SAMPLING AND ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN
FILL WBZ TRENCH
NW NATURAL GASCO SITE

Prepared for

Department of Environmental Quality

Prepared on Behalf of

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220 NW Second Avenue
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June 2014

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LIST OF ACRONYMS AND ABBREVIATIONS

ACOE	U.S. Army Corps of Engineers
Anchor QEA	Anchor QEA, LLC
bgs	below ground surface
CDR	Construction Design Report
COI	Chemical of Interest
ASTM	ASTM International
DEQ	Oregon Department of Environmental Quality
MFA	Maul Foster & Alongi, Inc.
PAH	polycyclic aromatic hydrocarbon
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
Site	NW Natural Gasco Site
SPT	Standard Penetration Test
VOC	volatile organic compounds
WBZ	Water Bearing Zone
Work Plan	Fill WBZ Trench Work Plan

1 INTRODUCTION

1.1 Background

This focused Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) has been prepared to support the Fill Water Bearing Zone (WBZ) Trench Work Plan (Work Plan) prepared by Anchor QEA for NW Natural in November 2013 (Anchor QEA 2013). On April 28, 2014, NW Natural received comments on the Work Plan from the Oregon Department of Environmental Quality (DEQ; DEQ 2014). In the same letter, DEQ informed NW Natural that the Work Plan was approved with the comments provided. Figure 1 shows the NW Natural site (site) and project location along the southwest bank of the Lower Willamette River.

1.2 Response to Comments

As requested by DEQ, NW Natural has adjusted the location of monitoring well MW-40F (subject to the limitations of drill equipment access). Figures 2 and 3 have been modified to incorporate information provided to NW Natural concerning the location of the SB-XX series of soil borings at the adjacent U.S. Mooring property. To clarify the scope of this program, the new Fill WBZ monitoring wells will be sampled consistent with the Groundwater Source Control Performance Monitoring Plan as described in the Revised Groundwater Source Control Construction Design Report (CDR) (Anchor QEA 2012). Under this plan, newly installed monitoring wells will be sampled for four quarters after installation and will be sampled for polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), metals, total cyanide, free cyanide, and available cyanide. Details on methods used for sampling and chemicals of interest (COIs) are contained in the CDR.

1.3 Investigation Objectives

The overall objective of the investigation program is to gather geotechnical and groundwater information necessary to support an alternatives evaluation for Fill WBZ, which will be presented in a Design Evaluation Report (per Section 4.3 of the Work Plan). The Design Evaluation Report will include an evaluation of trench construction methods, including the feasibility of the proposed methods adjacent to structures and armored slopes, and an assessment of the feasibility of constructing a Fill WBZ trench in sections (as further described in Section 2.3 of the Work Plan). To accomplish this evaluation, broad steps were identified in the Work Plan:

- Assess existing Site geotechnical and groundwater data to look for potential data gaps along alternative trench routes recommended for consideration in DEQ's September 22, 2011 comment letter

- Conduct geotechnical and groundwater investigations in the identified data gap areas
- Evaluate the data and prepare a Design Evaluation Report

1.4 Description of Work

Figure 2, reproduced from the Work Plan (Anchor QEA 2013), shows the locations of each proposed monitoring well and soil boring, including the relocation of MW-40F. The investigation scope includes the following five explorations:

- Four monitoring wells, each co-located with geotechnical testing and sampling
- One soil boring with no groundwater component

As discussed in the Work Plan, geotechnical data will be collected during the installation of the four proposed Fill WBZ monitoring wells (MW-39F, MW-40F, MW-41F, and MW-42F) and at the proposed soil boring AQ-B8. The proposed depths for these borings are based upon the anticipated depth to the bottom of the fill unit and include additional depth of confirmatory samples in the underlying unit. Based on a review of nearby explorations, the proposed soil boring depth for wells MW-39F, MW-40F, and MW-41F is 25 feet below ground surface (bgs), which assumes an anticipated fill thickness of 15 feet. The proposed soil boring depth of MW-42 and AQ-B8 is 40 feet bgs, which assumes an anticipated fill thickness of 30 feet. Table 1 provides a summary of proposed exploration depths and coordinates.

Once an interceptor trench concept and location are selected, final design can be completed. Data needs necessary to design the final interceptor trench would include, at a minimum, the following:

- Type and extent of debris likely within the construction area
- Soil type and characteristics
- Thickness of the WBZ
- Depth of groundwater
- Soil index parameters and consistency
- Unit weight of the WBZ
- Hydraulic conductivity of the WBZ
- Short- and long-term strength of the WBZ and possibly soils below

Siltronic (MFA 2013) also presents a number of suggested data needs for final design of a Fill WBZ interceptor trench on its property.

2 INVESTIGATION SCOPE

2.1 Proposed Groundwater Data Collection

As stated in the Work Plan, groundwater information is needed for the potential extension of the interceptor trench alignment adjacent to the northern property line and along the waterfront of the Siltronic property. To better understand the groundwater conditions in these areas, Anchor QEA recommends the installation of four shallow monitoring wells (MW-39F, MW-40F, MW-41F, and MW-42F; see Figures 2 and 3), with the specific intent of monitoring groundwater elevations in the surficial fill unit.

In August 2013, three Fill WBZ monitoring wells were installed on Siltronic property. The locations of these monitoring wells are shown on Figures 2 and 3. Information obtained from these monitoring wells will also be used for the Fill WBZ trench alternatives analysis.

After the proposed monitoring wells are installed and developed, groundwater elevations will be measured at the newly installed wells (MW-39F, MW-40F, MW-41F, and MW-42F), existing Fill observation wells (OW-1F, OW-2F, OW-5F, OW-7-17, OW-8-15, OW-9-25, and OW-10F), and Siltronic fill monitoring wells WS-44-29, WS-45-23, and WS-46-33.

Measurements will be taken with an electronic water level indicator. Levels will be measured to the nearest 0.01 foot from a surveyed notch or mark at the top of the polyvinyl chloride casing or other reference point. Measurements will be recorded immediately on a water level record sheet with the date, time (on a 24-hour clock), reference point, and initials of the person who made the measurements.

2.2 Proposed Geotechnical Data Collection

As stated in the Work Plan, geotechnical information is needed for the portion of the potential interceptor trench alignment adjacent to the northern property boundary and along the waterfront of the Siltronic property. To better understand the variation in soil engineering characteristics and thicknesses of the fill unit in these areas, geotechnical data will be collected during the installation of the four proposed Fill WBZ monitoring wells (MW-39F, MW-40F, MW-41F, and MW-42F) and the proposed soil boring AQ-B8. The proposed depths for these borings are based upon the anticipated depth to the bottom of the fill unit and include additional depth of confirmatory samples in the underlying unit. Based on a review of nearby explorations, the proposed soil boring depth for wells MW-39F, MW-40F, and MW-41F is 25 feet bgs, which assumes an anticipated fill thickness of 15 feet. The proposed soil boring depth of MW-42 and AQ-B8 is 40 feet bgs, which assumes an anticipated fill thickness of 30 feet.

Field data will include the collection of soil samples for geotechnical laboratory testing and in situ measurements of strength using the Standard Penetration Test (SPT; ASTM D-1586).

2.3 Data Use

As stated in the Work Plan, upon completion of soil borings and laboratory analysis, a data report will be produced summarizing the field activities and results. Boring logs, well installation logs, and laboratory results will be included in the data report, which will be provided as an appendix to the Design Evaluation Report.

3 WELL DESIGN

The wells will be constructed consistent with Appendix K – Well Construction and Development Plan of the CDR (Anchor QEA 2012). This document is included as Attachment 1 of this focused SAP/QAPP.

4 WELL DEVELOPMENT

The wells will be developed consistent with the Well Construction and Development Plan (Anchor QEA 2012; see Attachment 1).

5 GEOTECHNICAL SAMPLING AND TESTING

5.1 General

For geotechnical sampling and testing, the procedures described in Section 3.4.1 ("Top of Riverbank Exploration and Sampling") of the Final Field Sampling Plan, Data Gaps QAPP (Anchor QEA 2010) will be followed. This document is provided as Attachment 2 of this focused SAP/QAPP. DEQ requested a focused SAP/QAPP that refers to previously submitted documents for field procedures where appropriate; therefore, Attachment 2 is provided to describe procedures for work in this focused SAP/QAPP. Because Attachment 2 was originally prepared for another project, some of the procedures do not apply to the Work Plan; such as transition zone water sampling and bioassay, chemical, and physical testing. Modifications and clarifications to the procedures described in Sections 3.4.1, 3.4.1.1, and 3.4.1.2 of Attachment 2 are described as follows:

- Geotechnical sampling will provide qualitative and geotechnical data to satisfy objectives; however, chemical analyses will not be performed.

- Boring depths are based on estimated depths to the bottom of the fill unit. MGP oil or tar observations will be noted in the logs, if present, but such observations are not relevant to geotechnical engineering.
- Soil samples will be collected at 2.5-foot intervals for the first 10 feet of boring depth and will be collected every 5 feet thereafter. Modifications to sample intervals may be made in the field, at the discretion of the geotechnical engineer.
- Soil samples will be collected and sent to a qualified geotechnical laboratory for tests, including Atterberg Limits, moisture content, and grain size distribution. Table 2 provides an estimate of the number and types of soil tests to be performed.

Borings for monitoring wells and soil borings will be advanced by a Sonic drill rig using methods as described in Section 3.4.1.2 of Attachment 2 (Anchor QEA 2010). Disturbed geotechnical samples (split spoon samples) will be obtained and sampled at the frequency and depth intervals described above. As described in Section 3.4.1.2 of Attachment 2, the SPT (ASTM D-1586) will be employed to obtain empirical estimates of soil density and strength. If significantly thick deposits of soft silt or clay deposits are encountered, undisturbed geotechnical samples (Shelby tubes) may be collected.

5.2 Station and Sample Identification

Each discrete soil sample will be assigned a unique alphanumeric identifier according to the method described in the following paragraphs. The identifiers facilitate sample tracking by incorporating identifying information.

The alphanumeric identifiers will be assigned in the following manner for geotechnical samples:

- The first two characters will identify the soil boring location: MW = for soil samples collected at locations co-located with monitoring wells; AQ = for soil samples collected at soil boring locations.
- The next set of characters identifies the sample station: -39F = Station 39 (Fill) or -8 for AQ-B8.
- The next set of characters identifies the upper sample depth: -2.5 = 2.5 feet below ground surface.
- The next set of characters identifies the collection date: -YYMMDD.

For example, sample number MW-39F-2.5-140705 indicates a soil sample obtained from station MW-39F with an upper sample depth of 2.5 feet below ground surface, July 5, 2014. The representative depths for each sampling interval will be defined in the soil boring logs.

5.3 Field QA/QC

Due to the heterogeneity of the soil, duplicates of soil samples will not be collected at each station. Because chemical testing will not be performed, field blanks will not be collected.

5.4 Sample Handling

This section describes the sample containers, sample handling and storage, and sample shipping for all geotechnical soil sampling activities.

Each container will be clearly labeled with the name of the project, sample number, date, time, and initials of the person preparing the sample. Prior to transport to the laboratory, samples will be stored in a cool and dry place.

5.5 Soil Boring Abandonment

Soil boring AQ-B8 will be abandoned using either bentonite chips (saturated zones), granular bentonite (unsaturated zones), bentonite grout, or organoclay-bentonite grout if DNAPL is present. If bentonite grout or organoclay-bentonite grout is used, the borehole will be grouted from the bottom of the borehole to the ground surface via tremie tube methodology.

6 HORIZONTAL POSITIONING AND VERTICAL CONTROL

Horizontal and vertical positioning for all monitoring well and soil boring locations will be performed by a licensed land surveyor. Measuring point elevations for the monitoring wells will be determined to the nearest 0.01 foot.

7 FIELD DOCUMENTATION

A complete record of field activities will be maintained including the following:

- Documentation of field activities in a daily field log
- Documentation of samples collected for analysis on a boring log
- Documentation of well construction and well development

The onsite field staff will maintain the field forms. On-site activities, including health and safety entries, and field observations will be documented in the daily field log. Entries will be made in indelible ink. The field log is intended to provide sufficient data and observations to enable readers to reconstruct events that occurred during the sampling period. The field log will include clear information concerning modifications to the details and procedures identified in this focused SAP/QAPP. A collection of field forms is provided as Attachment 3.

Logs and field notes of boring samples will be maintained as samples are collected and correlated to the sampling location map. The following information will be included in this log:

- Sample station number
- Length and depth intervals of core/boring section
- Percent recovery date and time of sample collection
- Names of field supervisor and person(s) collecting and logging in the sample
- Observations made during sample collection, including weather conditions, complications, and other details associated with the sampling effort
- Deviations from the approved field sampling program

8 EQUIPMENT DECONTAMINATION AND INVESTIGATION DERIVED WASTE

Procedures for Equipment Decontamination and the handling and disposal of Investigation Derived Waste, as discussed in Section 3 of the Well Construction and Development Plan (see Attachment 1; Anchor QEA 2012), will be followed.

9 FIELD SAMPLING SCHEDULE

The field sampling program will be scheduled as soon as possible, following DEQ approval of this SAP/QAPP and associated documents, subject to availability of the drilling subcontractor. It is anticipated that drilling activities will take 1 week. The actual start and end dates for the sampling event will depend on DEQ approval of the project plans and coordination with subcontractors. Other conditions that may affect the sampling schedule are weather, sub-consultant availability, and equipment availability.

