basis for completeness. The completeness goal is 90 percent useable data for the samples/analyses planned. If the completeness goal is not achieved, an evaluation will be performed to determine if the data are adequate to meet study objectives.

Comparability expresses the confidence with which one set of data can be compared to another. Although numeric goals do not exist for comparability, a statement on comparability will be prepared to assess overall usefulness of data sets generated during the project, following the evaluation of precision and accuracy.

2.6. Holding Times

Holding times are defined as the time between sample collection and extraction, sample collection and analysis, or sample extraction and analysis. Some analytical methods specify a recommended holding time for analysis only. For many methods, recommended holding times may be extended by sample preservation techniques in the field. If a sample exceeds a recommended holding time, then the results may be biased low. For example, if the extraction holding time for volatile analysis of soil samples is exceeded, then the possibility exists that some of the organic constituents may have volatilized from the sample or degraded. Results for that analysis would be qualified as estimated to indicate that the reported results may be lower than actual site conditions. Recommended holding times are presented in Tables 4 and 5.

2.7. QC Blank Samples

According to the *National Functional Guidelines for Organic Data Review* (EPA, 2008), "The purpose of laboratory (or field) blank analysis is to assess the existence and magnitude of contamination resulting from laboratory (or field) activities. The criteria for evaluation of blanks apply to any blank associated with the samples (e.g., method blanks, instrument blanks, trip blanks, and equipment blanks)." Trip blanks are placed with samples during shipment; method blanks are created during sample preparation and follow samples throughout the analysis process.

QC blanks are discussed further in Section 6.0. Analytical results for QC blanks will be interpreted in general accordance with EPA's *National Functional Guidelines for Organic and Inorganic Data Review* and professional judgment.

3.0 SAMPLE COLLECTION, HANDLING, AND CUSTODY

The SAPs (Appendices C and D of the Work Plan) discuss sample collection, handling, and custody procedures. Topics addressed in the SAPs include, but are not limited to, sampling equipment to be used; equipment decontamination procedures; field screening procedures; sample containers and labeling; sample storage; sample delivery to the analytical laboratory; chain-of-custody procedures; laboratory custody procedures; and field documentation.

4.0 CALIBRATION PROCEDURES

4.1. Field Instrumentation

Field instrument calibration and calibration checks facilitate accurate and reliable field measurements. The calibration of the instruments will be checked and adjusted as necessary in general accordance with manufacturers' recommendations. Methods and frequency of calibration checks and instrument maintenance will be based on the type of instrument, stability characteristics, required accuracy, intended use, and environmental conditions. The basic calibration check frequencies are described below.

If a photoionization detector (PID) is used for headspace vapor screening, its calibration will be checked at the start of each day it is used. If necessary (based on the calibration check results), the instrument will be calibrated in general accordance with the manufacturer's specifications. Calibration check and calibration results will be recorded in the field report.

The calibration of the water quality meter (e.g., Horiba U-22) will be checked, and if necessary, the instrument will be calibrated, prior to each water sampling event. The instrument will be calibrated in general accordance with the manufacturer's specifications. Calibration check and calibration results will be recorded in the field report.

4.2. Laboratory Instrumentation

For chemical analytical testing, calibration procedures will be performed in general accordance with the analytical methods used and the laboratory's Standard Operating Procedures (SOPs). Calibration documentation will be retained at the laboratory for a period of 6 months.

5.0 LABORATORY DATA REPORTING AND DELIVERABLES

Laboratories will report data in formatted hardcopy and electronic form to the Project Manager and QA Leader. Upon completion of analyses, the laboratory will prepare electronic deliverables for data packages in accordance with the specifications in the agreed-upon *Special Conditions for Lab Analysis* document. The laboratory will provide electronic data deliverables (EDDs) within 2 business days after GeoEngineers' receipt of printed-copy analytical results, including the appropriate QC documentation. Analytical laboratory measurements will be recorded in standard formats that display, at a minimum, the client/field sample identification, the laboratory sample identification, reporting units, analytical methods, analytes tested, analytical results, extraction and analysis dates, quantitation limits, and data qualifiers. Each sample delivery group will be accompanied by sample receipt forms and a case narrative identifying data quality issues.

GeoEngineers will establish EDD requirements with the contract laboratory.

Chromatograms will be provided for samples analyzed using Ecology Method NWTPH-Dx. The laboratory will assure that the full height of all peaks appear on the chromatograms and that the same horizontal time scale is used for all chromatograms to allow for comparisons between chromatograms.

6.0 QUALITY CONTROL SAMPLES AND PROCEDURES

QC samples will be analyzed to ensure the precision, accuracy, representativeness, comparability, and completeness of the data. Table 6 summarizes the types and frequency of QC samples to be analyzed during the investigation, including both field QC and laboratory QC samples.

6.1. Field Quality Control Samples

Field QC samples serve as a control and check mechanism to monitor the consistency of sampling methods and the influence of off-site factors on environmental samples. Examples of potential off-site factors include airborne VOCs and potable water used in drilling activities. As shown in Table 6, two types of field QC samples will be processed: field duplicates and equipment rinsate blanks. The samples are collected in the field. Descriptions of these types of QC samples are provided in the following subsections.

6.1.1. Field Duplicates

Field duplicates serve as measures for precision. They are created by placing aliquots of the collected sample in separate containers, and identifying one of the aliquots as the primary sample and the other as the duplicate sample. Field duplicates measure the precision and consistency of laboratory analytical procedures and methods, as well as the consistency of the sampling techniques used by field personnel and/or the relative homogeneity of sample matrices. The duplicate sample is submitted to gain precision information on sample homogeneity, handling, shipping, storage and preparation, and analysis. Field duplicates will be analyzed for the same parameters as the associated primary samples.

For the supplemental investigation, one field duplicate will be collected for every twenty primary soil, sediment, and water samples (i.e., a frequency of 5% for each matrix). The duplicate samples will be collected at the same locations and as close as possible to the same times as the associated primary samples.

6.1.2. Equipment Rinsate Blanks

Equipment rinsate blanks will be used to evaluate the effectiveness of decontamination procedures for preventing possible cross-contamination of soil and groundwater project samples.

Equipment rinsate samples are not required for sediment sampling. Equipment rinsate blanks are the final rinse waters from the equipment decontamination procedure. The rinsate blanks will be collected by slowly pouring the distilled water used for sampling equipment decontamination over or through the decontaminated equipment (such as split-barrel core samplers) and collecting the rinsate in appropriate sample containers for analysis. Rinsate blanks will be analyzed for the same parameters as the associated project samples.

For the supplemental investigation, one rinsate blank will be collected for every twenty primary soil samples and every twenty primary water samples (i.e., a frequency of 5 percent for each matrix). A minimum of one equipment rinsate blank will be collected for each day of sampling activities that require reuse of decontaminated equipment.

6.1.3. Other QC Samples

Discretionary QC samples include field blanks. Field blanks will be used at the discretion of the QA Leader if there is a reason to suspect contamination introduced by ambient conditions in the field. Field blanks are samples of distilled water poured directly into sample containers in the field. Field blanks are analyzed for the same parameters as the associated project samples.

6.2. Laboratory Quality Control

The analytical laboratory will follow standard analytical method procedures that include specified QC monitoring requirements. These requirements will vary by method, but generally include:

- Method blanks;
- Internal standards;
- Instrument calibrations;
- Matrix spikes/matrix spike duplicates (MS/MSDs);
- Laboratory control samples/laboratory control sample duplicates (LCS/LCSDs);
- Laboratory replicates or duplicates; and
- Surrogate spikes.

6.2.1. Laboratory Blanks

Laboratory procedures employ the use of several types of blanks but the most commonly used blanks for QA/QC assessments are method blanks. Method blanks are laboratory QC samples that consist of either a soil-like material that has undergone a contaminant destruction process, or a sample of reagent water. Method blanks are extracted and analyzed with each batch of environmental samples undergoing analysis. Method blanks are particularly useful during volatiles analysis since VOCs can be transported in the laboratory through the vapor phase. If a substance is found in the method blank, it indicates that one (or more) of the following occurred:

- Measurement apparatus or containers were not properly cleaned and contained contaminants.
- Reagents used in the analytical process were contaminated with a substance(s) of interest.
- Contaminated analytical equipment was not properly cleaned.

- Volatile substances in the air with high solubility or affinities toward the sample matrix contaminated the samples during preparation or analysis.

It is difficult to determine which of the above scenarios took place if method blank contamination occurs. However, it is assumed that the conditions that affected the blanks also likely affected the project samples. If method blank contamination occurs, validation guidelines assist in determining which substances detected in associated project samples are likely truly present in the samples and which ones are likely attributable to the analytical process.

6.2.2. Matrix Spikes/Matrix Spike Duplicates

MS/MSDs are used to assess influences or interferences caused by the physical or chemical properties of the sample itself. For example, extreme pH can affect the results of SVOC analyses. Or, the presence of a particular analyte in a sample may interfere with accurate quantitation of another analyte. MS/MSD data is reviewed in combination with other QC monitoring data to evaluate matrix effects. In some cases, matrix effects cannot be determined due to dilution and/or high levels of related substances in the sample. An MS is created by spiking a known amount of one or more of the target analytes into a project sample, ideally at a concentration at least 5 to 10 times higher than the concentration in the un-spiked sample. A %R value is calculated by subtracting the un-spiked sample result from the spiked sample result, dividing by the spike amount, and multiplying by 100.

The samples designated for MS/MSD analysis should be obtained from a boring or sampling location that is suspected to not be highly contaminated. A sample from an area of low-level contamination is needed because the objective of MS/MSD analyses is to assess possible matrix interferences, which can best be achieved with low levels of contaminants. For the supplemental investigation, additional sample volume will be collected for MS/MSD analysis for every twenty primary soil samples and every twenty primary water samples (i.e., a frequency of 5 percent for each matrix), or as determined as necessary by the analytical laboratory.

6.2.3. Laboratory Control Spikes/ Laboratory Control Spike Duplicates

Also known as blank spikes, laboratory control spikes (LCS) and laboratory control spike duplicates (LCSDs) are similar to MS/MSD samples in that a known amount of one or more of the target analytes is spiked into a prepared medium and a %R value is calculated for the spiked substance(s). The primary difference between an MS and LCS is that the LCS spike medium is considered "clean" or contaminant-free. For example, reagent water is typically used for LCS water analyses. The purpose of an LCS is to help assess the overall accuracy and precision of the analytical process including sample preparation, instrument performance, and analyst performance. LCS data must be reviewed in context with other laboratory QC data to determine if corrective action is necessary for laboratory control limit exceedances.