10 REFERENCES

DEQ (Oregon Department of Environmental Quality), 2014. Letter from Dana Bayuk to NW Natural. Revised Fill Water-Bearing Zone Trench Investigation Work Plan –

Shoreline Segments 1 and 2, NW Natural Property and the Northern Portion of the Siltronic Corporation Property. April 28, 2014.

Anchor QEA (Anchor QEA, LLC), 2010. Final Field Sampling Plan. Data Gaps QAPP. Gasco Sediments Cleanup Action. Prepared for the U.S. Environmental Protection Agency, Region 10 on behalf of NW Natural. July 2010.

Anchor QEA, 2012. Revised Groundwater Source Control Construction Design Report. NW Natural Gasco Site. Prepared for NW Natural. Prepared by Anchor QEA. January 2012.

Anchor QEA, 2013. Fill WBZ Trench Investigation Work Plan Gasco/Siltronic. Prepared for NW Natural. Prepared By Anchor QEA. November 2013.

MFA (Maul Foster & Alongi, Inc.), 2013. Fill Zone Well Installation Work Plan. Prepared for Siltronic Corporation, Portland, Oregon. ECSI No. 183. May 10, 2013.

TABLES

Table 1
Proposed Explorations

Location ID	Northing[1]	Easting[1]	Proposed Exploration Depth[2] (feet)
MW-39F	705,973	7,623,063	25
MW-40F	705,822	7,622,888	25
MW-41F	705,601	7,622,702	25
MW-42F	705,139	7,624,624	40
AQ-B8	704,972	7,624,908	40

Notes:

1. Coordinate Datum: Oregon State Plane North NAD 83 (International Feet)

2. Proposed Exploration Depths subject to change based on field conditions. Exploration depths are below ground surface.

Table 2
Proposed Geotechnical Soil Testing Scope

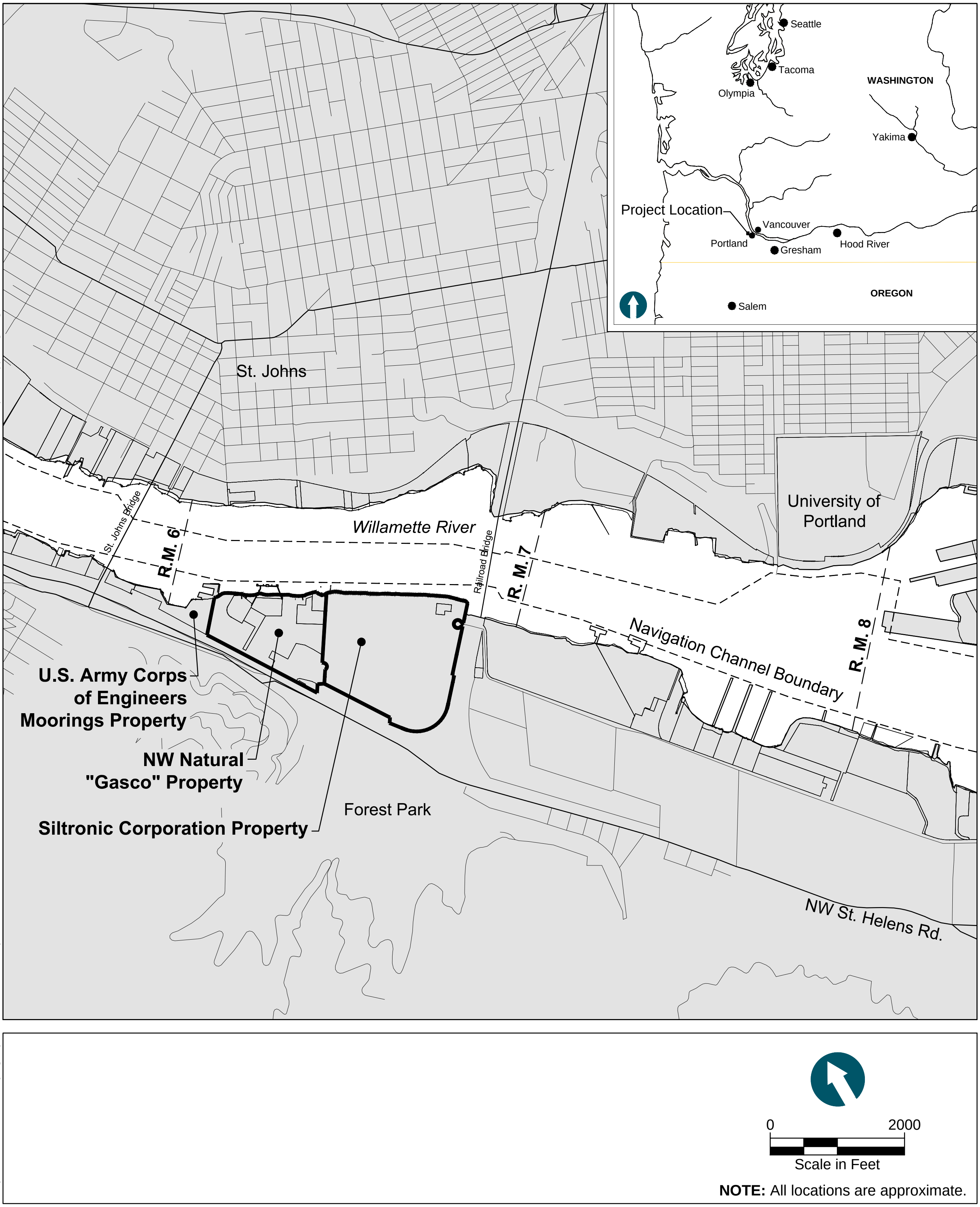
Test Type[1]	ASTM Standard	Estimated Number of Tests[1]
Standard Penetration Test	D1586	43
Atterberg Limits	D4318	15
Water Content	D2216	50
Grain Size Distribution	D422	15

Notes:

1. The number and types of tests performed will vary based on the soils encountered and sampled.

ASTM = American Society for Testing Materials International

FIGURES

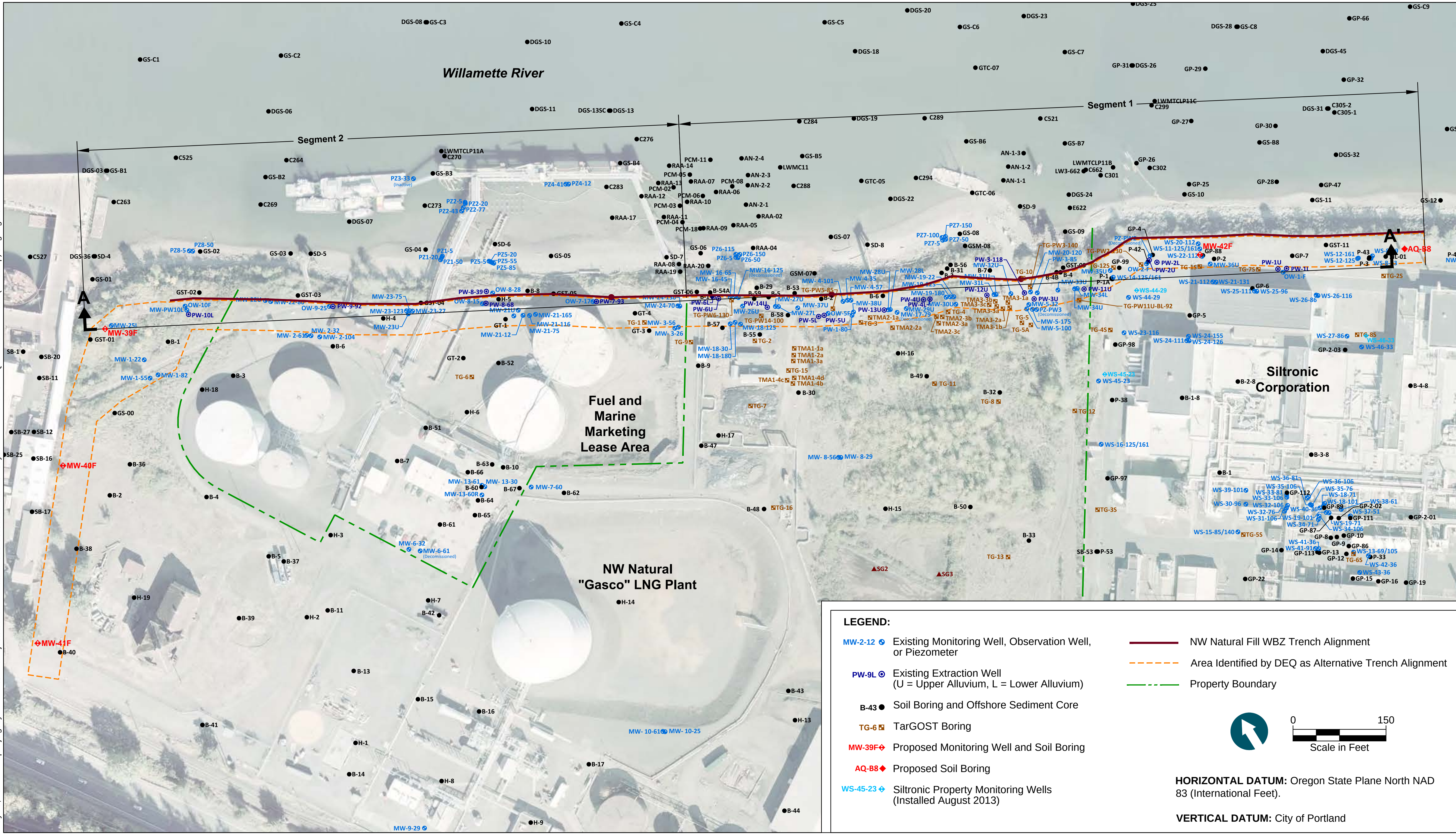


T:\CAD\Projects\0029-NW Natural Gas Co\Gasco Source Controls\Fill WBZ Trench - SAP QAPP\0029-RP-001 (Vicinity).dwg Figure 1

May 16, 2014 9:42am jbigsby

Figure 1
Vicinity Map
Fill WBZ Trench Investigation Focused SAP/QAPP
Gasco/Siltronic

ANCHOR QEA

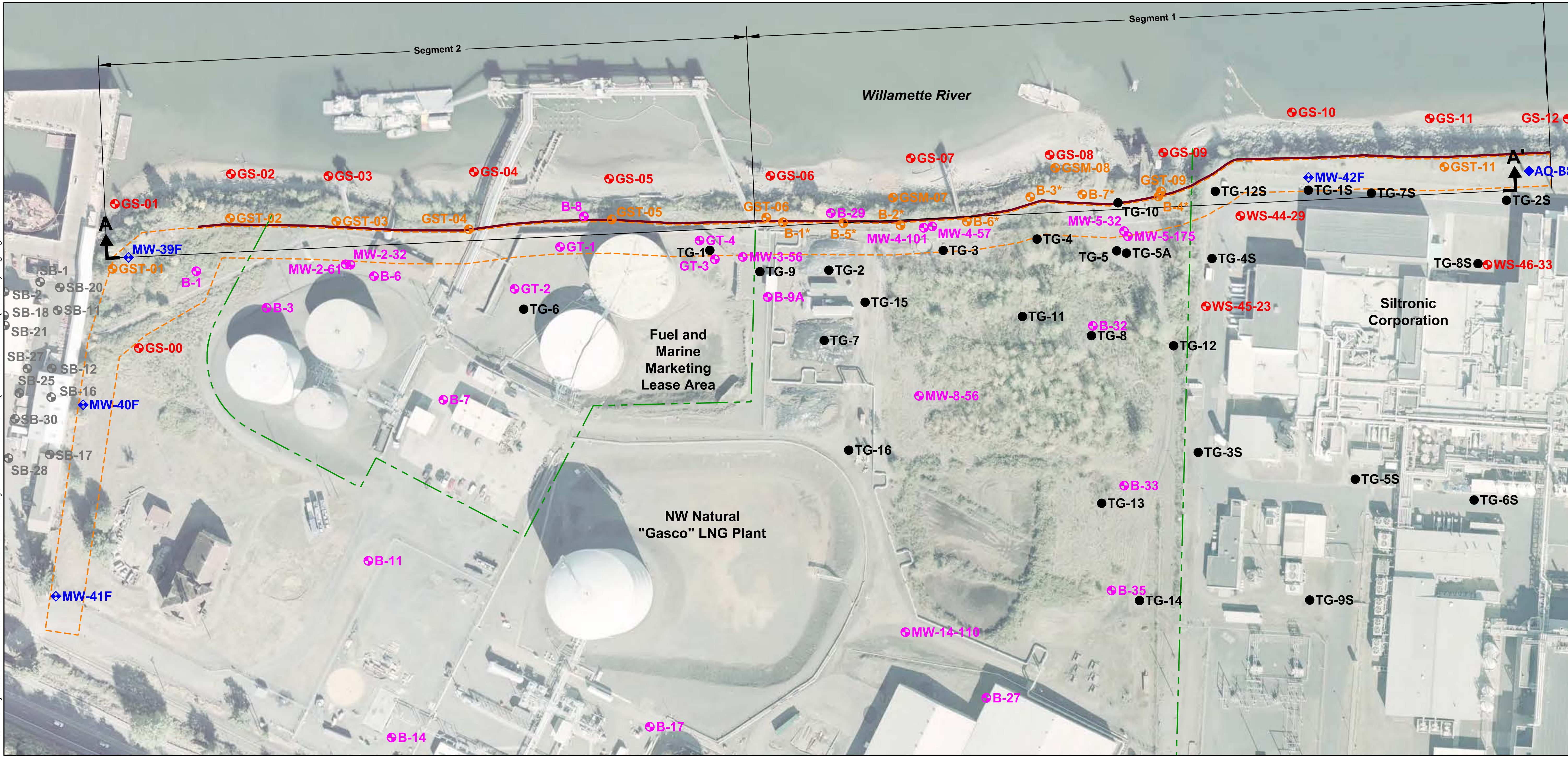


T:\CAD\Projects\0029-NW Natural Gas Co\Gasco Site Remedy\Fill WBZ Trench SAP QAPP\0029-RP-002 (All Samp).dwg Figure 2

May 19, 2014 12:14pm jbigsby

ANCHOR QEA

Figure 2
Sample Locations
Fill WBZ Trench Investigation Focused SAP/QAPP
Gasco/Siltronic



T:\CAD\Projects\0029-NW Natural Gas Co\Gasco Site Remedy\Fill WBZ Trench SAP QAPP\0029-RP-003 (Geotech).dwg Figure 3

May 19, 2014 12:20pm jbigsby

HORIZONTAL DATUM: Oregon State Plane North NAD 83 (International Feet).

VERTICAL DATUM: City of Portland

NOTE: Drawing prepared from CAD file provided by Advanced Remediation Technologies Co, dated January 5, 2012.

LEGEND:

- B-7 — Soil Boring with SPT Data (No Lab Data)
- GST-04 — Geoprobe, Soil Boring, or Sonic Boring with Index Lab Data, (No SPT Data)
- GST-09 — Soil Boring, Sonic Boring, or Geoprobe with Lab Data and SPT Data
- TG-16 — CPT
- SB-1 — U.S. Moorings Remedial Investigation Soil Borings (No SPT or Lab Data)
- MW-40F — Proposed Soil Boring and Monitoring Well
- AQ-B8 — Proposed Soil Boring
- NW Natural Fill WBZ Trench Alignment
- Area Identified by DEQ as Alternative Trench Alignment
- Property Boundary

0 150
Scale in Feet

ANCHOR QEA

Figure 3
Geotechnical Explorations
Fill WBZ Trench Investigation Focused SAP/QAPP
Gasco/Siltronic

ATTACHMENT 1
APPENDIX K: WELL CONSTRUCTION AND DEVELOPMENT PLAN

APPENDIX K
WELL CONSTRUCTION AND DEVELOPMENT PLAN
REVISED GROUNDWATER SOURCE CONTROL CONSTRUCTION DESIGN REPORT
NW NATURAL GASCO SITE

Prepared for
NW Natural

Prepared by
Anchor QEA, LLC

January 2012

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1 INTRODUCTION

This *Well Construction and Development Plan* has been prepared as Appendix K to the *Revised Groundwater Source Control Construction Design Report* for the NW Natural Gasco Site (Site) in Portland, Oregon. Extraction wells, observation wells, and piezometers will be drilled and installed. Prior to installation of each well or piezometer, a borehole will be drilled using Sonic drilling techniques. The drilling contractor will obtain Oregon Start Cards for each well or piezometer. Each location will be checked for underground and above-ground utilities prior to the start of drilling. For sites where the location of underground utilities is uncertain, a NW Natural representative will pre-approve the drilling locations. The well construction and development work will be done under the direction of an Oregon Registered Geologist. During drilling activities, continuous cores will be obtained from the deepest boring at each location. The cores will then be photographed and a geologic log will be created in the field to assist in selection of the appropriate screen interval. Step-down drilling techniques will be used in areas of where non-aqueous phase liquid (NAPL) is present as shown on Figure 2-3b of the Draft Final Design Report. In those locations, the casing will be advanced a minimum of 5 feet below the expected depth of NAPL and a bentonite plug will be placed in the bottom of the borehole. The bentonite chips will be allowed to hydrate and the contaminated water will be removed from the borehole immediately after the upper casing is seated in the bentonite plug, and just before the secondary casing is placed downhole.

2 WELL DESIGN

2.1 Extraction Well Design

The extraction wells will be constructed of 6-inch diameter steel flush threaded casing with 15 to 20 feet of stainless steel wire-wrapped screen with 0.035-inch slots and a 5-foot bottom sump. The stainless steel screens will be ordered in 5- and 10-foot lengths to provide flexibility in design of the extraction well screen depth at each location. Upon completion of drilling activities, the well screen and casing will be placed in the borehole to the desired depth. A filter pack (filter pack design will be based on grain-size analysis) will be installed in the annulus from the total depth of the borehole to approximately 2 feet above the top of the screened interval. After placement of the filter pack, the well screen will be surged to allow proper settlement and prevent bridging of filter pack material. If the level of the filter pack drops during surging, more filter pack material will be added to maintain a thickness of approximately 2 feet above the top of the screened interval. A filter pack seal of at least 3 feet thickness consisting of 3/8-inch bentonite chips, coated chips, or fine sand will then be installed in the annulus on top of the filter pack. If heavy sheen or NAPL is present, fine graded sand will be used as a filter pack seal. A bentonite grout annular seal mixed to a weight of at least 9.5 pounds per gallon will be pumped in the remaining annulus via tremie pipe from the top of the bentonite seal until grout returns are observed at the surface, ensuring a complete grout column. If NAPL is present, an organoclay mix will be used instead of the bentonite grout seal and a NAPL funnel will be installed at the base of the screen. If a NAPL funnel is required, it will not be possible to fill the annular space below the NAPL funnel using standard tremie methods. To fill the annulus below the funnel, a prefabricated seal will be fabricated and attached to the sump before installation. The seal will consist of bentonite granules, chips, or pellets. Upon immersion, the bentonite will swell, providing a permanent annular seal in the annulus surrounding the sump. Anchor QEA will communicate with the Oregon Water Resources Department, DEQ, and the drilling contractor regarding the details of this sealing method and to obtain a variance, as needed. A well monument and concrete surface seal will then be installed at the ground surface.

2.2 Observation Well Design

A surficial fill water bearing zone (WBZ) observation well will also be installed adjacent to the pumping wells. Construction of the surficial fill observation wells will follow the design of the monitoring wells described below.

2.3 Monitoring Well Design

Monitoring wells will be installed between extraction wells to monitor water level drawdown effects at various depths in the Alluvium WBZ due to pumping. The monitoring wells will be constructed of 2-inch diameter PVC casing with stainless steel wire-wrapped screen with 0.020-inch slots and a 3-foot bottom sump. The filter pack will be constructed of 10 x 20 silica sand. Upon completion of drilling activities, the well screen and casing will be placed in the borehole to the desired depth. Other than as described above in this section, monitoring well installation will follow the same procedures as described in Section 2.1, "Extraction Well Design."

2.4 Piezometer Design

Piezometers will be installed in the river sediments on the shoreline downgradient of some of the extraction wells. The purpose of the piezometers will be to measure groundwater levels in the river sediments during testing of the shoreline extraction wells and during full-scale operation of the system. The piezometers at the base of the riprap slope will be drilled with a track mounted sonic drill rig or, if river levels are high enough, from a barge. The piezometers will consist of 2-inch diameter PVC casing with 5 feet of 0.020-inch slotted PVC screen with a pre-packed sand filter pack and a 3-foot sump. Piezometer installation will follow the installation procedures as described above. The piezometers installed on the shoreline will be completed with locking above-ground pipe casings, surrounded by protective casing monuments. As with the previously installed PZ5 cluster, monuments will be installed to extend to approximately 16 feet, City of Portland datum.

3 WELL DEVELOPMENT

Following installation, the wells and piezometers will be developed to clean the wells of drilling materials and remove fine materials from the annular sand pack, thereby developing the sand pack and increasing communication with the aquifer.

Monitoring wells, observation wells, and piezometers will be surged for at least 10 minutes with a device equipped with a surge-block in order to move water in and out of the well screen to loosen and flush out sediment from the well screen and from the filter sand pack. The well will then be pumped until at least 10 casing volumes of water have been removed, water quality parameters (pH, specific conductivity, turbidity, and temperature) have stabilized to +/-10% of the previous reading, and sediment is removed from the well. Ideally, development will continue until turbidity is below 50 NTU; however, this is not always possible with poorly producing wells, or with wells installed in silty or clayey soils.

Extraction wells will undergo a more rigorous development process to obtain the best practical condition of the annular sand pack. The development of the extraction wells will be completed by the driller while the rig is still in location on the borehole. The drilling contractor will select the development method, but the well screens will be surged and pumped until the water is clear and colorless. In some instances, clear and colorless conditions will not be possible. If this is the case, development will continue until turbidity stabilizes at the best practical condition and field water quality parameters are stable. This may take up to 24 hours of development activities per extraction well.

4 EQUIPMENT DECONTAMINATION AND INVESTIGATION DERIVED WASTE PROTOCOLS

Between borehole locations, all drilling and downhole sampling equipment will be decontaminated at a prepared location on site. The drilling equipment will be decontaminated by steam cleaning or a hot water pressure wash.

Residual soils, groundwater, and decontamination fluids (commonly referred to as investigation-derived waste [IDW]) will be handled as specified in this section. Generally, material generated during this scope of work will be contained, identified, and characterized. Holding containers will be labeled with their contents, the date of collection, and the origin of the material. The holding containers will be secured and stored in a designated IDW storage area on the site until their contents have been characterized.

After the work is complete and analytical results are received, residual soils and liquids will be evaluated for disposal method consistent with Oregon Department of Environmental Quality (DEQ) regulations and procedures currently in place and being used by NW Natural and Siltronic.

4.1 Soil Cuttings

Soil cuttings originating from the soil borings will be contained in 55-gallon drums or lined drop boxes, which will be stored in the designated IDW storage area. Each storage container will be labeled to include the source of the soil.

4.2 Groundwater

Water generated during well development and sampling will be contained in 55-gallon drums or temporarily transferred to the on-site liquid holding container. The liquids will be treated using the on-site carbon filtration system and discharged to the publicly owned treatment works (POTW) under the existing industrial wastewater discharge permit. The only exception to this would be if the water contains chlorinated solvents from the Siltronic site. In that case, the groundwater may not be treated in the on-site carbon unit, and other treatment/disposal options will be evaluated for approval by DEQ. Groundwater from the Siltronic site will be stored in separate containers from the groundwater sourced from the Gasco site.

4.3 Decontamination Water

Water generated by equipment decontamination will be properly contained during decontamination activities. Decontamination water will be transferred to the liquid storage containers and treated/disposed as described in the previous section for groundwater.

From: John Edwards
Sent: Friday, May 18, 2007 12:41 PM
To: Dana Bayuk (BAYUK.dana@deq.state.or.us)
Cc: John Renda; John Edwards; Carl Stivers; rjw@nwnatural.com; Patty Dost (Schwabe)
Subject: Gasco Extraction well design

Dana,

FYI, we have a change to the screen/annular pack design.

Further discussions between Boart Longyear and Johnson UOP have resulted in the following design.

All well screens are still stainless wire wrapped Johnson screens, 8 inch diameter, but all with 0.035 inch slots.

All annular sand packs 10/20 sand.

We had previously spec'd 20 slot screens for some of the wells, and 16-30 and 12-20 annular sand packs for different wells.

The consensus between Johnson UOP and the drillers is that 35 slot screen will be less subject to clogging and encrustation, and that development of the annular sand packs will allow efficient screening of fines.

Also that the 16-30 and 12-20 sands are not commercially available, would have to be custom manufactured, and that 10/20 sand will work as well.

I am Ok with these changes because the zones that we are proposing to screen are primarily sand, and we have deliberately avoided screening the zones with significant silt layers.

Let me know if you want to discuss this.

thanks

John

John E. Edwards, RG, CEG
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http://www.anchorenv.com

OGLEBAY NORTON INDUSTRIAL SANDS, INC.