6.2.4. Laboratory Replicates/Duplicates

Laboratories often utilize MS/MSDs, LCS/LCSDs, and/or replicates to assess precision. Replicates are a second analysis of a field-collected environmental sample. Replicates can be split at varying stages of the sample preparation and analysis process, but most commonly consist of a second analysis on the extracted media.

6.2.5. Surrogate Spikes

Surrogate spikes are used to verify the accuracy of the analytical instrument and extraction procedures used. Surrogates are substances similar to the target analytes. A known concentration of surrogate is added to each project sample and passed through the instrument, noting the surrogate recovery. Each surrogate used has an acceptable range of %R. If a surrogate recovery is low, sample results may be biased low, and, depending on the %R value, a possibility of false negatives may exist. Conversely, when surrogate recoveries are above the specified range of acceptance, a possibility of false positives exists, although non-detected results are considered accurate.

6.2.6. Instrument Calibrations

Several types of instrument calibrations are used, depending on the method, to determine whether the methodology is 'in control' by verifying the linearity of the calibration curve and to assure that the sample results reflect accurate and precise measurements. This is done by verifying that the percent relative standard deviations (%RSD) and/or the correlation coefficients are within the control limits specified in the validation documents. The main calibrations used are initial calibrations, daily calibrations, and continuing calibration verification.

7.0 PETROPHYSICALTESTING

Petrophysical testing will be performed by PTS Laboratories (PTS) located in Santa Fe Springs, California. These tests are specialty tests that are a combination of ASTM and American Petroleum Association (API) approved procedures and propriety methods developed by PTS. PTS has internal quality assurance procedures established for these specialty tests.

8.0 DATA REDUCTION AND ASSESSMENT PROCEDURES

This section describes the process for generating and checking data, as well as the process for producing reports for field and analytical laboratory data.

8.1. Data Reduction

Data reduction involves the conversion or transcription of field and analytical data to a useable format. The laboratory personnel will reduce the analytical data for review by the QA Leader and Project Manager. This will involve both hard-copy forms and EDDs. Both forms of data will be compared with each other to verify that the data are reliable and error-free.

8.2. Review of Field Documentation and Laboratory Receipt Information

Documentation of field sampling data will be reviewed periodically for conformance with project QC requirements described in this QAPP. At a minimum, field documentation will be checked for proper documentation of the following:

- Sample collection information (date, time, location, matrices, etc.);
- Field instruments used and calibration data;

- Sample collection protocol;
- Sample containers, preservation, and volume;
- Field QC samples collected at the frequency specified;
- Chain-of-custody protocols; and
- Sample shipment information.

Sample receipt forms provided by the laboratory will be reviewed for QC exceptions. The final laboratory data package will describe (in the case narrative) the effects that any identified QC exceptions have on data quality. The laboratory will review transcribed sample collection and receipt information for correctness prior to delivering the final data package.

8.3. Data Verification/Validation

Project decisions, conclusions, and recommendations will be based upon verified (validated) data. The purpose of data verification is to ensure that data used for subsequent evaluations and calculations are scientifically valid, of known and documented quality, and legally defensible. Field data verification will be used to eliminate data not collected or documented in accordance with the protocols specified in the SAP. Laboratory data verification will be used to eliminate data not obtained using prescribed laboratory procedures.

The QA Leader will validate data collected during the supplemental investigation to ensure that the data are valid and usable. Data will be validated in general conformance with EPA functional guidelines for data validation (EPA, 2004, 2005, and 2008). At a minimum, the following items will be reviewed to verify the data as applicable:

- Documentation that a final review of the data was completed by the Laboratory QA Coordinator;
- Documentation of analytical and QC methodology;
- Documentation of sample preservation and transport;
- Sample receipt forms and case narratives; and
- The following QC parameters:
  - Holding times and sample preservation
  - Method blanks
  - MS/MSDs
  - LCS/LCSDs
  - Surrogate spikes
  - Duplicates/replicates

When sample analytical data are received from the analytical laboratory, they will undergo a QC review by the QA Leader. The accuracy and precision achieved will be compared to the laboratory's analytical control limits. Example control limits are presented in Tables 1, 2, and 3. Calculations of RPDs will follow standard statistical conventions and formulas as presented in

Section 2.0. Additional specifications and professional judgment by the QA Leader may be incorporated when appropriate data from specific matrices and field samples are available.

A data quality assessment will be prepared to document the overall quality of the data relative to the DQOs. The major components of the data quality assessment are as follows:

- **Data Validation Summary.** Summarizes the data validation results for all sample delivery groups by analytical method. The summary identifies any systematic problems, data generation trends, general conditions of the data, and reasons for any data qualification.
- **QC Sample Evaluation.** Evaluates the results of QC sample analyses, and presents conclusions based on these results regarding the validity of the project data.
- **Assessment of DQOs.** An assessment of the quality of data measured and generated in terms of accuracy, precision, and completeness relative to objectives established for the project.
- **Summary of Data Usability.** Summarizes the usability of data, based on the assessment performed in the three preceding steps.

The data quality assessment will help to achieve an acceptable level of confidence in the decisions that are to be made based upon the project data. The project analytical data will be submitted to Ecology's EIM system after the data quality assessment is completed.

9.0 REFERENCES

Environmental Protection Agency. Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, OSWER 9240.1-45, EPA 540-R-04-004. October 2004.

Environmental Protection Agency. Contract Laboratory Program National Functional Guidelines for Chlorinated Dioxin/Furan Data Review. EPA 540-R-05-01. September 2005.

Environmental Protection Agency. Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, EPA-540-R-08-01. June 2008.

Washington State Department of Ecology (Ecology), "Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies," July 2004.

Washington State Department of Ecology (Ecology), "Sediment Sampling and Analysis Appendix: Guidance on the Development of Sediment Sampling and Analysis Plans Meeting the Requirements of the Sediment Management Standards." Chapter 173-204 WAC. Ecology Publication Number 03-09-043. February 2008.

Washington Administrative Code (WAC) 173, Chapter 173-340-820.

TABLE 1

TARGET PRACTICAL QUANTITATION LIMITS
AND QUALITY CONTROL LIMITS FOR SOIL SAMPLES

R.G. HALEY INTERNATIONAL SITE

BELLINGHAM, WASHINGTON

Analyte	CAS Number	Target Practical Quantitation Limits for Soil [1]	Quality Control Limits for Soil	
			RPD*	% R
Total Petroleum Hydrocarbons by NWTPH-Gx and NWTPH-Dx (mg/kg)				
Diesel-Range Petroleum Hydrocarbons	NA	5	0-30	50-150
Heavy Oil-Range Petroleum Hydrocarbons	NA	10	0-30	50-150
Metals by EPA Methods 6000/7000 series (mg/kg)				
Copper	7440-50-8	0.2	0-20	75-125
Volatile Organic Compounds by EPA Method 8260 (ug/kg)				
Benzene	71-43-2	1.4	0-30	80 - 126
Ethylbenzene	100-41-4	25	0-30	80 - 134
Toluene	108-88-3	25	0-30	79 - 120
Xylenes (Total)	1330-20-7	3	NA	NA
Polycyclic Aromatic Hydrocarbons by EPA 8270-SIM (ug/kg)				
Acenaphthene	83-32-9	5	0-30	31 - 100
Acenaphthylene	208-96-8	5	0-30	26 - 102
Anthracene	120-12-7	5	0-30	30 - 117
Benzo(a)anthracene	56-55-3	5	0-30	36 - 125
Benzo(a)pyrene	50-32-8	5	0-30	33 - 122
Benzo(b)fluoranthene	205-99-2	5	0-30	42 - 124
Benzo(g,h,I)perylene	191-24-2	5	0-30	27 - 107
Benzo(k)fluoranthene	207-08-9	5	0-30	37 - 129
Chrysene	218-01-9	5	0-30	42 - 115
Dibenzo(a,h)anthracene	53-70-3	5	0-30	30 - 128
Fluoranthene	206-44-0	5	0-30	43 - 119
Fluorene	86-73-7	5	0-30	33 - 106
Indeno(1,2,3-cd)pyrene	193-39-5	5	0-30	29 - 126
Naphthalene	91-20-3	5	0-30	27 - 107
Phenanthrene	85-01-8	5	0-30	38 - 108
Pyrene	129-00-0	5	0-30	36 - 122
Total cPAHs TEC	NA	3.8	NA	NA
Chlorophenols by EPA 8041 (mg/kg)				
Pentachlorophenol	87-86-5	0.00625	0-30	10-162
2,4,6-Trichlorophenol	88-06-2	0.00625	NA	NA
Semivolatile Organic Compounds by EPA 8270-Low level (ug/kg)				
2-Methylnaphthalene	91-57-6	20	0-30	27 - 107
2-Methylphenol	95-48-7	20	0-30	37 - 100
2,4-Dichlorophenol	120-83-2	100	0-30	41 - 100
2,4-Dimethylphenol	105-67-9	40	0-30*	34 - 100
2,4,5-Trichlorophenol	95-95-4	100	0-30	43 - 103
2,3,4,6-Tetrachlorophenol	58-90-2	100	0-30	
Butyl benzyl phthalate	85-68-7	20	0-30	35 - 122
Dibenzofuran	132-64-9	20	0-30	53 - 100
N-Nitrosodiphenylamine	86-30-6	20	0-30	27 - 162

Analyte	CAS Number	Target Practical Quantitation Limits for Soil [1]	Quality Control Limits for Soil	
			RPD*	% R
Dioxins/Furans by EPA 1613 Modified-Low level (ng/kg)				
2,3,7,8-TCDD	1746-01-6	1	NA	67-158
1,2,3,7,8-PeCDD	40321-76-4	1	NA	70–142
1,2,3,4,7,8-HxCDD	39227-28-6	2.5	NA	70-164
1,2,3,6,7,8-HxCDD	57653-85-7	2.5	NA	76-134
1,2,3,7,8,9-HxCDD	19408-74-3	2.5	NA	64-162
1,2,3,4,6,7,8-HpCDD	35822-46-9	2.5	NA	82-132
OCDD	3268-87-9	5	NA	78-144
2,3,7,8-TCDF	51207-31-9	1	NA	75-158
1,2,3,7,8-PeCDF	57117-41-6	2.5	NA	70–142
2,3,4,7,8-PeCDF	57117-31-4	1	NA	68-160
1,2,3,4,7,8-HxCDF	70648-26-9	2.5	NA	70-164
1,2,3,6,7,8-HxCDF	57117-44-9	2.5	NA	76-134
2,3,4,6,7,8-HxCDF	60851-34-5	2.5	NA	70–156
1,2,3,7,8,9-HxCDF	72918-21-9	2.5	NA	78-130
1,2,3,4,6,7,8-HpCDF	67562-39-4	2.5	NA	82-132
1,2,3,4,7,8,9-HpCDF	55673-89-7	2.5	NA	78-138
OCDF	39001-02-0	5	NA	63-170
Total Dioxins/Furans TEC (in ng/kg)	NA	0.57	NA	NA
Total Dioxins/Furans TEC (in mg/kg)	NA	5.7E-07	NA	NA

Notes:

[1] The laboratory analytical reports for dioxin and furan analyses will report the Effective Detection Limit (EDL) in addition to the target RL. The EDL is generally an order of magnitude less than the RL. However, the EDL is compound and sample specific and therefore, will vary. The EDL will be used as the limit of detection for evaluating dioxin and furan concentratio

CAS = Chemical Abstract Services

RPD = Relative percent difference

% R = Percent recovery

* Listed RPD is for laboratory replicates and duplicate spiked samples; RPD goal for field duplicates is 0-50.