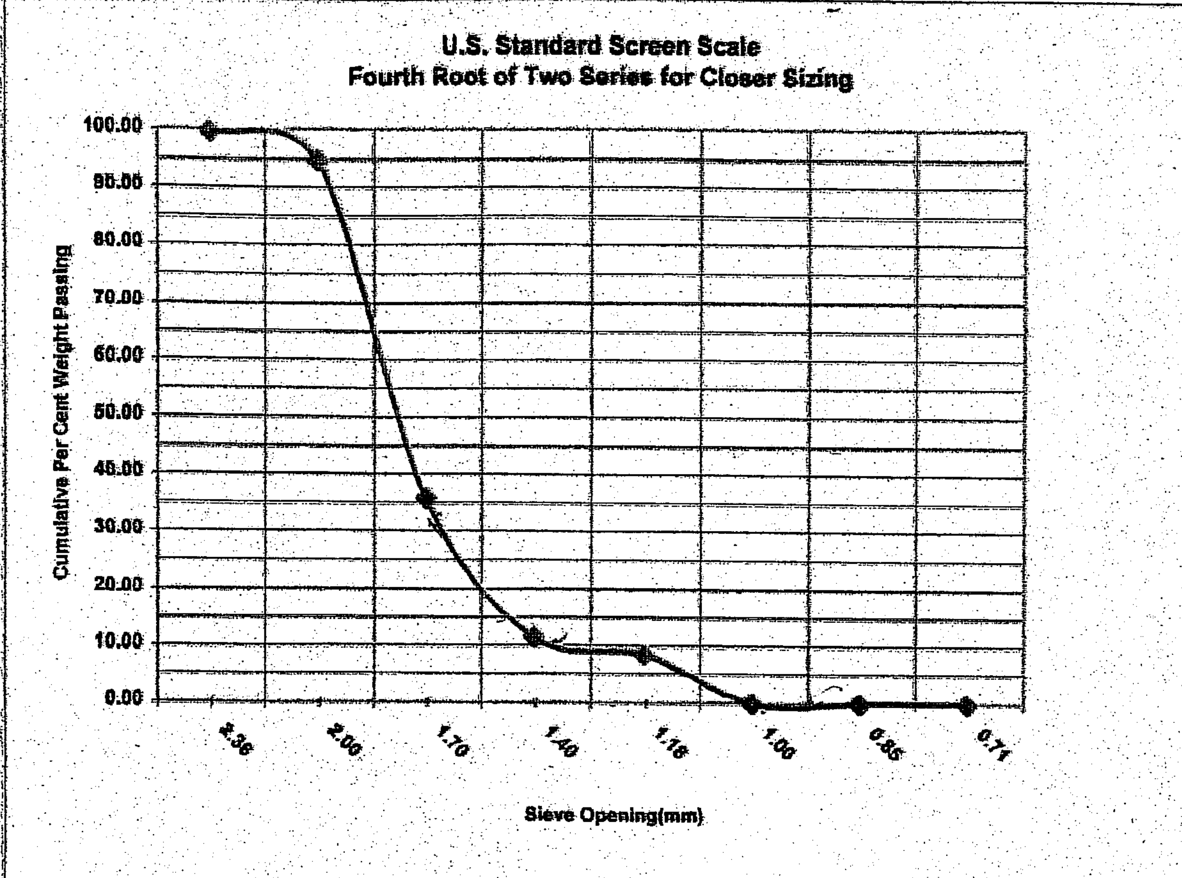
Name:	Requestor:	Analyst: J. Jones

Test pass on effective size of	1.27	Test pass on uniformity coefficient.of	1.43

D10 = 1.27 E.S. = 1.27 Date: December 1, 2006

D60 = 1.82 U.C. = 1.43 Blend:

Cumulative Direct Diagram of Screen Analysis on Sample of 10x20



Sieve Standard Openings (Screen Scale Ratio 1.189)			Cum. Sample Weight Retained	Ind. Sample Weight Retained	Cum. % Retained	Ind. % Retained	Cum. % Passing	Customer Spec % Passing
U.S. No. Mesh	Opening Inches	Opening Millimeter						
8	0.0929	2.360	0.00	0.00	0.00	0.00	100.00	
10	0.0787	2.000	10.80	10.80	5.14	5.14	94.86	
12	0.0669	1.700	134.70	123.90	64.08	58.94	35.92	
14	0.0551	1.400	185.50	50.80	88.25	24.17	11.75	
16	0.0465	1.180	191.80	6.30	91.25	3.00	8.75	
18	0.0394	1.000	210.00	18.20	99.90	8.66	0.10	
20	0.0335	0.850	210.00	0.00	99.90	0.00	0.10	
25	0.028	0.710	210.00	0.00	99.90	0.00	0.10	
Pan			210.20	0.20	100.00	0.10	0.00	
				210.20		100.00		

ATTACHMENT 2
FINAL FIELD SAMPLING PLAN
DATA GAPS QAPP

FINAL
FIELD SAMPLING PLAN

DATA GAPS QAPP
GASCO SEDIMENTS CLEANUP ACTION

Prepared for

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LIST OF ACRONYMS AND ABBREVIATIONS

AIR	Project Area Identification Report
AOC	Administrative Settlement Agreement and Order on Consent
ARI	Analytical Resources, Inc.
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDF	confined disposal facility
COC	chemical of concern
CVOC	chlorinated volatile organic compounds
DEQ	Oregon Department of Environmental Quality
DM	data manager
DNAPL	dense non-aqueous phase liquid
DP	direct push
DQOs	data quality objectives
DRET	Dredge Elutriate Test
EPA	U.S. Environmental Protection Agency
EE/CA	Engineering Evaluation/Cost Analysis
FC	field coordinator
FID	flame ionization detector
FM	Field Manager
FS	Feasibility Study
FSDS	field sampling data sheet
FSP	Field Sampling Plan
HARN	High Accuracy Reference Network
HDPE	high-density polyethylene
IDW	investigation derived waste
LWG	Lower Willamette Group
MFA	Maul Foster & Alongi, Inc.
MGP	Manufactured Gas Plant
MS/MSD	matrix spike/matrix spike duplicate
μg/L	microgram per liter

NAD	North American Datum
NAVD 88	North America Vertical Datum 1988
NELAP	National Environmental Laboratories Accreditation Program
PAH	polycyclic aromatic hydrocarbons
PBRA	probable benthic risk area
PCB	polychlorinated biphenyl
PID	photoionization detector
PM	project manager
Portland Harbor Site	Portland Harbor Superfund Site
PPE	personnel protective equipment
PTFE	polytetrafluoroethylene
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RBC	risk-based concentrations
RCRA	Resource Conservation and Recovery Act
REV	reference envelope value
RI	Remedial Investigation
RSL	regional screening level
ROD	Record of Decision
SBLT	Sequential Batch Leachate Testing
Siltronic	Siltronic Corporation
SLVs	screening level values
SPT-N	Standard Penetration Test
SOW	Statement of Work
SVOC	semi-volatile organic compound
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TPH-Dx	total petroleum hydrocarbons – diesel range
TZW	transition zone water
WRD	Oregon Water Resources Department
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
vibracore	vibratory core sampler
VOA	volatile organic analysis
VOC	volatile organic compound

1 INTRODUCTION

On September 9, 2009, NW Natural and Siltronic Corporation (Siltronic) entered into a Administrative Settlement Agreement and Order on Consent (AOC; Docket No. CERCLA 10-2009-0255) with the U.S. Environmental Protection Agency (EPA) to conduct an Engineering Evaluation/Cost Analysis (EE/CA), and to design a final remedy for the Gasco Sediments Site within the Portland Harbor Site (Figure 1-1). The AOC contemplates that construction of the remedy would occur under a Consent Decree with EPA after the issuance of the Portland Harbor Site Record of Decision (ROD), although EPA has reserved its authority to require other action through separate order. As required by the Statement of Work (SOW) attached to the AOC, additional investigation to fill identified data gaps are proposed to further refine the extents of the in-water and riverbank Project Area as well as support development of an EE/CA and remedy design.

The procedures that NW Natural and Siltronic plan to implement when conducting all field activities are described in the Project Area Identification Report and Data Gaps QAPP (AIR). The Quality Assurance Project Plan (QAPP; Appendix A to the AIR) will ensure that sample collection and analytical activities are conducted in accordance with technically acceptable protocols so that data meet data quality objectives (DQOs). The QAPP provides DQOs and methods for meeting those objectives and includes this Field Sampling Plan (FSP), which details the procedures for planning and executing the data gaps sampling activities.

NW Natural's and Siltronic's contractors (Anchor QEA, LLC, and Maul Foster & Alongi, Inc. [MFA], respectively) have also prepared separate Health and Safety Plans (HASPs; Attachments 2 and 3 to the QAPP) that are designed to protect their personnel from physical, chemical, and other hazards posed by sampling activities in the Project Area.

1.1 Purpose and Objectives

The overall objective of this FSP is to detail the sampling and data-gathering methods that will be used in the data gaps investigation (summarized in Section 6 of the AIR). The data gaps to be addressed are summarized as follows:

- Visual observations of substantial product in sediment cores and riverbank borings in key areas to provide data to refine the horizontal and vertical extent of substantial product and the initial Project Area boundary.

- Sediment bioassay toxicity and surface sediment chemistry data to refine the probable benthic risk area (PBRA) and the initial Project Area boundary.
- Surface and subsurface sediment chemistry data to refine the horizontal and vertical extent of contamination and the initial Project Area boundary.
- Geotechnical and chemical mobility (e.g., elutriate or other tests) testing of sediment and riverbank soil to obtain data to support EE/CA alternatives evaluation and/or design.
- Riverbank soils chemistry data to refine the horizontal and vertical extent of contamination and the initial Project Area boundary.
- Transition zone water (TZW) and groundwater chemistry data in Area 1 to confirm the nature and extent of the trichloroethene (TCE) groundwater plume entering the river from the Siltronic property and to provide data necessary to estimate in-river attenuation rates for TCE and its degradation products.
- Waste characterization sampling to support a preliminary determination of the presence or absence of RCRA hazardous waste or Special Waste (as defined in the SOW) in the initial Project Area, and the extents of such wastes.

This FSP includes sampling objectives, a detailed description of sampling activities, sample locations, sample analysis, sampling equipment and procedures, sampling schedule, station positioning, sample handling (e.g., sample containers and labels, sample preservation), and chain-of-custody procedures. This FSP also provides the basis for planning field activities, and establishes the specific quality assurance requirements, which are presented in the QAPP.

1.2 Document Organization

This FSP is organized into the following sections:

- Section 2 – Project Management and Responsibilities
- Section 3 – Sediment and Soil Sample Collection, Processing and Handling Procedures
- Section 4 – Area 1 TZW and Groundwater Sample Collection, Processing and Handling Procedures
- Section 5 – Bioassay, Chemical and Physical Testing
- Section 6 – Field Sampling Schedule
- Section 7 – References

2 PROJECT MANAGEMENT AND RESPONSIBILITIES

This section describes the overall project management strategy for implementing and reporting of the field activities. Section 3.1 of the QAPP identifies key project management personnel and their roles and responsibilities.

MFA will implement the in-river Area 1 TZW and groundwater data gaps sampling portion of this FSP in coordination with the remainder of the data gaps investigation activities to be implemented by Anchor QEA.

As described in the QAPP, the project managers (PMs) for Anchor QEA and MFA will be responsible for overall project coordination, including production of all project deliverables and administrative coordination to assure timely and successful completion of the project.

The Anchor QEA and MFA field coordinators (FCs) will be responsible for day-to-day technical and quality assurance/quality control (QA/QC) oversight. They will ensure that appropriate protocols for sample collection, preservation, and holding times are observed and will submit environmental samples to the designated laboratories for chemical and physical analyses. They will be assisted by additional personnel at Anchor QEA, as necessary. The data managers (DMs) will be responsible for coordination and oversight of data validation and data management, and will report to the PMs.

Specialized investigation activities will be subcontracted. The names and qualifications of subcontractors proposed for this work will be submitted to the EPA for approval prior to commencement of work, in conformance with the AOC. Subcontracted services will be used to complete the following activities:

- Laboratory analysis of environmental media
- In-water and upland drilling
- Site preparation for upland drilling
- Transportation and disposal of investigation derived waste (IDW)

The Anchor QEA and MFA field teams will provide oversight of subcontractor field operations. All subcontractors will follow the protocols established in this FSP. The sampling and analysis will be completed with equipment owned or rented by Anchor QEA, MFA, or by subcontractors.

The designated laboratories will be qualified and experienced in the analysis of environmental samples. As described in the QAPP, the laboratory manager will oversee all laboratory operations associated with the receipt of the environmental samples, chemical analyses, and laboratory report preparation for this project. The analytical and bioassay laboratories will be responsible for:

- Perform the methods outlined in the QAPP and attachments, including those methods referenced for each analytical or bioassay procedure
- Follow documentation, custody, and sample logbook procedures
- Meet all reporting and QA/QC requirements
- Deliver electronic data files as specified in the QAPP and attachments
- Meet turnaround times for deliverables as described in QAPP and attachments
- Allow EPA and the QA/QC contractor to perform laboratory and data audits

The designated analytical laboratories will also provide certified, pre-cleaned sample containers, appropriate sample preservatives.

3 SEDIMENT AND SOIL SAMPLE COLLECTION, PROCESSING, AND HANDLING PROCEDURES

The following sections describe the sample collection, processing, and handling procedures to be followed during the data gaps investigation for the Manufactured Gas Plant (MGP)-related sampling to be performed by Anchor QEA. The QAPP details the quality assurance/quality control protocols to be followed during these activities.

3.1 Substantial Product Observations

Anchor QEA will visually inspect and log the full depth of each sediment grab sample, sediment core, and riverbank boring for the presence of substantial product, as defined in Section 3.6.2.1 of the SOW. For reference, the SOW definition is reiterated here:

"The working definition of 'substantial presence of product' is those sediments that meet the following criteria based on core observations:

1. "**Criterion 1:** Bands of product, layers of product, 'saturated' sediments, 'stained' sediments, and/or seams of product that are greater than 2 inches thick.
2. "**Criterion 2**: Any layer or seam of product, regardless of thickness, that is clearly defined as liquid DNAPL that is also mobile (i.e., 'oozes' or 'drips' out of the core during core observations).

"Modifying factors to these criteria are:

- "If the top 5 feet of a core has no substantial product under Criterion 1, then deeper product should be judged as 'not substantial,' even if relatively thick layers of product exist at greater depths.
- "If there are any seams of mobile liquid DNAPL (not solid or semisolid tar) per Criterion 2, then this is substantial product regardless of depth and the characteristics of overlying sediments.

"The following is NOT defined as substantial presence of product:

- "Any layers of non-mobile product (i.e., bands, layers, saturated sediments, stained sediments) that are less than 2 inches thick
- "Petroleum odors that are not associated with visual evidence of product beyond sheens and blebs

- "Sheens that are not associated with more substantial visuals of product
- "Isolated product blebs or spots not associated with more substantial visuals of product"

Detailed core collection and processing procedures are presented in Section 3.3.

3.2 Surficial Sediment Grab Samples

Surface sediment samples will be collected at the 20 locations shown on Figure 1-2 using a van Veen grab sampler and submitted for laboratory toxicity testing and bulk sediment testing for the project chemicals of concern (COCs) per the analyte list in Table 1-1. The surficial sediment grab sample protocols used in this investigation will be consistent with recent sediment toxicity testing conducted as part of the Portland Harbor Site Remedial Investigation (RI). The following sections present the van Veen grab sample collection and processing protocols. Analytical methods to be used for toxicity testing are described in Section 5.