NWTPH = Northwest Total Petroleum Hydrocarbons

Gx = Gasoline extended range

Dx = Diesel extended range

mg = Milligrams

ug = Micrograms

kg = Kilograms

ng = Nanograms

NA = Not applicable

TEC = Toxic equivalent concentration; PQL calculated as prescribed in WAC 173-340 using one-half the PQL for individual constituents.

TABLE 2

TARGET PRACTICAL QUANTITATION LIMITS
AND QUALITY CONTROL LIMITS FOR GROUNDWATER SAMPLES

R.G. HALEY INTERNATIONAL SITE

BELLINGHAM, WASHINGTON

Analyte	CAS Number	Target Practical Quantitation Limits for Water [1]	Quality Control Limits for Water	
			RPD*	% R
Total Petroleum Hydrocarbons by NWTPH-Gx and NWTPH-Dx (ug/L)				
Diesel-Range Petroleum Hydrocarbons	NA	250	0-30	50-150
Heavy Oil-Range Petroleum Hydrocarbons	NA	500	0-30	50-150
Metals by EPA Methods 200.8 and 7470 (ug/L)				
Copper	7440-50-8	0.5	0-20	75-125
Volatile Organic Compounds by EPA Method 8260-Low level (ug/L)				
Benzene	71-43-2	0.45	0-30	73 - 120
Ethylbenzene	100-41-4	0.42	0-30	71 - 128
Toluene	108-88-3	0.48	0-30	74 - 120
Xylenes (Total)	1330-20-7	0.78	NA	NA
Polycyclic Aromatic Hydrocarbons by EPA 8270-SIM-Low level (ug/L)				
Acenaphthene	83-32-9	0.01	0-30	33 - 114
Acenaphthylene	208-96-8	0.01	0-30	25 - 104
Anthracene	120-12-7	0.01	0-30	18 - 113
Benzo(a)anthracene	56-55-3	0.01	0-30	31 - 125
Benzo(a)pyrene	50-32-8	0.01	0-30	10 - 109
Benzo(b)fluoranthene	205-99-2	0.01	0-30	31 - 134
Benzo(g,h,I)perylene	191-24-2	0.01	0-30	17 - 133
Benzo(k)fluoranthene	207-08-9	0.01	0-30	39 - 128
Chrysene	218-01-9	0.01	0-30	50 - 121
Dibenzo(a,h)anthracene	53-70-3	0.01	0-30	30 - 126
Fluoranthene	206-44-0	0.01	0-30	37 - 135
Fluorene	86-73-7	0.01	0-30	42 - 112
Indeno(1,2,3-cd)pyrene	193-39-5	0.01	0-30	32 - 124
Naphthalene	91-20-3	0.01	0-30	31 - 111
Phenanthrene	85-01-8	0.01	0-30	46 - 118
Pyrene	129-00-0	0.01	0-30	36 - 132
Total cPAHs TEC	NA	0.0076	NA	NA
Chlorophenols by EPA 8041 (ug/L)				
Pentachlorophenol	87-86-5	0.25	0-30	27-115
2,4,6-Trichlorophenol	87-86-5	0.25	NA	NA
Semivolatile Organic Compounds by EPA 8270 (ug/L)				
2-Methylnaphthalene	91-57-6	1	0-30	27 - 107
2-Methylphenol	95-48-7	5	0-30	37 - 100
2,4-Dichlorophenol	120-83-2	5	0-30	30 - 134
2,4-Dimethylphenol	105-67-9	3	0-30	15 - 118
2,4,5-Trichlorophenol	95-95-4	5	0-30	36 - 134
Butyl benzyl phthalate	85-68-7	1	0-30	14 - 172
Dibenzofuran	132-64-9	1	0-30	53 - 100
N-Nitrosodiphenylamine	86-30-6	1	0-30	44 - 155
Dioxins/Furans by EPA 1613 Modified-Low level (pg/L)				
2,3,7,8-TCDD	1746-01-6	10	NA	67-158
1,2,3,7,8-PeCDD	40321-76-4	50	NA	70–142
1,2,3,4,7,8-HxCDD	39227-28-6	50	NA	70-164
1,2,3,6,7,8-HxCDD	57653-85-7	50	NA	76-134
1,2,3,7,8,9-HxCDD	19408-74-3	50	NA	64-162
1,2,3,4,6,7,8-HpCDD	35822-46-9	50	NA	82-132
OCDD	3268-87-9	100	NA	78-144
2,3,7,8-TCDF	51207-31-9	10	NA	75-158
1,2,3,7,8-PeCDF	57117-41-6	50	NA	70–142
2,3,4,7,8-PeCDF	57117-31-4	50	NA	68-160
1,2,3,4,7,8-HxCDF	70648-26-9	50	NA	70-164

Analyte	CAS Number	Target Practical Quantitation Limits for Water [1]	Quality Control Limits for Water	
			RPD*	% R
Dioxins/Furans by EPA 1613 Modified-Low level (pg/L) (continued)				
1,2,3,6,7,8-HxCDF	57117-44-9	50	NA	76-134
2,3,4,6,7,8-HxCDF	60851-34-5	50	NA	70–156
1,2,3,7,8,9-HxCDF	72918-21-9	50	NA	78-130
1,2,3,4,6,7,8-HpCDF	67562-39-4	50	NA	82-132
1,2,3,4,7,8,9-HpCDF	55673-89-7	50	NA	78-138
OCDF	39001-02-0	100	NA	63-170
Total Dioxins/Furans TEC (in pg/L)	NA	5.7	NA	NA
Total Dioxins/Furans TEC (in ug/L)	NA	5.7E-06	NA	NA
Water Quality (m/L)				
Nitrate	NA	NA	NA	NA
Sulfate	14808-79-8	NA	NA	NA
Total Organic Carbon	NA	NA	NA	NA
Dissolved Inorganic Carbon	NA	NA	NA	NA

Notes:

[1] The laboratory analytical reports for dioxin and furan analyses will report the Effective Detection Limit (EDL) in addition to the target RL. The EDL is generally an order of magnitude less than the RL. However, the EDL is compound and sample specific and therefore, will vary. The EDL will be used as the limit of detection for evaluating dioxin and furan concentrations.

CAS = Chemical Abstract Services

RPD = Relative percent difference

% R = Percent recovery

* Listed RPD is for laboratory replicates and duplicate spiked samples; RPD goal for field duplicates is 0-35.

NWTPH = Northwest Total Petroleum Hydrocarbons

Gx = Gasoline extended range

Dx = Diesel extended range

mg = Milligrams

ug = Micrograms

kg = Kilograms

ng = Nanograms

pg = Picograms

NA = Not applicable

TEC = Toxic equivalent concentration; PQL calculated as prescribed in WAC 173-340 using one-half the PQL for individual constituents.

Analytes	Screening Criteria[1]	Target PQL/RL[2,3]
1,2,3,4,7,8,9-HpCDF	--	2.5
OCDF	--	5

Notes:

[1] Screening criteria are Sediment Management Standards (SMS) Lowest Apparent Effects Threshold (LAET) unless otherwise noted.

[2] Target PQLs and RLs obtained from Analytical Resources, Inc. of Tukwila, Washington.

[3] The laboratory analytical reports for dioxin and furan analyses will report the Effective Detection Limit (EDL) in addition to the target RL. The EDL is generally an order of magnitude less than the RL. However, the EDL is compound and sample specific and therefore, will vary. The EDL will be used as the limit of detection for evaluating dioxin and furan concentrations.

[4] Numerical criteria for sediment do not currently exist for petroleum hydrocarbons under SMS. A screening level for petroleum hydrocarbons of 200 mg/kg was used by Ecology to screen petroleum hydrocarbon results collected as part of a study in Bellingham Bay performed by Hart Crowser in 2009. The petroleum hydrocarbon screening level used by Ecology (i.e., 200 mg/kg) is being used in this study.

PQL = Practical quantitation limit

RL = Reporting limit

TPH = Total petroleum hydrocarbons

LPAHs = Low molecular weight polyclic aromatic hydrocarbons

HPAHs = High molecular weight polyclic aromatic hydrocarbons

TEC ND=0 denotes toxic equivalent concentration calculated treating non-detections as zero.

TEC ND=1/2 denotes toxic equivalent concentration calculated treating non-detections at one half the detection limit.

-- No screening criteria available

µg/kg = microgram per kilogram

mg/kg = milligram per kilogram

ng/kg = nanogram per kilogram

TABLE 3

TARGET PRACTICAL QUANTITATION LIMITS FOR SEDIMENT SAMPLES

R.G. HALEY INTERNATIONAL SITE

BELLINGHAM, WASHINGTON

Analytes	Screening Criteria[1]	Target PQL/RL[2,3]
Metals (mg/kg)		
Mercury	0.41	0.05
Petroleum Hydrocarbons (mg/kg)		
Diesel-range Hydrocarbons	--	10
Heavy Oil-Range Hydrocarbons	--	10
Total TPH	200 [4]	50
Total LPAHs (ug/kg)		
Total LPAH	5,200	140
Naphthalene	2,100	20
Acenaphthylene	1,300	20
Acenaphthene	500	20
Fluorene	540	20
Phenanthrene	1,500	20
Anthracene	960	20
2-Methylnaphthalene	670	20
Total HPAHs (ug/kg)		
Total HPAH	12,000	240
Fluoranthene	1,700	20
Pyrene	2,600	20
Benzo(a)anthracene	1,300	20
Chrysene	1,400	20
Total Benzofluoranthenes	3,200	40
Benzo(a)pyrene	1,600	20
Indeno(1,2,3-cd)pyrene	600	20
Dibenzo(a,h)anthracene	230	20
Benzo(ghi)perylene	670	20
Chlorinated Hydrocarbons (ug/kg)		
1,2-Dichlorobenzene	35	5
1,3-Dichlorobenzene	170	5
1,4-Dichlorobenzene	110	5
1,2,4-Trichlorobenzene	31	5
Hexachlorobenzene	22	5

Analytes	Screening Criteria[1]	Target PQL/RL[2,3]
Phthalates (ug/kg)		
Dimethyl phthalate	71	20
Diethyl phthalate	200	50
Dibutyl phthalate	1,400	20
Butyl benzyl phthalate	63	20
Bis(2-Ethylhexyl) Phthalate	1,300	25
Di-N-Octyl Phthalate	6,200	20
Miscellaneous Extractables (ug/kg)		
Dibenzofuran	540	20
Hexachlorobutadiene	11	5
N-Nitrosodiphenylamine	28	20
Benzyl Alcohol	57	20
Benzoic Acid	650	400
Phenols (ug/kg)		
Phenol	420	20
2-methylphenol	63	20
4-methylphenol	670	40
2,4-Dimethylphenol	29	20
Pentachlorophenol	360	200
Dioxins and Furans (ng/kg)		
2,3,7,8-TCDD	--	1
1,2,3,7,8-PeCDD	--	1
1,2,3,4,7,8-HxCDD	--	2.5
1,2,3,6,7,8-HxCDD	--	2.5
1,2,3,7,8,9-HxCDD	--	2.5
1,2,3,4,6,7,8-HpCDD	--	2.5
OCDD	--	5
2,3,7,8-TCDF	--	1
1,2,3,7,8-PeCDF	--	2.5
2,3,4,7,8-PeCDF	--	1
1,2,3,4,7,8-HxCDF	--	2.5
1,2,3,6,7,8-HxCDF	--	2.5
1,2,3,7,8,9-HxCDF	--	2.5
2,3,4,6,7,8-HxCDF	--	2.5
1,2,3,4,6,7,8-HpCDF	--	2.5

Analytes	Screening Criteria[1]	Target PQL/RL[2,3]
1,2,3,4,7,8,9-HpCDF	--	2.5
OCDF	--	5

Notes:

[1] Screening criteria are Sediment Management Standards (SMS) Lowest Apparent Effects Threshold (LAET) unless otherwise noted.

[2] Target PQLs and RLs obtained from Analytical Resources, Inc. of Tukwila, Washington.

[3] The laboratory analytical reports for dioxin and furan analyses will report the Effective Detection Limit (EDL) in addition to the target RL. The EDL is generally an order of magnitude less than the RL. However, the EDL is compound and sample specific and therefore, will vary. The EDL will be used as the limit of detection for evaluating dioxin and furan concentrations.

[4] Numerical criteria for sediment do not currently exist for petroleum hydrocarbons under SMS. A screening level for petroleum hydrocarbons of 200 mg/kg was used by Ecology to screen petroleum hydrocarbon results collected as part of a study in Bellingham Bay performed by Hart Crowser in 2009. The petroleum hydrocarbon screening level used by Ecology (i.e., 200 mg/kg) is being used in this study.

PQL = Practical quantitation limit

RL = Reporting limit

TPH = Total petroleum hydrocarbons

LPAHs = Low molecular weight polyclic aromatic hydrocarbons

HPAHs = High molecular weight polyclic aromatic hydrocarbons

TEC ND=0 denotes toxic equivalent concentration calculated treating non-detections as zero.

TEC ND=1/2 denotes toxic equivalent concentration calculated treating non-detections at one half the detection limit.

-- No screening criteria available

µg/kg = microgram per kilogram

mg/kg = milligram per kilogram

ng/kg = nanogram per kilogram

TABLE 4

SEDIMENT TEST METHODS, SAMPLE CONTAINERS, PRESERVATION AND HOLDING TIMES

R.G. HALEY INTERNATIONAL SITE

BELLINGHAM, WASHINGTON

Analysis	Method [1]	Soil/Sediment				Water			
		Minimum Sample Size	Sample Containers	Sample Preservation	Holding Times [2]	Minimum Sample Size	Sample Containers	Sample Preservation	Holding Times [2]
Diesel- and Heavy Oil-Range Total Petroleum Hydrocarbons	Ecology NWTPH-Dx with acid/silica gel cleanup	25 g	8 oz widemouth with Teflon-lined lid	Cool ≤6°C	14 days to extraction (1 year if frozen), 40 days from extraction to analysis	500 mL	Two 500 mL amber glass with Teflon-lined lid	Cool ≤6°C	7 days to extraction 40 days from extraction to analysis
SVOCs	EPA 8270 (soil at PSEP levels)	50 g	(2) 8 oz or one 16 oz glass widemouth with Teflon-lined lid	Cool ≤6°C	14 days to extraction (1 year if frozen), 40 days from extraction to analysis	500 mL	Two 500 mL amber glass with Teflon-lined lid	Cool ≤6°C	7 days to extraction 40 days from extraction to analysis
Chlorophenols (Pentachlorophenol & 2,4,6-Trichlorophenol)	EPA 8041	50 g	(2) 8 oz or one 16 oz glass widemouth with Teflon-lined lid (share same jar as SVOC)	Cool ≤6°C	14 days to extraction (1 year if frozen), 40 days from extraction to analysis	500 mL	Two 500 mL amber glass with Teflon-lined lid	Cool ≤6°C	7 days to extraction 40 days from extraction to analysis
cPAHs	EPA 8270 SIM (Request "low level" for water samples)	30 g	(2) 8 oz or one 16 oz glass widemouth with Teflon-lined lid (share same jar as SVOC)	Cool ≤6°C	14 days to extraction (1 year if frozen), 40 days from extraction to analysis	500 mL	Two 500 mL amber glass with Teflon-lined lid	Cool ≤6°C	7 days to extraction 40 days from extraction to analysis
Mercury	EPA 6010B/6020/200.8/7740/7471	100 g	2 or 4 oz glass widemouth with Teflon-lined lid	Cool ≤6°C	180 days to digestion, 180 days to analysis (28 days for mercury)	500 mL	1 L HDPE	HNO_3 - pH<2 (Dissolved metals preserved after filtration)	180 days to digestion, 180 days to analysis (28 days for mercury)
Dioxins/Furans	EPA 1613 Modified	100 g	8 oz glass widemouth with Teflon-lined lid	Cool ≤6°C	1 year to extraction analyzed within 45 days of extraction	1 L	Two 1 L amber glass with Teflon-lined lid	Cool ≤6°C	1 year to extraction analyzed within 45 days of extraction
Total Organic Carbon	Plumb, 1981	25 g	4 oz glass widemouth with Teflon-lined lid	Cool ≤6°C	14 days to sample prep, 180 days to analysis	NA	NA	NA	NA

Analysis	Method [1]	Soil/Sediment				Water			
		Minimum Sample Size	Sample Containers	Sample Preservation	Holding Times [2]	Minimum Sample Size	Sample Containers	Sample Preservation	Holding Times [2]
Total Solids	PSEP, 1986	25 g	4 oz glass widemouth with Teflon-lined lid (share same jar as TOC)	Cool ≤6°C	7 days: when used for dry weight correction, same as parameter	NA	NA	NA	NA
Grain Size	PSEP, 1986	300 g	16 oz HDPE	Cool ≤6°C	6 months	NA	NA	NA	NA

Notes:

[1]Target practical quantitation limits are listed in QAPP Tables 1 and 2.

[2]Holding times are based on elapsed time from date of sample collection.

[3]VOCs analysis in water will be conducted using EPA Method 8260 lowest level reporting limits (20 ml purge) and must include acrolein and acrylonitrile in suite of VOCs analyzed.

cPAHs = Carcinogenic polycyclic aromatic hydrocarbons

SVOCs = Semivolatile organic compounds

VOCs = Volatile organic compounds

PSEP = Puget Sound Estuary Program

HCl = Hydrochloric acid

HNO_3 = Nitric acid

H_2SO_4 = Sulfuric acid

HDPE = High density polyethylene

oz = Ounce

mL = Milliliter

L = Liter

g = Gram

TABLE 5

SOIL AND WATER TEST METHODS, SAMPLE CONTAINERS, PRESERVATIVES AND HOLDING TIMES

R.G. HALEY INTERNATIONAL SITE

BELLINGHAM, WASHINGTON

Analysis	Method	Minimum Sample Size		Sample Containers		Sample Preservatives		Sample Holding Times[2]	
		Soil	Water	Soil	Water	Soil	Water	Soil	Water
BTEX	EPA 8260B[1]	50 g	120 mL	2 oz glass widemouth with Teflon-lined septa lid	3 - 40 mL VOA Vials	Cool ≤6°C	Cool ≤6 °C, HCl to pH < 2	14 days	14 days
SVOCs	EPA 8270C	50 g	1 L	4 or 8 oz glass widemouth with Teflon-lined lid	Two 500-mL amber glass with Teflon-lined lid	Cool ≤6°C	Cool ≤6°C	14 days to extraction, 40 days from extract to analysis	7 days to extraction, 40 days from extract to analysis
Copper	ICP EPA 6020/200.8	10 g	500 mL	4 or 8 oz glass widemouth with Teflon-lined lid	500 mL HDPE	Cool ≤6°C	Cool ≤6 °C, HNO_3 to pH < 2	180 days to digestion, 180 days to analysis	180 days to digestion, 180 days to analysis
Dioxins/Furans	EPA 8290 and EPA 1613	50 g	1 L	4 or 8 oz glass widemouth with Teflon-lined lid	Two 1 liter amber glass with Teflon-lined lid	Cool ≤6°C	Cool ≤6°C	1 year to extraction analyzed within 45 days of extraction	1 year to extraction analyzed within 45 days of extraction
Diesel-range Hydrocarbons	NWTPH-Dx	20 g	500 mL	4 or 8 oz glass widemouth with Teflon-lined lid	Two 500-mL amber glass with Teflon-lined lid	Cool ≤6°C	Cool ≤6 °C, HCl to pH < 2 optional	14 days	14 days preserved, 7 days unpreserved, 40 days from extract to analysis
UV Photography and Petrophysical Testing	Various	--	--	Frozen core, maximum length of 2.5 feet.	--	Freeze	--	Send to PTS Laboratory within two days of collection	--

Notes:

[1]Sample extraction and analysis for BTEX in soil will be in accordance with EPA Method 5035A for low-level volatiles analysis.

[2]Holding times are based on elapsed time from date of sample collection.