3.2.1 Van Veen Grab Collection Methods

Surface sediment samples will be collected using either a hydraulic or gravity driven van Veen grab sampling device with a 1-foot depth. Sampling locations will be approached at slow boat speeds with minimal wake to minimize disturbance of bottom sediments prior to sampling. The grab sampler, which will be weighted as necessary to help achieve the target penetration depth, will be lowered over the side of the boat using a winch and davit connected to a cable at an approximate speed of 0.3 feet per second. When the sampler reaches the mudline, the cable will be drawn taut and DGPS coordinates recorded. The sampler will be retrieved aboard the vessel and evaluated for acceptance based on the following criteria:

- Overlying water is present and has low turbidity
- Target penetration depth of 1 foot is achieved based on visual measurements (for example, using a ruler)
- Sampler is not overfilled
- Sediment surface is undisturbed
- No signs of winnowing or leaking from sampling device

Grab samples not meeting these criteria will be rejected and the sample collection steps repeated until the acceptance criteria are met. Deployments will be repeated within a 20-foot radius of the proposed sample location. If adequate penetration is not achieved (i.e., 1 foot below mudline) after multiple attempts, less penetration will be accepted and noted in the field notebook. Only one sample per station is proposed, but if additional volume is required to meet the testing requirements at a single station due to limited penetration, additional grabs will be collected slightly offset from previous sampling locations to avoid collected deeper sediments below the mudline. If this occurs, representative volumes from the full penetration depth of each individual grab will be collected in separate stainless steel bowls. An approximately equal volume aliquot of each grab sample will then be composited to create the final sample. Once accepted, the sample(s) will be processed and logged as described in Section 3.2.2. The sampler will be rinsed with site water between grabs and decontaminated between stations following the procedures identified in Section 3.10.

All grab samples, regardless of acceptance, will be logged as they are collected. Sample information and observations will be recorded in the field log, following the specifications in Section 3.2.2 and in the surface sediment sample log sheet (Attachment 1-1).

3.2.2 Sample Processing

The following protocols will be used to process accepted surface sediment samples:

- *Siphon Water:* Siphon off water overlying the mudline taking care not to remove sediment.
- *Volatile organic compounds (VOC) sampling (not homogenized)* – Immediately following opening of the grab, a representative sample from each of the above designated sample intervals will be collected using a clean, stainless steel spoon and placed into a pre-labeled container. The sample will be collected prior to homogenization and the 2-ounce jar will be filled completely (i.e., no headspace) to minimize volatilization. The jar lid will be closed tightly and examined to minimize the potential for excess sediment inhibiting a tight seal. Additional volume will be collected and archived pending future potential VOC analysis (e.g., treatability testing) within the appropriate hold time.
- *Photograph Grab*: Take digital photographs of each grab with a label indicating project, sample location, date.
- *Sample Logging*: Record the sample description on the grab sample log form, including, but not limited to, the following observations as appropriate:
  - Physical soil description in accordance with the Unified Soil Classification System (includes soil type, density/consistency, color, etc.)
  - Substantial product and sheens
  - Odor (e.g., hydrogen sulfide, petroleum, etc.)

- Vegetation
- Man-made debris
- Biological activity (e.g., shells, tubes, bioturbation, organisms, etc.)
- Any other distinguishing characteristics or features

- *Remove Debris.* Materials in the sample more than 2 inches in diameter and debris will not be subsampled into sample containers.
- *Homogenize Grab*. Collect the upper 1 foot (i.e., 30 centimeters consistent with the Portland Harbor Site definition of surface sediment) of sediment from inside the van Veen sampler, without touching the sidewalls, using a decontaminated stainless steel trowel or equivalent. Place the sediment into a single decontaminated stainless steel bowl or high-density polyethylene (HDPE) bucket and homogenize until uniform color and texture is achieved. Some portion of the remaining volume following filling of the sample containers will be placed into additional laboratory-provided sample containers for potential future analysis.
- *Fill Sample Containers*. Using a decontaminated stainless steel spoon, fill pre-labeled, decontaminated sample containers for sediment toxicity tests and bulk chemistry characterization.

Samples will then be packed on ice and transferred to the chemistry and biological testing laboratories following the handling and chain-of-custody protocols described in 3.9.3.

3.3 Sediment Core Collection and Processing

Anchor QEA's in-water drilling subcontractor will collect sediment cores in up to 27 target locations (Figure 1-2) using vibratory core sampler (vibracore) methods. These target stations may change based on the encountered field conditions (e.g., presence of rip rap, accessibility, weather conditions, etc.) and/or observations of substantial product in surface grab or core samples. The collected sediment cores will be visually inspected and logged for the presence of substantial product per the definition provided in Section 3.1 and sampled for chemical, elutriate, leachate, and/or geotechnical analysis at the selected analytical laboratory.

As shown on Figure 1-2, 18 sample station locations are currently targeted for core collection and 9 additional cores are identified as "contingency" core locations based on observations of substantial product in the target locations collected at adjacent locations. These contingency cores will be collected if one or more of the 18 original cores contains substantial product that results in an unbounded perimeter of areas that will likely be defined to contain substantial product. Additional contingency cores may be required to further refine areas of substantial product within the bounded perimeter as well. Such additional core locations will be identified and proposed in the field in coordination with EPA prior to collection.

Sediment core samples will be collected and processed using the methodologies presented in the following sections.

3.3.1 Sediment Core Collection

Coring procedures follow the guidance set forth in the *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual* (EPA 2001). The vibracorer will be deployed from the bow of the vessel using an A-frame and winch assembly. A 20-foot decontaminated aluminum pipe with a 3.75-inch inside diameter will be clamped to the vibracorer.

Core tubes will be decontaminated prior to use following the protocols outlined in Section 3.10. Care will be taken during sampling to avoid contact of the core tube with potentially contaminated surfaces. Extra core tubes will be available during sampling operations for uninterrupted sampling in the event of a potential core tube breakage or contamination. Core tubes suspected to have been accidentally contaminated will not be used.

The vibracorer will be deployed over the bow and sent to the bottom. If the location is on a sloping mudline, the A-frame base may be reconfigured to attempt to match the slope to facilitate vertical penetration of the core. Once in position the unit will then be energized and driven to a maximum of 20 feet below mudline or refusal at all sampling locations. The physical characteristics at each proposed sampling station is anticipated to be variable precluding an accurate estimation of the core recovery at each station prior to collection. Once refusal occurs, the vibracorer will be turned off and returned to the surface for comparison to the sample acceptability criteria. The penetration depth will be evaluated based on the length of line released from the winch unit, data from the vessel's onboard penetration monitor, blemishes on the side of the core barrel, and examination of material residing within the tip of the core barrel. During deployment and retrieval of the coring device, care will be taken to ensure that the end of the core tube does not become contaminated. When retrieved, each core will be inspected and a physical description of the material at the mouth of the core will be entered into the core log and photographed with a label showing the project name, location, and sampling date.

The core acceptability criteria are as follows:

- Recovery was at least 75 percent of the length of core penetration.
- Cored material did not extend out the top of the core tube or contact any part of the sampling apparatus at the top of the core tube.
- There were no obstructions in the cored material that might have blocked the subsequent entry of sediment into the core tube and resulted in incomplete core collection.

If multiple core rejections (three attempts) require the core station to be relocated, the proposed station relocation will be documented and the actual coordinates will be reported to the EPA after sample collection is complete. Efforts will be made to relocate the station within a 20-foot radius of the proposed station.

All sediment cores, regardless of acceptance, will be logged as they are pushed to refusal. Sediment core information and observations will be recorded in the field log (following the specifications in Section 3.3.2) and in the core sampling log sheet (Attachment 1-2).

Core tubes longer than 4 feet will be cut to facilitate upright storage and transport to the offsite processing location. The cut tubes will be individually labeled and adequately sealed to prevent material loss during transport. Core orientation will also be etched on each tube. Labels identifying the core section will also be securely attached to the outside of the tube using tape and waterproof ink. The core sections will be stored approximately upright in iced containers in the appropriate orientation until core processing is conducted.

3.3.2 Core Processing

The cores will be carefully transferred from the sampling vessel to large containers full of ice at a designated shore-side location where processing will be conducted. The anticipated processing facility is on the Gasco property along the central portion of the property near the top of bank area. At the processing facility, cores will be cut open vertically and logged. The entire core length at each sampling station will be opened to facilitate a visual inspection and logging throughout the entire length of the core. Each core will be inspected and logged for the presence of substantial product and other signs of visual contamination, as described in this section.

Within each collected core, one half of the core tube will be sampled for chemical analysis (Table 1-1) and the other half will be sampled for dredging elutriate testing (DRET; see Table 1-2) and waste characterization testing (Table 1-1 [ammonia, sulfide, pH, corrosivity, ignitability] and Table 1-3 [TCLP]). Bulk chemistry and geotechnical sampling will be conducted in every core collected within the following intervals: mudline to 1 foot, 1 to 4 feet, and in four foot intervals to the bottom elevation of the core. Based on the bottom elevation the last sampled interval may not be 4 feet (i.e., the last sampling interval in a core that penetrates to 14 feet below mudline will be from 12 to 14 feet). DRET and waste characterization testing will be conducted at the designated stations shown in Figure 1-2. The sampling interval in each core will be determined in the field based on where substantial product is observed and visual observations indicating the greatest potential for chemical mobility.

The following description provides a detailed account of the core processing procedures:

- *Open Cores* – Lay out the core tubes for the entire penetration depth for a sampling station. Cut the aluminum core tubes longitudinally using a circular saw, setting the saw blade depth to minimize penetration and disturbance of the sediment during cutting.
- *VOC sampling (not homogenized)* – Immediately following opening of the core, a representative sample from each of the above designated sample intervals will be collected using a clean, stainless steel spoon and placed into a pre-labeled container. The sample will be collected prior to homogenization and the 2-ounce jar will be filled completely (i.e., no headspace) to minimize volatilization. The jar lid will be closed tightly and examined to minimize the potential for excess sediment inhibiting a tight seal Additional volume will be collected and archived pending future potential VOC analysis (e.g., treatability testing) within the appropriate hold time.
- *Inspect for Substantial Presence of Product* – Examine the stratigraphy of the captured sediment core to identify the presence of substantial product as described in Section 3.1.
- *Core Logging* – Record the description of the full length of the core sample on the core log form, including but not limited to the following observations as appropriate:
  - Sample recovery (recovered sediment depth relative to penetration depth, and percent compaction)

  - Physical soil description in accordance with the Unified Soil Classification System (includes soil type, density/consistency, color, etc.)
  - Substantive presence of product, sheens
  - Odor (hydrogen sulfide, petroleum, etc.)
  - Vegetation
  - Man-made debris
  - Biological activity (e.g., shells, tubes, bioturbation, organisms, etc.)
  - Any other distinguishing characteristics or features

- *Photograph Core* – Take digital photographs of each 1-foot core interval with a label indicating the location and depth of the core interval.
- *Identify Sample Intervals* – The sampling interval in each core will be determined in the field based on where substantial product is observed and visual observations indicating the greatest potential for chemical mobility (for example, liquid NAPL that "oozes" or "drips"). Observations of substantial product will be made consistent with the definition identified in Section 3.6.2.1 of the SOW. Measurements will be taken to determine the thickness of substantial product relative to the 2 inch thick criteria.
- *Homogenize Core* – Using a clean spoon, place a proportionate volume of sediment from the identified sample interval(s) into a single cleaned stainless steel bowl or HDPE bucket, and homogenize until uniform color and texture is achieved.
- *Fill Sample Jars –* Using a decontaminated stainless steel spoon, fill pre-labeled, laboratory-provided sample containers for all proposed analyses (see sections 3.9.1 to 3.9.3). Some portion of the remaining volume following filling of the sample containers will be placed into additional laboratory-provided sample containers for potential future analysis (e.g., treatability testing).

Samples will be packed and transferred to the laboratory following the handling and chain-of-custody protocols described in Section 3.9.3.

Table 1-4 lists the holding times, preservation, and maximum holding times for the categories of analytes, as described in the *Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual* (EPA 2001).

3.4 Soil Boring Collection and Processing

Top of riverbank and slope of riverbank borings are proposed to provide additional information on the lateral and vertical extents of substantial product and soils chemical concentrations.

3.4.1 Top of Riverbank Exploration and Sampling

This section describes the top of river bank testing plan, techniques for drilling top of riverbank test borings, collecting soil samples for chemical, physical, and geotechnical analysis, and performing geotechnical field testing. Tasks related to drilling (i.e., borehole logging and soil classification) are described in Section 3.4.3. The methods outlined in this section conform to requirements in Oregon Water Resources Department (WRD) administrative rules Chapter 690, division 240.

3.4.1.1 Top of Riverbank Testing Plan

The top of riverbank testing plan includes borings located to provide qualitative, chemical, and geotechnical data to refine the shoreline extents of the initial Project Area and inform the EE/CA and design. The target top of riverbank station coordinates and locations are provided in Table 1-5 and Figure 1-2, respectively. The objective is to collect each boring as close as accessible to the top of riverbank up gradient from the existing toe of riverbank GS-01 through GS-12 borings, as well as further upstream to the extent of the initial Project Area (Figure 1-2). The target locations may change based on encountered field conditions and accessibility.