BTEX = benzene, toluene, ethylbenzene, xylenes

SVOC = Semivolatile organic compounds

VOA = Volatile organic analysis

HCl = Hydrochloric Acid

HDPE = High density polyethylene

HNO_3 = nitric acid

oz = ounce

mL = milliliter

L = liter

g = gram

TABLE 6

QUALITY CONTROL SAMPLES TYPE AND MINIMUM FREQUENCY

R.G. HALEY INTERNATIONAL SITE

BELLINGHAM, WASHINGTON

Parameter	Field QC Samples		Laboratory QC Samples			
	Field Duplicates	**Equipment Rinsate Blanks**	**Method Blanks**	**LCS or OPR**	**MS/MSD**	**Lab Duplicates**
Diesel- and Heavy Oil-Range Total Petroleum Hydrocarbons (with acid/silica gel cleanup)	1 per 20 primary groundwater/soil/sediment samples	1 per 20 primary groundwater/soil samples (1 per day minimum)	1 per batch*	1 per batch*	1 per batch*	NA
SVOCs (incl. PCP)			1 per batch*	1 per batch*	1 per batch*	NA
Metals			1 per batch*	1 per batch*	MS per batch*	1 per batch*
Dioxins/Furans			1 per batch*	1 per batch*	NA	NA

Notes:

*An analytical batch is defined as a group of samples taken through a preparation procedure and sharing a method blank, LCS, and MS/MSD (or MS and lab duplicate). No more than 20 field samples are contained in one batch.

LCS = Laboratory control sample

OPR = Ongoing precision and recovery

MS = Matrix spike

MSD = Matrix spike duplicate

SVOCs = Semivolatile organic compounds

PCP = Pentachlorophenol

NA = Not applicable

APPENDIX F
Site Health and Safety Plan

Final Site Health and Safety Plan

R.G. Haley International Site
Bellingham, Washington

for
City of Bellingham

February 23, 2012

GeoEngineers

Plaza 600 Building
600 Stewart Street, Suite 1700
Seattle, Washington 98101
206.728.2674

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GEOENGINEERS, INC.
SITE HEALTH AND SAFETY PLAN
SUPPLEMENTAL DATA COLLECTION FIELD INVESTIGATION
R.G. HALEY INTERNATIONAL CORPORATION
FILE NO. 0356-114-06

This HASP is to be used in conjunction with the GeoEngineers Safety Program Manual. Together, the written safety programs and this HASP constitute the site safety plan for this site. This plan is to be used by GeoEngineers personnel on this site and must be available on-site. If the work entails potential exposures to other substances or unusual situations, additional safety and health information will be included, and the plan will need to be approved by the GeoEngineers Health and Safety Manager. All plans are to be used in conjunction with current standards and policies outlined in the GeoEngineers Health and Safety Program Manual.

Liability Clause: If requested by subcontractors, this site safety plan may be provided for informational purposes only. In this case, Form 3 shall be signed by the subcontractor. Please be advised that this Site Safety Plan is intended for use by GeoEngineers Employees only. Nothing herein shall be construed as granting rights to GeoEngineers' subcontractors or any other contractors working on this site to use or legally rely on this Site Safety Plan. GeoEngineers specifically disclaims any responsibility for the health and safety of any person not employed by them.

1.0 GENERAL PROJECT INFORMATION

Project Name:	R. G. Haley Supplemental Data Collection Field Investigation
Project Number:	00356-114-06
Type of Project:	Subsurface investigation and groundwater, soil, and sediment sampling
Site Address	500 Cornwall Ave, Bellingham, WA
Start/Completion:	2011-2012
Subcontractors:	Utility Locate Contractor Drilling Contractor Excavation Contractor Survey Contractor Subtidal Sediment Sampling

2.0 WORK PLAN

GeoEngineers will conduct an environmental investigation of the R.G. Haley International Site (Site). The purpose of the investigation is to fill specific data gaps so that a comprehensive characterization of the contaminants of potential concern (COPCs) associated with former wood treating operations can be completed. Information obtained from this investigation will be used to evaluate cleanup action alternatives for the Site. The investigation scope is expected to include:

- Subsurface investigation including drilling and surface soil sampling using a hand auger. Soil samples will be obtained, field screened, and submitted to a laboratory.
- Installation and development of groundwater monitoring wells; redevelopment of existing groundwater monitoring wells, low-flow groundwater sampling from monitoring wells, and hydrologic testing of wells.
- Sampling floating oil product in wells.
- Sampling sediment in intertidal and subtidal portions of the Site. Subtidal sampling will include sampling from a boat (subcontracted).
- Video survey of sto0rmwater drains and sampling of solids in the drains.
- Analytical testing for COPCs in collected samples may include: metals, VOCs, SVOCs (including cPAHs), PCBs, diesel-range, and heavy oil-range total petroleum hydrocarbons, and dioxins and furans. Bioassays will be conducted on sediment samples.
- Surveying of exploration locations.

2.1 Site Description

The approximately 7-acre site, located at the foot of Cornwall Avenue in Bellingham, Washington, is relatively flat. The Site is vacant and most of it is surrounded by a chain link fence. Inside the fence is an ecology block wall area that designates where recovered fluids are stored. Monitoring wells and areas where additional explorations will be completed are located both inside and outside the fenced area. Vehicle access to the site is limited to authorized vehicles by a gate across the access road. The shoreline is accessible to the public.

2.2 Site History

Wood treatment activities were conducted at the site from about 1951 to 1985. The wood was treated using pentachlorophenol (PCP) in a P-9 carrier oil (diesel-range petroleum) and this liquid was released to soil and groundwater at the Site.

Chemicals released at the Site include pentachlorophenol (PCP) in a diesel oil carrier (P9 oil), dioxins/furans (associated with the PCP), and polycyclic aromatic hydrocarbons.

2.3 List of Field Activities

Check the activities to be completed during the project:

	Site reconnaissance	X	Field Screening of Soil Samples
X	Exploratory Borings	X	Vapor Measurements
	Construction Monitoring	X	Groundwater Sampling
X	Surveying	X	Groundwater Depth and Free Product Measurement
	Test Pit Exploration	X	Product Sample Collection
X	Monitoring Well Installation		Soil Stockpile Testing
X	Monitoring Well Development		Remedial Excavation
X	Soil Sample Collection		Underground Storage Tank (UST) Removal Monitoring
	Remediation System Monitoring	X	Sediment Sampling

Check the activities to be completed during the project:

3.0 LIST OF FIELD PERSONNEL AND TRAINING

Name of Employee on Site	Level of HAZWOPER Training (24-/40-hr)	Date of 8-Hr Refresher Training	Date of HAZWOPER Supervisor Training	First Aid/ CPR	Date of Other Trainings	Date of Respirator Fit Test
Amanda K. Fickeisen	40	5/5/2010	NA	11/23/2009	NA	4/6/2011
Robert Miyahira	40	11/1/09	02/22/01	03/25/10	--	03/17/10
Brian Anderson	40	12/11/08	12/04/02	09/18/08	08/15/08	--
Garrett Leque	40	6/15/11	--	8/15/11	--	2/3/10

Chain of Command	Title	Name	Telephone Numbers
1	Project Manager	Jay Lucas	206-437-9561 (c)
2	HAZWOPER Supervisor	Jay Lucas	206-437-9561 (c)
3	Field Engineer/Geologist	Robert Miyahira	425-861-6067 (o) 425-941-2055 (c)
		Garrett Leque	253-312-7958 (c)
4	Site Safety and Health Supervisor*	Amanda K. Fickeisen	360-441-2961 (c)
		Robert Miyahira	425-941-2055 (c)
		Brian Anderson	425-750-1326 (c)
5	Client Assigned Site Supervisor	TBD	
6	Health and Safety Program Manager	Wayne Adams	W 253-383-4940
7	Current Owner	City of Bellingham - Sam D. Shipp	W 360-778-7900
8	Subcontractors	TBD	

* **Site Safety and Health Supervisor** – The individual present at a hazardous waste site responsible to the employer and who has the authority and knowledge necessary to establish the site-specific health and safety plan and verify compliance with applicable safety and health requirements.

4.0 EMERGENCY INFORMATION

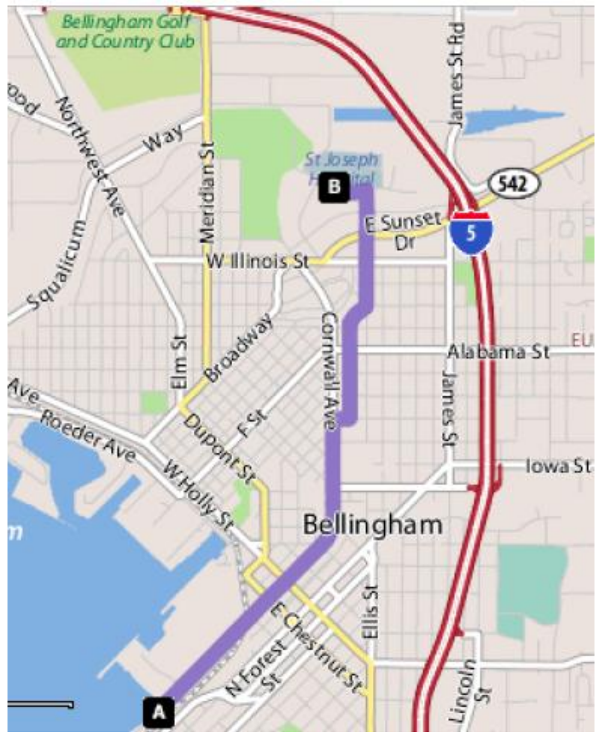
Hospital Name and Address:

St. Joseph Hospital
2901 Squalicum Parkway
Bellingham, WA 98225-1898
Phone: (360) 734-5400

Phone Numbers (Hospital ER): ER: 206.731.3000

Route to Hospital:
Distance: 2.58 miles
Time: 12 minutes

1. Start at 500 CORNWALL AVE, BELLINGHAM going toward E PINE ST - go 1.4 mi/
2. Turn Right on VIRGINIA ST
3. Turn Left on DEAN AVE - go 0.4 mi/
4. Continue on HAMPTON PL - go 0.1 mi/
5. Bear Left on ELLIS ST - go 0.5 mi/
6. Turn Left on SQUALICUM PKY - go 0.1 mi/
7. Arrive at 2901 SQUALICUM PKY, BELLINGHAM, on the Right



Ambulance: 9-1-1
Poison Control: (800) 732-6985
Police: 9-1-1
Fire: 9-1-1
Location of Nearest Telephone: Cell phones are carried by field personnel.
Nearest Fire Extinguisher: Located in the GeoEngineers vehicle on-site.
Nearest First-Aid Kit: Located in the GeoEngineers vehicle on-site.

4.1 Standard Emergency Procedures

Get help

- Send another worker to phone 9-1-1 (if necessary)

- As soon as feasible, notify GeoEngineers' Project Manager

Reduce risk to injured person

- Turn off equipment
- Move person from injury location (if in life-threatening situation only)
- Keep person warm
- Perform CPR (if necessary)

Transport injured person to medical treatment facility (if necessary)

- By ambulance (if necessary) or GeoEngineers vehicle
- Stay with person at medical facility
- Keep GeoEngineers manager apprised of situation and notify Human Resources Manager of situation

5.0 HAZARD ANALYSIS

- Note: A hazard assessment will be completed at every site prior to beginning field activities. Updates will be included in the daily log. This list is a summary of hazards listed on the form.

5.1 Physical Hazards

X	Drill rigs and Concrete Coring, including working inside a warehouse
	Backhoe
	Trackhoe
	Crane
	Front End Loader
	Excavations/trenching (1:1 slopes for Type B soil)
	Shored/braced excavation if greater than 4 feet of depth
	Overhead hazards/power lines
X	Tripping/puncture hazards: working close to eroded 4 to 6 foot tall bluff along shoreline. In places the edge of the bluff is obscured by vegetation so care should be taken to ensure sure footing.
	Unusual traffic hazard – Street traffic: Transients frequent the site and GeoEngineers personnel should leave the Site and call police at any indication of a threat.
X	Heat/Cold, Humidity
X	Utilities/ utility locate
X	Tide fluctuations in portion of Site affected by tides

- High-visibility vests will be worn by on-site personnel to ensure they can be seen by vehicle and equipment operators.
- Field personnel will be aware at all times of the location and motion of heavy equipment in the area of work to ensure a safe distance between personnel and the equipment. Personnel will be visible to the operator at all times and will remain out of the swing and/or direction of the equipment apparatus. Personnel will approach operating heavy equipment only when they are certain the operator has indicated that it is safe to do so through hand signal or other acceptable means.
- Safety glasses will be worn during sampling to protect against splashing or other potential eye injuries.
- Caution will be taken near the drill rig to avoid moving parts of the drill rig, as well as falling or flying objects.
- Field personnel will minimize time spent near drill rig; will not wear loose clothing; will use safety glasses, hard hat, and steel-toed boots.
- Personnel will avoid tripping hazards, steep slopes, pits and other hazardous encumbrances. If it becomes necessary to work within 6 feet of the edge of a pit, slope or other potentially hazardous area, appropriate fall protection measures will be implemented by the Site Safety and Health Supervisor in accordance with OSHA/DOSH regulations and the GeoEngineers Health and Safety Program.
- Personnel shall understand the times and magnitude of tides when working in the intertidal areas.
- Cold stress control measures will be implemented according to the GeoEngineers Health and Safety Program to prevent frost nip (superficial freezing of the skin), frost bite (deep tissue freezing), or hypothermia (lowering of the core body temperature). Heated break areas and warm beverages shall be available during periods of cold weather.
- Heat stress control measures required for this site will be implemented according to GeoEngineers Health and Safety Program with water provided on-site.

5.2 Engineering Controls

______	Trench shoring (1:1 slope for Type B Soils)
X	Location work spaces upwind/wind direction monitoring
X	Other soil covers (as needed)
X	Dust Control (as needed)

5.3 Chemical Hazards

CHEMICAL HAZARDS (POTENTIALLY PRESENT AT SITE)

SUBSTANCE	PATHWAYS
Pentachlorophenol	Free product/Water/Soil
Dioxins and Furans (PCDD's, TCDD's, related congeners and other organics)	Free product /Water/Soil
Diesel fuel	Free product/ Water/Soil
Polycyclic aromatic hydrocarbons (PAHs)	Free product /Water/Soil

SPECIFIC CHEMICAL HAZARDS AND EXPOSURES (POTENTIALLY PRESENT AT SITE)

COMPOUND/ DESCRIPTION	EXPOSURE LIMITS/IDLH	EXPOSURE ROUTES	SYMPTOMS/HEALTH EFFECTS
Diesel Fuel — liquid with a characteristic odor	None established by OSHA, but ACGIH has adopted 100 mg/m^3 for a TWA (as total hydrocarbons)	Ingestion, inhalation, skin absorption, skin and eye contact	Irritated eyes, skin, and mucous membrane; fatigue; blurred vision; dizziness; slurred speech; confusion; convulsions; headache; dermatitis
Polycyclic aromatic hydrocarbons (PAH) as coal tar pitch volatiles	PEL 0.2 mg/m^3 TLV 0.2 mg/m^3 REL 0.1 mg/m^3 IDLH 80 mg/m^3	Inhalation, ingestion, skin and/or eye contact	Dermatitis, bronchitis, potential carcinogen
Pentachlorophenol	PEL 0.5 mg/m^3 TLV 0.5 mg/m^3 REL 0.5 mg/m^3 IDLH 2.5 mg/m^3	Inhalation, ingestion, skin and/or eye contact	Irritating to the eyes, nose, throat; sneezing, cough; lassitude (weakness, exhaustion), anorexia, weight loss; sweating; headache, dizziness; nausea, vomiting; dyspnea (breathing difficulty), chest pain; high fever; dermatitis.
Dioxins and Furans (PCDD's, TCDD's, related congeners and other organics)	Data not available	Ingestion, skin and/or eye contact	Increased risk of severe skin lesions such as chloracne and hyperpigmentation, altered liver function and lipid metabolism, general weakness associated with drastic weight loss, changes in activities of various liver enzymes, depression of the immune system, and endocrine- and nervous-system abnormalities

COMPOUND/ DESCRIPTION	EXPOSURE LIMITS/IDLH	EXPOSURE ROUTES	SYMPTOMS/HEALTH EFFECTS
Copper	PEL 1 mg/m3 IDLH 100 mg/m3	Inhalation, ingestion, skin and eye contact	Irritated eyes, nose, pharynx; nasal septum perforation; metallic taste; dermatitis

Notes:

IDLH = immediately dangerous to life or health
OSHA = Occupational Safety and Health Administration
ACGIH = American Conference of Governmental Industrial Hygienists
mg/m³ = milligrams per cubic meter
TWA = time-weighted average (Over 8 hrs.)
PEL = permissible exposure limit
TLV = threshold limit value (over 10 hrs.)
STEL = short-term exposure limit (15 min)
ppm = parts per million

5.3.1 Diesel Oil

Diesel fuels are similar to fuel oils used for heating (fuel oils no. 1, no. 2 and no. 4). All fuel oils consist of complex mixtures of aliphatic and aromatic hydrocarbons. Diesel fuels predominantly contain a mixture of C10 through C19 hydrocarbons, which include approximately 64 percent aliphatic hydrocarbons, l to 2 percent olefinic hydrocarbons and 35 percent aromatic hydrocarbons. Workers may be exposed to fuel oils through their skin without adequate protection, such as gloves, boots, coveralls or other protective clothing. Breathing diesel fuel vapors for a long time may damage your kidneys, increase your blood pressure, or lower your blood's ability to clot. Constant skin contact (for example, washing) with diesel fuel may also damage your kidneys. The International Agency for Research on Cancer (IARC) has determined that residual (heavy) fuel oils and marine diesel fuel are possibly carcinogenic to humans (Group 2B classification).

5.3.2 Polycyclic Aromatic Hydrocarbons (PHAs), Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)

Exposure to cPAHs can occur via inhalation of vapors, ingestion, and skin and eye contact. Skin contact can result in reddening or corrosion. Ingestion can cause nausea, vomiting, blood pressure fall, abdominal pain, convulsions and coma. Damage to the central nervous system can also occur. The U.S. Department of Health and Human Services (1989) has classified 15 PAHs compounds as having sufficient evidence for carcinogenicity, while the U.S. EPA (1990) has classified at least 5 of the identified PAHs as human carcinogens. There is no currently assigned PEL-TWA for cPAHs, but the closely related material coal tar is listed as coal tar pitch volatiles with a PEL-TWA of 0.2 mg/m3. PAHs and cPAHs as soil contaminants can be irritating to eyes and mucous membranes. PAHs are also formed during combustion and are linked to lung cancers with exposure to combustion byproducts. Lymphatic cancers are reported in the literature with PAHs in the presence of carbon black.

5.3.3 PCP

Pentachlorophenol (penta or PCP), like other chlorinated phenolics, n-nitrosodiphenylamine, and dibenzofuran are absorbed through the skin. They are irritating to eyes, nose, and mucous membranes. They are potential carcinogens or listed as animal carcinogens. When inhaled they may cause cough, dizziness, headache, drowsiness, difficulty breathing, and sore throat. They are also hazardous by ingestion (soil particles, etc.) causing abdominal cramps, diarrhea, nausea, vomiting, and weakness. Penta has low volatility (VP @ 77 degrees F is 0.0001 mmHg) like the others, but often the combination of chemical odors in oils or heavily contaminated soils can cause transient nausea and headache. Penta (liquid) has an IDLH limit of 2.5 mg/m3 based on acute toxicity data in humans. This may be a conservative value due to the lack of relevant acute toxicity data for workers exposed to concentrations above 2.4 mg/m3.

5.3.4 Dioxins/Furans

Very little human toxicity data from exposure to TCDD's and/or PCDDs are available. Health-effect data obtained from occupational settings in humans are based on exposure to chemicals contaminated with dioxins. It produces a variety of toxic effects in animals and is considered one of the most toxic chemicals known. Most of the toxicity data available are from high-dose oral exposures to animals (including tumor production, immunological dysfunction, and teratogenesis). Very little dermal and inhalation exposure data are available in the literature. It is important for field personnel to remember that while dioxins are toxic and carcinogenic (see next paragraph), most of the information is based on high doses to liquid product. These products are not very volatile, so the major concern is on skin protection and inhalation/ingestion of soil particles. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a 20 ppm TLV for 1,4 dioxane (an example of numerous dioxin compounds), lists it as being absorbed through the skin, as potentially carcinogenic as well as toxic to liver and kidneys. This is typical of health effects for dioxin/furan compounds. Care should be taken especially in sampling product from drums and wells known to contain detectable levels of dioxins. Emphasis will be on working outside in well-ventilated areas using proper PPE (as discussed later in this plan). There is a wide range of difference in sensitivity to regarding lethality in animals. The signs and symptoms of poisoning with chemicals contaminated with dioxins in humans, however are analogous to those observed in animals.

Generally, dioxin exposures to humans are associated with increased risk of severe skin lesions such as chloracne and hyperpigmentation, altered liver function and lipid metabolism, general weakness associated with drastic weight loss, changes in activities of various liver enzymes, depression of the immune system, and endocrine- and nervous-system abnormalities. It is a potent teratogenic and fetotoxic chemical in animals. A very potent promoter in rat liver cancers, TCDD also causes cancers of the liver and other organs in animals. Populations occupationally or accidentally exposed to chemicals contaminated with dioxin have increased incidences of soft-tissue sarcoma and non-Hodgkin's lymphoma.