Nine boring locations (GST–01 through GST-06, GST-09, GST-11, and GST-13) are proposed along the top of riverbank based on the rationale described in Section 6.1.2 of the AIR. No contingency top of riverbank borings are proposed based on observations of substantial product identified during the field sampling. Boring depths are based on target elevations that exceed the depths of substantial product observed, if any, in both in-water and upland borings adjacent to the proposed boring locations. In areas where substantial product has not been observed in either in-water or upland borings, boring depths are based on target elevations that are consistent with boring depths in adjacent top of riverbank locations.

Samples will be collected from 5 foot intervals in each boring. Chemical analysis will be performed on the 0 to 5 feet interval to characterize the surface soil interval and the deepest 5 feet interval to characterize the interval of soil that may be exposed if the shoreline is reconfigured and/or soil that may be exposed to shallow groundwater migration. Waste characterization testing will be performed on a total of three boring locations on intervals where substantial product is observed to evaluate those sediments with the highest potential of exceeding the TCLP criterion. Bulk geotechnical testing will be performed on all intervals as follows:

- Moisture content (collected in 5 feet intervals)
- Atterberg limits (collected every other 5 feet interval)
- Grain Size (collected every other 5 feet interval staggered with Atterberg limits intervals)

Specific gravity will be performed on at least three samples that will be chosen to represent the range of materials observed. Undisturbed core (Shelby tube) geotechnical testing will be conducted to facilitate laboratory testing of consolidated undrained (CU) Triaxial testing. One core will be obtained along each shoreline transect at an interval where cohesive soils are expected to be (i.e., the nature of the sample will not be determined until opening the Shelby tube in the laboratory). The exact intervals tested will be determined by a geologist based on field observations. CU Triaxial testing will be performed on four of the collected Shelby tubes. Table 1-6 summarizes the target boring surface elevations, approximate target depths, if the boring is a primary of contingency boring, and which intervals will be subjected to chemical analysis and geotechnical testing.

3.4.1.2 Top of Riverbank Exploration and Sampling Methods

The borings will be advanced by a Sonic drill rig following clearing of the target location as necessary to facilitate access. Continuous soil samples, disturbed geotechnical samples (split spoon samples) and undisturbed geotechnical samples (Shelby tube) will be obtained and sampled at the frequency and depth intervals identified in Table 1-6. Standard Penetration Test (SPT-N) blow count data will also be recorded during the split spoon sampling to collect disturbed samples. After the target depth is reached, undisturbed samples will be obtained by pushing a Shelby tube two feet using a constant push from off the drill rig, and per American Society for Testing and Materials (ASTM) D1587. Decontamination of drilling and sampling equipment will be performed as described Section 3.10.

During sampling, the number of hammer blows required to advance the sampler in 6-inch increments will be recorded as a measure of soil density using the SPT. This test is an approximate measure of soil density and consistency. As described in ASTM D 1586, this test employs a standard 2-inch outside diameter sampler. Using a 140 pound hammer free falling

30 inches, the sampler is driven into the soil for 18 inches. The number of blows required to drive the sampler the last 12 inches is the Standard Penetration Resistance. This resistance, or blow count, measures the relative density of granular soils and the consistency of cohesive soils. The blow counts are plotted on boring logs at their respective sample depths.

If dense materials (i.e. more than 50 blows per 6-inch drive) preclude driving the total 18-inch sample, the penetration resistance is entered in one of two ways: If less than 6 inches, enter the total number of blows over the number of inches of penetration on the boring log (e.g. "50/3"). If greater than 6 inches, sum the total number of blows completed after the first 6 inches of penetration. This sum is expressed over the number of inches driven that exceed the first 6 inches (e.g. "50/9"). In determining the final SPT blow count, the number of blows needed to drive the first 6 inches is not reported, as this first interval is considered potentially disturbed by the drilling action

3.4.2 Slope of Riverbank Exploration and Sampling

This section describes the slope of riverbank testing plan, techniques for drilling slope of riverbank test borings, collecting soil samples for chemical, physical and geotechnical analysis, and performing geotechnical field testing. Tasks related to drilling (borehole logging and soil classification) are described in Section 3.4.3. The methods outlined in this section conform to requirements in WRD administrative rules Chapter 690, division 240.

3.4.2.1 Slope of Riverbank Testing Plan

The slope of riverbank testing plan includes borings located to provide qualitative, chemical, and geotechnical data to refine the shoreline extents of the initial Project Area and inform the EE/CA and design. The target slope of riverbank station coordinates and locations are provided in Table 1-5 and Figure 1-2, respectively. These locations target collection in the middle portion of the shoreline slope but the locations may change based on field conditions and accessibility.

Five boring locations (GSM-07, GSM-08, GSM-10, GSM-12, and GSM-14) are proposed along the slope of the riverbank. An additional eight contingency boring locations (GSM-01 through GSM-05, GSM-09, GSM-11, and GSM-13) are proposed, based on observations in the top of riverbank bank primary boring locations. Boring depths are based on target elevations that exceed the depths of substantial product observed, if any, in both in-water and upland borings adjacent to the proposed boring locations. In areas where substantial product has not been observed in either in-water or upland borings, boring depths are based on target elevations that are consistent with boring depths in adjacent top of riverbank locations.

The disturbed (split spoon) and undisturbed (Shelby tube) sampling methods for collecting samples within target intervals are the same as noted above for top of bank sampling and detailed in Table 1-6.

3.4.2.2 Slope of Riverbank Sampling Site Preparation

The majority of the slope of riverbank sampling locations is covered with rip rap that will need to be removed before borings can be completed. An excavator will be used to remove the rip rap at each slope of riverbank sampling location and clear a path (anticipated to be accessed from the top of bank) to this location. Incidental soils that are removed during this clearing process will be handled as IDW, as described in Section 3.12. Sediment and erosion controls, appropriate to the site conditions and consistent with the Oregon Department of Environmental Quality's (DEQ)s *Erosion and Sediment Control Manual, Appendix F: Sediment Control BMPs* (2005) will be used to prevent any contaminated soils from eroding into the Willamette River during the clearing and testing. The rip rap will be temporarily staged on geotextile in a bermed area at an upland location to minimize potential tracking of soils on the rip rap to the temporary storage area. Rip rap will be put back into place after sampling is performed to approximately restore the original conditions. Any material that falls off the rip rap onto the geotextile will be disposed of as IDW.

3.4.2.3 Slope of Riverbank Exploration and Sampling Methods

The slope of riverbank borings will be advanced by a Geoprobe™ rig. Continuous soil samples, disturbed soil samples (split spoon samples) and undisturbed soil samples (Shelby tube) samples will be obtained and sampled at the frequency and depth intervals identified in Table 1-6. SPT-N blow count data will also be recorded. Shelby tube and SPT-N methods will be consistent with the methods described in Section 3.4.1.2. Decontamination of drilling and sampling equipment will be performed as described in Section 3.10.

3.4.3 Soil Core Logging and Processing Procedures

VOC sampling will be conducted immediately upon opening each 5-ft interval in the designated sampling intervals identified in Table 1-6 for the analytes identified in Table 1-1. This sampling will follow EPA method 5035A. Additional volume will be collected and archived pending future potential VOC analysis (e.g., treatability testing) within the appropriate hold time.

Following VOC sampling, a log of the boring will be prepared in the field by a geologist registered in Oregon or by an environmental scientist working under the supervision of a registered Oregon geologist. Boring logs will include the project name and location, name of the drilling contractor, name of the scientist completing the log, drilling method, sampling method, boring designation, soil sample depths, and description of soils encountered, including the presence of substantial product as defined in Section 3.1. The field geologist will also note any debris that is encountered or change in drilling action, and determine the static groundwater levels. Samples will be logged using ASTM designation D2488-00, Standard Practice for Description and Identification of Soils (Visual-Manual Procedures). The standard involves describing color, grain size, moisture content, density, organic matter, and other observed characteristics. Consistent with previous field investigations, soil samples and cores will be screened for the presence of MGP waste using ultraviolet fluorescence (that is, a short wavelength [2,500 to 3,000 angstroms] and long wavelength [3,000 to 4,000 angstrom] ultraviolet light). Additionally, soil should be screened with a flame ionization detector (FID) or a photoionization detector (PID) equipped with a 10.6 mV lamp, and using sheen tests if the sample is suspect (e.g. oily, dark). The information will be recorded on a standard Anchor QEA exploratory boring log form (Attachment 1-3). For each boring, the full length of the boring penetration will be logged.

EPA has requested that increased observation be conducted—with EPA coordination—during the proposed collection of top of riverbank roto-sonic cores to help identify and eliminate any observational problems that are encountered. Therefore, logging of roto-sonic borings will be conducted in the presence of EPA oversight personnel unless otherwise approved by EPA.

After logging is complete, discrete geotechnical samples will be taken and placed in laboratory-supplied sample containers. The remaining sample portion will be homogenized in a stainless steel bowl and placed in laboratory-supplied sample containers. The designated intervals for geotechnical and bulk chemical sampling are summarized in Table 1-6. The testing parameters for these samples are identified in Table 1-1. A portion of the remaining sample volume from each core following chemical and geotechnical sampling will be archived in laboratory-supplied sample containers for potential future analysis of toxic characteristic leaching procedure (TCLP), sequential batch leachate testing (SBLT), and or disposal treatment bench scale testing.

As discussed in Sections 7.3 of the AIR, soil from three soil borings will be submitted for TCLP testing and for analysis for the characteristics of ignitability and corrosivity (EPA currently has no currently acceptable methods for testing reactivity). The sampling interval in each core will be determined in the field based on where substantial product is observed and visual observations indicating the greatest potential for chemical mobility. The TCLP VOC tests for the bulk sediments will be expedited to facilitate receipt of results and comparison of the results to TCLP criterion within this time frame. If the VOC results exceed the criterion (benzene anticipated to have the highest probability for exceedance), a decision will be made as to whether disposal treatment bench scale tests (Section 5.2.1.5) will be run on archived samples to attempt to reduce the leachate concentrations below the criterion.

As discussed in Section 7.5 of the AIR, SBLT tests will be performed using soil from a variety of locations from the riverbank. The locations and depth intervals used for the tests as well as number of tests to be conducted will be based on a representative range of chemical and physical characteristics encountered in the field that will potentially be placed in a CDF. Because SBLT testing will not include volatile chemicals, sample volume at each core location will be archived pending logging of the collected cores and receipt and evaluation of the bulk sediment chemistry results. The bulk sediment chemistry results and substantial product observations from the SBLT samples will be evaluated against expected qualitative or quantitative placement criteria expected for Portland Harbor CDFs to determine whether the dredge areas represented by the SBLT samples are candidates for CDF disposal, whether sediment treatment may be needed prior to disposal, and if so, whether sediment treatment should be performed on the SBLT sample material before running the test(s).

The sample containers will be stored in an iced-cooler until transfer to the laboratory (following the chain-of-custody procedures described in Section 3.10) for analysis.

3.5 Horizontal Positioning and Vertical Control for Sediment and Soil Sampling

Horizontal positioning at each sampling location will be determined using a DGPS with a handheld GPS unit as backup if necessary. All vertical geographical coordinates will be relative to the North America Vertical Datum 1988 (NAVD 88) and horizontal geographical coordinates will be in the North American Datum (NAD) 83 High Accuracy Reference Network (HARN), Oregon State Plane, North Zone and use international feet.

Mudline elevation of each sediment sampling station will be determined relative to NAVD 88 by measuring the water depth with a calibrated fathometer or lead line and subtracting the tidal elevation. River elevations will be determined using the onsite river gauge transducer installed on the FAMM dock.

Depths associated with soil boring activities will be recorded in field documentation as depth below ground surface (bgs). The elevation of ground surface at each boring location will be surveyed following completion of soil boring installation activities, prior to the replacement of any erosion protection material.

3.6 Station and Sample Identification for Sediment and Soil Sampling

Each discrete sediment sample will be assigned a unique alphanumeric identifier according to the method described below. The identifiers facilitate sample tracking by incorporating identifying information. The alphanumeric identifiers will be assigned in the below manner for sediments and soils.

3.6.1 Sediments

The alphanumeric identifiers will be assigned in the following manner for sediments:

- The first three characters for the in-water locations identify the sample location by the project descriptor: DGS = Data Gaps Sample
- The next two characters identify the sample station: -01 = Station 01
- The next 2 characters identify the sampling matrix:
  - SC = Sediment Core
  - SG = Sediment Grab
- The next character identifies the sampling interval: -A = First Interval.
- The next six characters identify the collection date: -YYMMDD

For example, sample number DGS-02SCE-A-100101 indicates a sediment sample obtained from Station 02 within the first sampling interval on January 01, 2010. The representative depths for each sampling interval will be defined in the field logs and provided in the chemical analytical results tables.

3.6.2 Riverbank Soils

The alphanumeric identifiers will be assigned in the following manner for riverbank soils:

- The first three characters for the riverbank locations identify the sample location by the project descriptor: GSM = Gasco shoreline middle of riverbank and GST = Gasco shoreline top of riverbank
- The next two characters identify the sample station: -01 = Station 01
- The next 2 characters identify the sampling matrix: SO = Soil
- The next character identifies the sampling interval: -A = First Interval
- The next six characters identify the collection date: -YYMMDD

For example, sample number GSM-04SO-A-100204 indicates a middle of slope riverbank soil sample obtained from station 04 within the first sampling interval on February 4, 2010. The representative depths for each sampling interval will be defined in the field logs and provided in the chemical analytical results tables.