Dioxin-contaminated soil may result in dioxins occurring in a food chain. This is especially important for the general population. It has been estimated that about 98% of exposure to dioxins is through the oral route. Exposure as a vapor is normally negligible because of the low vapor pressure typical of these compounds. In the 1980s, a concentration level of 1 ppb 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in soil was specified as "a level of concern," based on cancer effects. However, recent studies indicate that end points other than cancer (such as those listed above) are also of concern based on a projected intake from 1 ppb TCDD in soil. TL-MW-3-P01, HS-SSP-S01, and other samples taken on this site indicate levels in the well and soils exceeding 1 ppb.

5.4 Biological Hazards and Procedures

Y/N	Hazard	Procedures
N	Poison Ivy or other vegetation	
Y	Insects or snakes	Work gloves and long sleeve shirt
Y	Used hypodermic needs or other infectious hazards	Do not pick up or contact
Y	Others: Blackberry bushes	Hard hat, gloves and long sleeve shirt

5.5 Additional Hazards

Update in Daily Report. Include evaluation of:

- *Physical Hazards* (equipment hazards, tripping hazards and others)
- *Chemical Hazards* (odors, spills, free product, airborne particulates and others present)
- *Biological Hazards* (stray dogs, discarded needles, pollen, bees/wasps and others present)

6.0 AIR MONITORING PLAN

Work upwind if at all possible.

Check instrumentation to be used:-None

X Photoionization Detector (PID)

___ Other (i.e., detector tubes): ____________________

6.1 Action Levels

- The workspace will be monitored using a photoionization detector (PID) and lower-explosive-limit meter (LEL). These instruments must be properly maintained, calibrated and charged (refer to the instrument manuals for details). Zero this meter in the same relative humidity as the area in which it will be used and allow at least a 10-minute warm-up prior to zeroing. Do not zero in a contaminated area. The PID can be tuned to read chemicals specifically if there are not multiple contaminants on-site. It can be tuned to detect one chemical with the response factor entered into the equipment, but the PID picks up all volatile organic compounds (VOCs) present. The ionization potential (IP) of the chemical has to be less than the PID lamp (11.7 / 10.6eV), and the PID does not detect methane. The LEL meter will detect if explosive gasses such as methane are present at concentrations approaching the lower explosive limit (LEL).
- An initial vapor measurement survey of the site should be conducted to detect "hot spots" every 15 minutes during initial excavation and boring of the soil. If ppm is below 5 ppm during this time the vapor measurement survey of the workspace can be conducted at least hourly or more often if persistent petroleum-related odors are detected. If vapor concentrations exceed 5 ppm above background continuously for a 15-minute period as measured in the breathing zone, upgrade to Level C personal protective equipment (PPE) or move to a non-contaminated area.

- Note: Standard industrial hygiene/safety procedure is to require that action be taken to reduce worker exposure to organic vapors when vapor concentrations exceed one-half the TLV. Because of the variety of chemicals, the PID will not indicate exposure to a specific PEL and is therefore not a preferred tool for determining worker exposure to chemicals. If odors are detected, then employees shall upgrade to respirators with Organic Vapor cartridges and will contact the Health and Safety Program Manager for other sampling options.

ACTION LEVEL TABLE FOR CHEMICAL MONITORING

CHEMICAL (OR CLASS)	MONITORING EQUIPMENT	ACTIVITY	MONITORING FREQUENCY LOCATION	LEVEL FOR RESPIRATORY USE	LEVEL FOR WORK STOPPAGE
Volatile Organics	Photo Ionization Detector (PID)	Drill boring	Four times per hour (15 min) in breathing zone during the start of the job.	5 TO 25 ppm Breathing Zone	>25 ppm Breathing Zone.
Organic Vapors	Photo Ionization Detector (PID)	Drill boring	Start of shift; prior to boring; every 30 to 60 minutes and in event of odors	5 TO 25 ppm Breathing Zone	>25 ppm Breathing Zone.

7.0 SITE CONTROL PLAN

Work zones will be considered within 10 feet of the well being monitored and the area within the ecology block enclosure. Employee should work upwind to the extent practical. The decontamination area and contaminant reduction zone are located in the ecology block enclosure. Employees must not leave the site without following decontamination procedures, such as washing hands, if they were handling fluids from the wells.

7.1 Traffic or Vehicle Access Control Plans

Traffic is restricted to authorized vehicles on the one road that goes through the Site. No work activities are within this road.

7.2 Site Work Zones

Hot zone/exclusion zone): *Within 10 feet of wells being worked at and at oil storage area.*

Method of delineation / excluding non-site personnel

______	Fence
X	Survey Tape
X	Traffic Cones-when traffic is present
X	Other. Oil storage area has exclusion signs posted.

7.3 Buddy System

Personnel on-site should use the buddy system (pairs), particularly whenever communication is restricted. If only one GeoEngineers employee is on-site, a buddy system can be arranged with subcontractor/ contractor personnel or by establishing call in/out times during the project to the Project Manager.

7.4 Site Communication Plan

Positive communications (within sight and hearing distance or via radio) should be maintained between pairs on-site, with the pair remaining in proximity to assist each other in case of emergencies. The team should prearrange hand signals or other emergency signals for communication when voice communication becomes impaired (including cases of lack of radios or radio breakdown). In these instances, you should consider suspending work until communication can be restored; if not, the following are some examples for communication:

1. Hand gripping throat: Out of air, can't breathe.
2. Gripping partner's wrist or placing both hands around waist: Leave area immediately, no debate.
3. Hands on top of head: Need assistance.
4. Thumbs up: Okay, I'm all right: or I understand.
5. Thumbs down: No, negative.

7.5 Decontamination Procedures

Decontamination consists of removing and discarding disposable gloves and outer protective Tyvek clothing and washing hands in the decontamination area. Soiled boots (if boot covers not worn) should be cleaned using bucket and brush provided on-site in the decontamination area. Employees will perform decontamination procedures and wash prior to eating, drinking or leaving the site.

All decontamination equipment and PPE must be left on Site and managed in accordance with the Fluid Recovery Management Plan.

7.6 Waste Disposal or Storage

PPE disposal: Used disposable PPE (gloves, Tyvek®) will be placed in plastic trash bags and disposed as solid waste.

Drill cutting/excavated sediment disposal or storage:

_______ On-site, pending analysis and further action
___X___ Secured (list method) __On-site in 55-gallon drum__________________________
_______ Other (describe destination, responsible parties): __________________________

8.0 PERSONAL PROTECTIVE EQUIPMENT

- Half-face combination organic vapor/high efficiency particulate air (HEPA) or P100 cartridge respirators will be available on-site to be used as necessary. P100 cartridges are to be used only if PID measurements are below the site action limit. P100 cartridges are used for protection against dust, metals and asbestos, while the combination organic vapor/HEPA cartridges are protective against both dust and vapor. Ensure that the PID or TLV will detect the chemicals of concern on-site.

- Level D PPE unless a higher level of protection is required will be worn at all times on the site. Potentially exposed personnel will wash gloves, hands, face and other pertinent items to prevent hand-to-mouth contact. This will be done prior to hand-to-mouth activities including eating, smoking, etc.
- Adequate personnel and equipment decontamination will be used to decrease potential ingestion and inhalation.

Check applicable personal protection gear to be used:

X Hardhat (if overhead hazards, or client requests)
X Steel-toed boots (if crushing hazards are a potential or if client requests)
X Safety glasses (if dust, particles, or other hazards are present or client requests)
X Hearing protection (if it is difficult to carry on a conversation 3 feet away)
X Chemical resistant boots or boot covers Rubbe

Gloves (specify):

X Nitrile
X Latex
___ Liners
___ Leather
X Other (specify) -Leather gloves or similar may be used if covered with outer glove or not worn when chance of coming into contact with fluids from wells.

Protective clothing:

X Tyvek (if dry conditions are encountered, Tyvek is sufficient)
___ Saranex (personnel shall use Saranex if liquids are handled or splash may be an issue)
___ Cotton
X Rain gear (as needed)
X Layered warm clothing (as needed)

Inhalation hazard protection:

X Level D
X Level C (respirators with organic vapor/HEPA or P100 filters) – only if needed as indicated by air monitoring)

8.1 Personal Protective Equipment Inspections

PPE clothing ensembles designated for use during site activities shall be selected to provide protection against known or anticipated hazards. However, no protective garment, glove or boot is entirely chemical-resistant, nor does any PPE provide protection against all types of hazards. To obtain optimum performance from PPE, site personnel shall be trained in the proper use and inspection of PPE. This training shall include the following:

- Inspect PPE before and during use for imperfect seams, non-uniform coatings, tears, poorly functioning closures or other defects. If the integrity of the PPE is compromised in any manner, proceed to the contamination reduction zone and replace the PPE.
- Inspect PPE during use for visible signs of chemical permeation such as swelling, discoloration, stiffness, brittleness, cracks, tears or other signs of punctures. If the integrity of the PPE is compromised in any manner, proceed to the contamination reduction zone and replace the PPE.
- Disposable PPE should not be reused after breaks unless it has been properly decontaminated.

8.2 Respirator Selection, Use and Maintenance

If respirators are required, site personnel shall be trained before use on the proper use, maintenance and limitations of respirators. Additionally, they must be medically qualified to wear a respiratory protection in accordance with 29 CFR 1910.134. Site personnel who will use a tight-fitting respirator must have passed a qualitative or quantitative fit test conducted in accordance with an OSHA-accepted fit test protocol. Fit testing must be repeated annually or whenever a new type of respirator is used. Respirators will be stored in a protective container.

8.3 Respirator Cartridges

If site personnel are required to wear air-purifying respirators, the appropriate cartridges shall be selected to protect personnel from known or anticipated site contaminants. The respirator/cartridge combination shall be certified and approved by the National Institute for Occupational Safety and Health (NIOSH). A cartridge change-out schedule shall be developed based on known site contaminants, anticipated contaminant concentrations and data supplied by the cartridge manufacturer related to the absorption capacity of the cartridge for specific contaminants. Site personnel shall be made aware of the cartridge change-out schedule prior to the initiation of site activities. Site personnel shall also be instructed to change respirator cartridges if they detect increased resistance during inhalation or detect vapor breakthrough by smell, taste or feel, although breakthrough is not an acceptable method of determining the change-out schedule.

8.4 Respirator Inspection and Cleaning

The Site Safety and Health Supervisor shall periodically (weekly) inspect respirators at the project site. Site personnel shall inspect respirators prior to each use in accordance with the manufacturer's instructions. In addition, site personnel wearing a tight-fitting respirator shall perform a positive and negative pressure user seal check each time the respirator is donned, to ensure proper fit and function. User seal checks shall be performed in accordance with the GeoEngineers respiratory protection program or the respirator manufacturer's instructions.