3.6.3 Field QA/QC

The field QA/ QC samples will be assigned a unique alphanumeric identifier according to the method described below:

- The first three characters identify the sample location by using the first letter of each word in the location name: DGS = Data Gaps Sample (used for sediments), GSM = Gasco shoreline middle of bank, and GST = Gasco shoreline top of riverbank.
- The rinsate blank samples will be followed with an -RB followed by the date in YYMMDD format
- The field blank samples will be followed with an –FB followed by the date in YYMMDD format
- The homogenization duplicate will be followed with –XXSE-A-YYMMDD (sediments) or –XXSO-A-YYMMDD (soils) where XX is the station number plus 50, A is the sampling interval, and YYMMDD is the sampling date.

For example, sample number DGS-RB(FB)-100105 and DGS-51SC-A-100105 represent a rinsate blank (field blank) collected on January 5, 2010 and a homogenization duplicate collected from station 01 interval A on January 5, 2010, respectively.

When necessary, extra sample volume collected for matrix spike/matrix spike duplicate (MS/MSD) analysis will be identified with the same designation as the sample.

3.7 Field QA/QC Samples for Sediment and Soil Sampling

Field QA/QC samples will be collected and used to evaluate the variability resulting from sample handling and the efficiency of field decontamination procedures (Section 3.10). All field QC samples will be documented in the site logbook.

3.7.1 Field Split for Sediment and Soil Sampling

Field duplicates (i.e., homogenization duplicates) will be collected at a frequency of one per 20 sediment and soil samples. The field duplicates will be prepared by dividing aliquots of the homogenate (during core or boring processing and/or field collection) into two distinct samples for the laboratory (the original sample and a duplicate). The samples will be processed in exactly the same way as the original sample and will be submitted to the laboratory as blind samples. The samples will be analyzed for the full suite of bulk sediment testing listed in Table 1-1. Field duplicate sample identification is described in Section 3.6.3. This type of field QA/QC samples is not applicable to VOCs given sampling for these chemicals does not include homogenization of the sample volume. Field duplicates for VOCs will be collected by taking an additional grab sample as close to the original sample as possible.

3.7.2 Field Blanks for Sediment and Soil Sampling

Field blank samples will be collected to evaluate the efficiency of field decontamination procedures. One rinsate blank and one field blank will be collected for each type of sampling technique utilized. The rinsate blank will consist of rinsing down the sediment coring and homogenization equipment after sample collection and decontamination with distilled water, and collecting the rinsate. The field blank will be collected by pouring distilled water directly in the sampling containers. In addition, a trip blank will be included in each container shipped to Analytical Resources, Inc. (ARI), containing samples to be analyzed for volatiles (i.e., VOCs). The field blank samples will be analyzed for cyanide, metals, VOCs, semi-volatile organic compound (SVOCs), polychlorinated biphenyls (PCBs), pesticides, and total petroleum hydrocarbons – diesel range (TPH-Dx). Rinsate and field blank sample identification are described in Section 3.6.3.

3.8 Field Documentation for Sediment and Soil Sampling

A complete record of all field activities will be maintained including the following:

- Documentation of all field activities in a field log book
- Documentation of all samples collected for analysis

The FC or a designee will maintain the field log book, which will consist of bound, numbered pages. All on-site activities, including health and safety entries, and field observations will be documented in a site log book. All entries will be made in indelible ink. The field log book is intended to provide sufficient data and observations to enable readers to reconstruct events that occurred during the sampling period. The field log book will include clear information concerning any modifications to the details and procedures identified in this FSP. Sediment grab sample, sediment core, and soil boring collection log sheets will be completed for each sampling station (sample log sheets are presented as Attachments 1-1, 1-2, and 1-3).

Logs and field notes of all core and boring samples will be maintained as samples are collected and correlated to the sampling location map. The following information will be included in this log:

- Elevation of each station sampled
- Percent recovery and factors used to determine the recovery (for cores)
- Location of each station as determined by DGPS
- Date and time of collection of each sample
- Names of field supervisor and person(s) collecting and logging in the sample
- Observations made during sample collection including: presence of substantial product per the definition provided in Section 3.1, weather conditions, complications, ship traffic, and other details associated with the sampling effort
- Sample station number
- Length and depth intervals of each core/boring section
- Qualitative notation of apparent resistance of sediment/soil column when coring/boring
- Any deviation from the approved FSP

3.9 Sample Handling for Sediment and Soil Sampling

This section describes the sample containers, sample handling and storage, chain-of-custody forms, and sample shipping for all sediment sampling activities.

3.9.1 Sample Containers for Analysis and Labeling for Sediment Sampling

All sample containers received from the analytical lab will be pre-cleaned and certified. Prior to shipping, the analytical laboratory will add preservative, where required. Sample container types are listed in Table 1-4.

Prior to filling, each container will be clearly labeled with the name of the project, sample number, type of analysis, date, time, and initials of the person preparing the sample.

3.9.2 General Sample Handling and Storage for Sediment and Soil Sampling

The guidelines for sample handling and storage for collected sediment, soil, and field QA samples are provided in Table 1-4. Sample containers, instruments, working surfaces, technician protective gear, and other items that may come into contact with sediment and soil sample material must meet high standards of cleanliness. All equipment and instruments used to remove sediment from the sampler will be made of glass, stainless steel, or polytetrafluoroethylene (PTFE), and will be decontaminated prior to each day's use and between sampling or homogenization events.

All working surfaces and instruments will be thoroughly cleaned, decontaminated (following the protocols in Section 3.10), and covered with aluminum foil to minimize outside contamination between sampling events. Disposable gloves will be discarded after processing each station and replaced prior to handling decontaminated instruments or work surfaces. Sample containers will be kept in packaging as received from the analytical lab until use; a sample container will be withdrawn only when a sample is to be collected and returned to a cooler containing completed samples.

3.9.3 Sample Transport and Chain-of-custody Procedures for Sediment and Soil Sampling

All containerized sediment and soil samples will be delivered to the designated analytical laboratories daily by courier after preparation is completed. Specific sample shipping procedures will be as follows:

- The shipping containers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the container, and consultant's office name and address) to enable positive identification
- Individual sample containers will be placed in a sealable plastic bag, packed to prevent breakage and transported in a sealed ice chest or other suitable container
- Glass jars will be separated in the shipping container by shock absorbent material (e.g., bubble wrap) to prevent breakage
- Ice (in separate, sealed plastic bags) will be placed in the cooler to maintain a storage temperature of approximately 4°C.
- A sealed envelope containing chain-of-custody forms will be enclosed in a plastic bag and taped to the inside lid of the cooler
- The cooler lids will be secured by wrapping the coolers in strapping tape
- Signed and dated chain-of-custody seals will be placed on all coolers prior to shipping
- Each cooler or container containing the sediment and soil samples for analysis will be picked up at the Gasco facility by courier daily.

Upon transfer of sample possession to the analytical laboratory, the persons transferring custody of the sample container will sign the chain-of-custody form. Upon receipt of samples at the laboratory, the shipping container seal will be broken and the receiver will record the temperature and condition of the samples, and cross-check the sample inventory with the chain-of-custody form. Chain-of-custody forms will be used internally in the lab to track sample handling and final disposition.

3.10 Field Equipment Decontamination for Sediment and Soil Sampling

To prevent sample cross contamination, sampling and processing equipment in contact with the environmental samples will undergo the following decontamination procedures prior to and between collection activities in accordance with EPA protocols (EPA 2001). Between samples, all sampling equipment that will come in contact with the sample media will be decontaminated prior to use by the following procedure:

- Rinse with site water and wash with scrub brush until free of sediment.
- Wash with phosphate-free detergent (e.g., Alconox®).
- Visually inspect the sampler and repeat the scrub and rinse step, if necessary. If scrubbing and rinsing with Alconox® is insufficient to remove visually observable tar/oil-related contamination on sampling equipment, the equipment will be scrubbed and rinsed using hexane (or similar type solution) until all visual signs of contamination are absent.
- Rinse with deionized water three times.

All sample homogenizing equipment (spoons, bowls, etc.) will be decontaminated prior to and between processing cores/borings at each station using the following procedure:

- Rinse with potable or site water and wash with scrub brush until free of sediment.
- Wash with Alconox®.
- Visually inspect the sampler and repeat the scrub and rinse step, if necessary. If scrubbing and rinsing with Alconox® is insufficient to remove visually observable tar/oil-related contamination on the core tubes and extension, the equipment will be scrubbed and rinsed using hexane (or similar type solution) until all visual signs of contamination are absent.
- Rinse with potable or site water.
- Rinse with deionized water three times.

3.11 Soil Boring Abandonment

Soil borings will be abandoned using an organoclay/bentonite grout slurry that will be placed from the bottom of the borehole to the mudline or ground surface via tremie tube methodology. The discharge end of the tremie tube shall be submerged in the grout to avoid breaking the seal while filling the borehole. The grout slurry will consist of a bentonite / organoclay blend, consisting of approximately 9 parts Wyoming sodium bentonite and 1 part organoclay by volume, mixed to a 20 percent solids content. The resulting mud weight of the 20 percent solids solution will be approximately 9.5 to 9.7 pounds per gallon. The mud weight of each batch of grout that is mixed will be weighed and recorded to verify appropriate solids content is achieved. The use granular bentonite across the portion of the borehole within the vadose zone is an acceptable alternative to the placement of the grout slurry across this zone.

3.12 Investigation Derived Waste

All IDW, including soil/sediment cuttings, fluids used for decontamination of sampling equipment, and disposable wastes (e.g., gloves, paper towels, foil, etc.) will be placed into appropriate containers and staged on-site for disposal.

Soil and sediments remaining following collection and processing will be placed into sealable containers (55-gallon open top drums). Disposable wastes will be placed into two heavy duty plastic bags (i.e., double-bagged). All solid waste will be disposed off-site at an appropriate RCRA-permitted solid waste disposal facility.

Per the current *IDW Management Plan* (HAI 2008) for the Gasco site, soil IDW will be characterized by collecting and analyzing one 5-part composite sample per drop box and one composite sample per every 5-10 55-gallon drums. Samples will be tested for the following site COCs:

- Free liquids by Paint Filter Test
- VOCs By EPA method 8260
- Diesel- and oil-range hydrocarbons by NW-TPH-Dx
- Gasoline-range hydrocarbons by NW-TPH-Gx
- Resource Conservation and Recovery Act (RCRA) Metals (total) by EPA Method 6010/7000
- Total Cyanide by EPA Method 335.4
- Polycyclic aromatic hydrocarbons (PAHs) by 8270C SIM

All soil IDW will be screened to determine whether the waste is characteristically hazardous. In addition, soil IDW generated within the TCE CMMA will be screened against F002 Threshold Screening Values, DEQ's most current risk-based concentrations (RBCs) for human health occupational exposure pathway for F002-related constituents in order to determine whether the waste will need to be handled as an F002-listed RCRA. *The IDW Management Plan (*HAI 2008) identifies the following chemicals as F002-related constituents:

- Trichloroethene
- cis-1,2 Dichloroethene
- Trans-1,2-Dichlorethene
- 1-1 Dichloroethene
- Vinyl Chloride

After laboratory results have been compiled and screened as required, NW Natural will prepare a letter of intent to dispose IDW which will be submitted to DEQ for review. The request to DEQ will include laboratory testing results, screening results, and the proposed final disposition of the waste. Upon DEQ approval of the proposed final waste disposition, a waste profile will be submitted to the selected disposal facility requesting acceptance of the waste for the disposal. Upon acceptance by the disposal facility, waste will be transported from the site to the facility by a selected licensed contractor.

The decontamination fluids and other water generated during the investigation will be stored in sealable containers and will be disposed based on the amount of visibly apparent oil. If the fluid contains only a small amount of visibly apparent oil it will be transferred into an on-site 250-gallon aboveground storage tank (AST) for treatment via the Gasco facility carbon treatment unit. Alternatively, fluids containing a visibly appreciable amount of oil will be transferred into a 500-gallon AST located at the MW-6 dense non-aqueous phase liquid (DNAPL) extraction system. When the containers are not being used, they will be sealed to prevent spills.

4 AREA 1 TZW AND GROUNDWATER SAMPLE COLLECTION, PROCESSING, AND HANDLING PROCEDURES

The following sections describe the sample collection, processing, and handling procedures to be followed during the data gaps investigation for the Area 1 TZW and groundwater sampling to be performed by MFA. The QAPP details the quality assurance/quality control protocols to be followed during these activities.

Thirteen sampling locations are proposed (Figure 1-3). TZW samples will be collected from the primary objective locations; TZW and groundwater samples replicating the historical data will be collected from the secondary objective locations. The combination of the proposed sampling depths and depth to mudline will require the use of barge-mounted direct-push equipment.

Meeting the secondary objective will be more complicated due to the uncertainty of obtaining samples from the precise locations of the earlier sampling points and the heterogeneity of the chlorinated volatile organic compounds (CVOCs) distribution in groundwater and TZW.

4.1 TZW and Groundwater Sampling Methods

A direct-push (DP) drill rig will be used to advance groundwater sampling equipment. Transition zone groundwater samples will be collected just below the mudline (0 to 1 foot below mudline). Deep groundwater samples will be collected at the same elevations as the 2004 and 2005 elevations above the 1,000 microgram per liter (µg/L) cutoff. Depth to groundwater and river stage will be measured before sampling.

Transition zone samples will be collected using the following procedures. A 3-inch-diameter temporary conductor casing will be lowered into the river to just above the mudline. A metal disk (approximately 2-foot diameter) with approximately 4-inch vertical siding extending downward will be attached to the bottom of the conductor casing to minimize infiltration of surface water into the water sampler. The disk is intended to reduce infiltration of surface water into the transition zone groundwater sample.