9.0 ADDITIONAL ELEMENTS

9.1 Cold Stress Prevention

Working in cold environments presents many hazards to site personnel and can result in frost nip (superficial freezing of the skin), frost bite (deep tissue freezing), or hypothermia (lowering of the core body temperature).

The combination of wind and cold temperatures increases the degree of cold stress experienced by site personnel. Site personnel shall be trained on the signs and symptoms of cold-related illnesses, how the human body adapts to cold environments, and how to prevent the onset of cold-related illnesses. Heated break areas and warm beverages shall be provided during periods of cold weather.

9.2 Heat Stress Prevention

State and federal OSHA regulations provide specific requirements for handling employee exposure to heat stress. GeoEngineers' program complies with these requirements and will be implemented in all areas where heat stress is identified as a potential health issue.

9.2.1 Minimize Exposure to Extreme Temperatures

Where acceptable temperature cannot be maintained, all outdoor work should be scheduled so as to minimize exposure to extreme temperatures.

9.2.2 Monitoring

Temperature and conditions in the work area should be monitored by supervisory personnel.

9.2.3 Appropriate Dress

Employees are required to dress appropriately for the relevant working conditions, including normal weather extremes. Limiting the time of exposure and wearing protective clothing will reduce the dangers of exposure to heat. Clothing should:

- Be constructed of an absorbent, close-weave material that doesn't allow penetration of sunlight; and
- Be worn in light layers that can be adjusted for comfort.

9.2.4 Preventive Measures for Working Outdoors

The following measures are to be implemented to protect employees working outdoors:

- Use of a range of sunscreens (with high protection factor) that are persistent on the skin irrespective of humidity and perspiration.
- Encouragement of the application of a sunscreen 15 minutes prior to exposure.
- Encouragement of regular re-application of sunscreen throughout the day.
- Use of safety sunglasses (where lighting is not an issue).

9.2.5 Appropriate Dress

Employees shall retire to shaded or cooled areas for rest breaks when possible.

9.2.6 Rest Breaks

When cool down is required, employees shall take rest breaks in a shaded or cooled area.

9.2.7 Drinking Water

Ensure an adequate supply of cool drinking water for the employees to replace water lost through perspiration. It is essential that water intake be approximately equal to the amount of sweat produced to avoid dehydration. Most workers exposed to hot conditions drink fewer fluids than needed because of an insufficient thirst drive. A worker, therefore, should not depend on thirst to signal when and how much to drink.

- Fluids shall be replaced approximately every 20 minutes in amounts of at least one gallon per day.
- Water shall be kept cool throughout the operation.
- Electrolyte replacement shall be in the form of a commercial electrolyte replacement drink (that is, Gatorade or equivalent).
- Avoid alcohol and caffeine (including coffee and tea), which contribute to dehydration.

9.2.8 Air Conditioning

Minimize humidity in the work environment to improve sweat evaporation from the surface of the skin. This can be accomplished by air conditioning or dehumidification. Cooling by the evaporation of sweat lets the body reduce its temperature; evaporation proceeds more quickly and the cooling effect is more pronounced within increasing air speed and low relative humidity. When possible, vehicle and work areas should be equipped with air conditioning.

9.2.9 Reduce Physical Demands

Increase work during high temperatures can add stress to the body. Reduce physical demands of work task when possible through mechanical means such as hoists, hand trucks, lift-tables etc.

9.2.10 Steps to Prevent Heat Stress

Steps to help prevent heat stress include:

- Consider a worker's physical condition when determining fitness to work in hot environments. Obesity, lack of conditioning, pregnancy and inadequate rest can increase susceptibility to heat stress.
- Certain medical conditions (such as heart conditions) or treatments (such as low-sodium diets and some medications) increase the risk from heat exposure.
- Seek medical advice when symptoms of heat stress appear.
- Schedule strenuous physical activity at the beginning and end of the day, when external temperatures may be cooler.
- Provide portable water sprayers so that employees can cool down skin surfaces.
- Provide whole-body cooling devices such as ice vests with frozen packs or recirculation systems.

10.0 MISCELLANEOUS

10.1 Emergency Response

Indicate what site-specific procedures you will implement.

- Personnel on-site will be working alone. Field personnel should carry a cell phone programmed with the GEI office number should it be necessary to communicate to others regarding emergencies.
- If any member of the field crew experiences any adverse exposure symptoms while on-site, the entire field crew should immediately halt work and act according to the instructions provided by the Site Safety and Health Supervisor.
- The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated should result in the evacuation of the field team, contact of the PM, and reevaluation of the hazard and the level of protection required.
- If an accident occurs, the Site Safety and Health Supervisor and the injured person are to complete, within 24 hours, an Accident Report for submittal to the PM, the Health and Safety Program Manager and Human Resources. The PM should ensure that follow-up action is taken to correct the situation that caused the accident or exposure.

10.2 Personnel Medical Surveillance

GeoEngineers employees are not in a medical surveillance program because they do not fall into the category of "Employees Covered" in OSHA 1910.120(f)(2), which states a medical surveillance program is required for the following employees:

1. All employees who are or may be exposed to hazardous substances or health hazards at or above the permissible exposure limits or, if there is no permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year;
2. All employees who wear a respirator for 30 days or more a year or as required by state and federal regulations;
3. All employees who are injured, become ill or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation; and
4. Members of HAZMAT teams.

10.3 Spill Containment Plans (Drum and Container Handling)

If fluid from the wells is spelled onto the ground the area should be identified and noted in the field report, If significant volume of fluid is spilled absorbent (such as cat litter) should be applied to the spill area and the project manager contacted. Spent absorbent material will need to be stored within the ecology block wall enclosure.

10.4 Sampling, Managing and Handling Drums and Containers

Drums and containers used during the cleanup shall meet the appropriate Department of Transportation (DOT), OSHA and U.S. Environmental Protection Agency (EPA) regulations for the waste that they contain. Site operations shall be organized to minimize the amount of drum or container movement. When practicable, drums and containers shall be inspected and their integrity shall be ensured before they are moved. Unlabeled drums and containers shall be considered to contain hazardous substances and handled accordingly until the contents are positively identified and labeled. Before drums or containers are moved, all employees involved in the transfer operation shall be warned of the potential hazards associated with the contents.

Drums or containers and suitable quantities of proper absorbent shall be kept available and used where spills, leaks or rupture may occur. Where major spills may occur, a spill containment program shall be implemented to contain and isolate the entire volume of the hazardous substance being transferred. Fire extinguishing equipment shall be on hand and ready for use to control incipient fires.

10.5 Personnel Medical Surveillance

GeoEngineers employees are not in a medical surveillance program because they do not fall into the category of “Employees Covered” in OSHA 1910.120(f)(2), which states a medical surveillance program is required for the following employees:

1. All employees who are or may be exposed to hazardous substances or health hazards at or above the permissible exposure limits or, if there is no permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year;
2. All employees who wear a respirator for 30 days or more a year or as required by state and federal regulations;
3. All employees who are injured, become ill or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation; and
4. Members of HAZMAT teams.

10.6 Sanitation

Water should be available in the decontamination area for washing.

11.0 DOCUMENTATION TO BE COMPLETED FOR HAZWOPER PROJECTS

The following forms are required for Hazardous Waste Operations and Emergency Response (HAZWOPER) projects:

- Field Log
- Health and Safety Plan acknowledgment by GeoEngineers employees (Form 2)
- Contractors Health and Safety Plan Disclaimer (Form 3)

- Conditional forms available at GeoEngineers office: Accident Report

NOTE: The Field Report is to contain the following information:

- Updates on hazard assessments, field decisions, conversations with subcontractors, client or other parties, etc.;
- Air monitoring/calibration results, including: personnel, locations monitored, activity at the time of monitoring, etc.;
- Actions taken;
- Action level for upgrading PPE and rationale; and
- Meteorological conditions (temperature, wind direction, wind speed, humidity, rain, snow, etc.).

12.0 DOCUMENTATION EXPECTED TO BE COMPLETED

NOTE: The Field Log is to contain the following information:

- Updates on hazard assessments, field decisions, and conversations with subs, client or other parties.
- Actions taken
- Meteorological conditions (temperature, wind direction, wind speed, humidity, rain, snow, etc.).
- Required forms:
- Field Log
- FORM 1 Health & Safety Meeting
- FORM 2 SITE SAFETY PLAN – GEOENGINEERS' EMPLOYEE ACKNOWLEDGMENT
- FORM 3 SUBCONTRACTOR AND SITE VISITOR SITE SAFETY FORM

13.0 APPROVALS

1. Plan Prepared	______________________ Signature	______________ Date
2. Plan Approval	______________________ PM Signature	______________ Date
3. Health & Safety Officer	______________________ Health & Safety Program Manager	______________ Date

HASP FORM 1
HEALTH AND SAFETY BRIEFING
SUPPLEMENTAL DATA COLLECTION FIELD INVESTIGATION
FORMER R.G. HALEY WOOD TREATMENT SITE
FILE NO. 0356-114-06

Inform employees, contractors and subcontractors or their representatives about:

- The nature, level, and degree of exposure to hazardous substances they're likely to encounter;
- Emergency response procedures; and
- Any identified potential fire, explosion, or other health or safety hazards, and associated safe work practices.

Date	Topics	Attendee	Company Name	Employee Initials

HASP FORM 2
SITE SAFETY PLAN – GEOENGINEERS' EMPLOYEE ACKNOWLEDGMENT
FORMER R.G. HALEY WOOD TREATMENT SITE
FILE NO. 0356-114-06

(All GeoEngineers' Site workers shall complete this form, which should remain attached to the Safety Plan and filed with other project documentation).

I hereby verify that a copy of the current Safety Plan has been provided by GeoEngineers, Inc., for my review and personal use. I have read the document completely and acknowledge an understanding of the safety procedures and protocol for my responsibilities on Site. I agree to comply with all required, specified safety regulations and procedures.

Print Name	Signature	Date

HASP FORM 3
SUBCONTRACTOR AND SITE VISITOR SITE SAFETY FORM
FORMER R.G. HALEY WOOD TREATMENT SITE
FILE NO. 0356-114-06

I verify that a copy of the current Site Safety Plan has been provided by GeoEngineers, Inc. to inform me of the hazardous substances on Site and to provide safety procedures and protocols that will be used by GeoEngineers' staff at the Site. By signing below, I agree that the safety of my employees is the responsibility of the undersigned company.

Print Name	Signature	Firm	Date

Have we delivered World Class Client Service?

Please let us know by visiting **www. geoengineers.com/feedback**.

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