A 1.5-inch-outside-diameter Geoprobe water sampler will be lowered inside the conductor casing to the same vertical location (i.e., just above the mudline), using standard DP rods. A Teflon ring will be affixed to the rod to serve as a plunger, displacing the river water that has collected in the conductor casing. Both the casing and DP rods will be lowered to the mudline.

When casing and DP rods are on the mudline, trip rods will be extended inside the rods to advance the water sampler 1 foot into the sediment for transition zone groundwater sample collection.

Deep groundwater samples will be collected using a 4-foot-long, 1.5-inch-outside-diameter Geoprobe water sampler, consistent with the previous in-river sampling. The Geoprobe sampler will be advanced to the desired depth, exposing the internal stainless steel well point screen for a depth-specific reconnaissance groundwater sample.

All groundwater samples will be collected using conventional methods associated with the direct-push drilling method (i.e., check-ball or peristaltic pump). Deep groundwater samples will be extracted using a peristaltic pump and dedicated tubing if water head levels allow for use of the pump. The check-ball method will be used if the groundwater is too deep to retrieve with a peristaltic pump. Groundwater will be drawn into single-use tubing with a disposable check-ball valve. After the tubing is advanced to terminal depth, groundwater will be purged prior to sample collection. Water quality measurements, including pH, specific conductance, temperature, turbidity, and reduction potential will be measured before samples are collected. Ferrous iron (Fe+2) will also be measured for deep groundwater samples. Groundwater collected for VOC analysis will be transferred directly from the tubing into the laboratory-supplied containers.

4.2 Horizontal Positioning and Vertical Control for TZW and Groundwater Sampling

DGPS will be used on a barge to locate and maintain the sampling position for each station. Approximate coordinates of the proposed new and replicate sampling locations will be programmed into the navigation system. Horizontal coordinates will be referenced to the Oregon State Plane (NAD 83). The DGPS will be used to record the location of the top of casing at each sample location. The depth to the mudline will be measured from the surface of the water, using a weighted line. The Willamette River stage data will be downloaded from the U.S. Geological Survey (USGS) website during the investigation period.

It should be noted that the horizontal precision of DGPS equipment used in the 2004-2005 work was limited to approximately three feet. In support of this FSP, discussion with platform operators suggests that barge positioning can achieve horizontal precision of approximately one foot. With respect to the secondary objective locations, the best approximation is that the historical locations can be located within approximately 4 feet. Groundwater elevations will be collected from inside the direct-push casing before collection of groundwater samples. Multiple readings will be collected until the readings have stabilized to within approximately 0.1 foot, depending on conditions. The elevations will be combined with Willamette River stage data to assist in evaluating vertical hydraulic gradients beneath the river.

4.3 Field QA/QC Samples for TZW and Groundwater Sampling

The following samples will be prepared by sampling personnel in the field and submitted to the laboratory as natural samples:

- **Equipment Rinsate Blanks**—To ensure that decontamination procedures are sufficient, an equipment rinsate blank should be collected when non-dedicated equipment is used. At least one equipment rinsate blank will be collected for each sampling event or for every 20 samples collected. If more than 20 samples are collected with the same equipment, or if high concentrations of contaminants are encountered, additional equipment rinsate blanks should be collected, as warranted. Equipment rinsate blanks should be collected by passing deionized/distilled water through or over sampling equipment. If any investigation-related constituents are detected in the equipment rinsate blanks, decontamination procedures should be reviewed and modified accordingly.
- **Trip Blanks**—A trip blank monitors the potential of sample-to-sample cross-contamination during sample collection and transport. A trip blank consists of reagent-grade water in a new sample container, which is prepared at the same time as the sample containers. The trip blank should accompany the samples throughout collection, shipment, and storage. One trip blank should be included with each cooler where samples for VOC analysis are stored.
- **Field Duplicates**—Field duplicates are collected to measure sampling and laboratory precision. For water samples, volatile organic analysis (VOA) vials (three vials per sample) are filled consecutively and labeled as two different samples. At least one duplicate sample should be collected during each sampling event or one for every 20 samples of each matrix type.

4.4 Field Documentation for TZW and Groundwater Sampling

The following data forms will be used for documenting specific field observations and conditions:

- Water field sampling data sheet (FSDS)

The sampler will record the following information on the FSDS for each water sample collected:

- Facility name
- Sampler's name
- Sample name
- Boring site number and location
- Boring condition, well depth, depth to water, and date and time of measurement
- Boring purging method, volume, depth, date, and time
- Sampling method, depth, date, and time
- Type of sample container and preservative
- Climatic or other noteworthy conditions (e.g., nearby activities)
- Problems encountered with equipment or methods
- Field measurements (pH, specific conductance, temperature, etc.)
- Number of sample bottles filled
- Laboratory used (if other than specified in the QAPP)

General field observations will be recorded in ink in a dedicated field notebook throughout the work, as well as digitally recorded using the Adapx pen-based documentation system.

At a minimum, the following information will be included in the field notes:

- Names of the driller, vessel captain, and person(s) collecting and logging in the samples
- Weather conditions
- Depth to mudline from surface water
- River stage
- Date and time of collection of each sample
- Sample station number
- Any deviation from the approved FSP

4.5 Sample Handling for TZW and Groundwater Sampling

The following section describes the sampling handling procedures for TZW and groundwater sampling activities in Area 1.

4.5.1 Sample Containers for Analysis and Labeling for TZW and Groundwater Sampling

Sample container, preservation, and handling requirements, for each analysis, are summarized in Table 1-4. The samples will be stored in iced coolers at 4° ± 2° Celsius. The laboratory will supply sample containers for each sampling event.

Sample container labels will clearly indicate:

- Project name
- Project number
- Sample ID
- Date and time of sample collection
- Sampler's initials
- Any pertinent comments such as specifics of filtration or preservation.

Labels will be filled out at the time of sampling. Sample labeling information will also be recorded on the FSDS and in a field notebook.

Samples that will be collected on a regular basis (e.g., groundwater samples collected from monitoring wells) will be assigned blind sample numbers to prevent laboratory bias. Blind sample numbers and actual sample locations will be recorded on the FSDSs. The FSDSs will not be sent to the laboratory.

4.5.2 Sample Transport and Chain of Custody Procedures for TZW and Groundwater

After sample containers have been filled, they will be packed on blue ice in coolers. To ensure that the laboratory has ample time to complete all analyses within holding time requirements, and to reduce the potential for field degradation of samples, the samples will be transported by courier from the field to the laboratory at the end of each sampling day. Samples will be stored in iced shipping containers or a refrigerator designated for samples, and then transported in iced shipping containers (with a custody seal affixed) to the laboratory by courier.

- Samples will be packaged and transported in accordance with U.S. Department of Transportation regulations as specified in 49 CFR 173.6 and 49 CFR 173.24.
- Individual sample containers will be packed to prevent breakage.
- A sealed envelope will be included, containing chain-of-custody forms that are signed by personnel relinquishing the samples. The chain-of-custody forms will be enclosed in a plastic bag and placed inside the lid of the cooler.

Sample custody will be tracked from point of origin through final analysis and disposal using a chain-of-custody (chain-of-custody) form, which will be filled out with the appropriate sample/analytical information as soon as possible after samples are collected. For purposes of this work, custody will be defined as follows:

- In plain view of MFA field representatives
- Inside a cooler that is in plain view of MFA representatives
- Inside any locked space such as a cooler, locker, car, or truck to which the MFA field representatives have the only available key(s)

The following items will be recorded on the chain-of-custody form:

- Project name
- Project number
- MFA project manager
- Sampler's name(s)
- Sample number, date and time collected, media, number of bottles submitted
- Requested analyses for each sample
- Type of data package required
- Turnaround requirements
- Signature, printed name, organization name, date, and time of transfer of all persons having custody of samples
- Additional instructions or considerations that would affect analysis (nonaqueous layers, archiving, etc.)

Persons in possession of the samples will be required to sign and date the chain-of-custody form whenever samples are transferred between individuals or organizations. The chain-of-custody will be included in the shipping containers with the samples, and the containers will be sealed with a laboratory custody seal. The laboratory will implement its in-house custody procedures, which begin when sample custody is transferred to laboratory personnel.

The following custody procedures will be followed. The chain-of-custody will be signed and custody will be relinquished. The signed chain-of-custody(s) will be packed in shipping containers with the samples, and a custody seal will be placed on the container to reduce the potential for tampering. The samples will be shipped with proper shipping insurance. Signed documentation will be obtained from the shipper acknowledging receipt of the samples. The shipping document will be used to track the samples while in transit to the laboratory.

At the analytical laboratory, a designated sample custodian will accept custody of the received samples, and will verify that the chain-of-custody form matches the samples received. The shipping container or set of containers is given a laboratory identification number, and each sample is assigned a unique sequential identification number, which includes the original shipping container identification number. Upon receipt of samples at the laboratory, the condition of the samples will be recorded.

4.6 Field Equipment Decontamination for TZW and Groundwater Sampling

Decontamination will be conducted on the barge using a self-contained decontamination trailer in secondary containment. All downhole drilling and sampling equipment and related tools, including the back of the drilling machine, will be high-pressure washed with hot water between sample locations. The screen used to collect groundwater samples will be thoroughly cleaned before use according to the following procedure:

- Wash with brush and Alconox soap
- Site water rinse
- Rinse with methanol
- Site water rinse
- Rinse with hexane
- Site water rinse
- Rinse with distilled water

All other equipment is dedicated, single-use equipment.

4.7 Boring Abandonment for TZW and Groundwater Sampling

Following collection of the deepest groundwater sample, borings deeper than 1 foot below mudline will be abandoned with bentonite grout injected into the subsurface through the casing.

4.8 Investigation-Derived Waste for TZW and Groundwater Sampling

IDW is expected to include decontamination fluids and personnel protective equipment (PPE). All investigation-derived waste will be contained in drums until conclusion of the investigation. IDW disposal will be managed by a licensed hazardous waste handler.

5 BIOASSAY, CHEMICAL, AND PHYSICAL TESTING

This section summarizes the target physical and chemical analyses for the various media sampled. All sample analyses will be conducted in accordance with EPA-approved methods and the QAPP. Prior to analysis, all samples will be maintained according to the appropriate holding times and temperatures for each analysis (Table 1-4). Tables 1-1, 1-2, 1-3, 1-4, and 1-7 present the proposed analytes, analytical methods, and targeted reporting limits for the chemical and physical testing. Table 1-8 provides test performance criteria for biological tests. The analytical laboratories will prepare a detailed report in accordance with the QAPP.

Prior to the chemical analysis of the samples, the laboratories will calculate method detection limits for each analyte of interest, where applicable. Method detection limits will be below the values specified in Tables 1-1, 1-2, 1-3, 1-4 and 1-8 if technically feasible. To achieve the required detection limits, some modifications to the methods may be necessary. These modifications from the specified analytical methods will be provided by the laboratories at the time of establishing the laboratory contract.

Sediment and soil chemical and physical testing will be conducted at ARI located in Tukwila, Washington. ARI is accredited under the National Environmental Laboratories Accreditation Program (NELAP). TZW and groundwater chemical analysis will be conducted at Specialty Analytical located in Tualatin, Oregon. All chemical and physical testing will adhere to SW-846 QA/QC procedures and analysis protocols (EPA 1986) or follow the appropriate ASTM or Standard Method protocols. If more current analytical methods are available, the laboratory may use them.

Sediment toxicity testing will be performed by Northwestern Aquatic Sciences located in Newport, Oregon. Sediment toxicity tests will adhere to EPA and ASTM test methods, as described in this section.

5.1 Sediment Toxicity Testing

Sediment toxicity testing will be conducted to determine whether COCs are present and bioavailable at concentrations that are toxic to biota. Sediment toxicity test procedures used in this program will be conducted in accordance with protocols recommended by the American Society for Testing and Materials (ASTM) Method E 1706-00 (ASTM 2003) and EPA 600/R-

99/064 (EPA 2000). Detailed information regarding testing protocol can be found in Windward (2007a, 2007b).

Two sediment toxicity tests will be conducted on each of the 20 surface sediment samples to be collected at the site:

- Chronic 28-day freshwater amphipod (*Hyalella azteca)*
- Acute 10-day freshwater midge (*Chironomus dilutus*, formerly *C. tentans*)

The test conditions and endpoints are summarized in Tables 1-9 and 1-10; acceptability criteria are summarized in Tables 1-11 and 1-12. The negative control and three reference sediment samples will be used in interpreting toxicity responses in the sediment samples collected at the site. The reference sediment samples will be included in each batch of sediment toxicity tests, and the responses of the organisms exposed to site sediments will be statistically compared to the responses of the organisms in the reference sediments and the reference envelope values (REVs) defined in this section. In addition, all site and reference responses will be statistically compared to negative control responses (see Section 3.5.3.6).

If species substitutions are required due to the acceptability, availability, or other factors, such substitutions will be confirmed with EPA prior to test initiation.

Reference sediments will also be included with each toxicity test. Reference sediments provide toxicity data that can be used to separate toxicant effects from unrelated effects, such as those of sediment grain size and total organic carbon. Reference sediments will be collected from upriver reach sampling locations used in the Reference Envelope Approach specified in the Draft Baseline Ecological Risk Assessment (BERA, Appendix G of the *Draft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009]).

The Reference Envelope Approach (MacDonald and Landrum 2008) is the EPA recommended method for evaluating sediment toxicity to benthic organisms (EPA 2008). To implement the reference envelope approach, the Lower Willamette Group (LWG) and EPA agreed on a set of upriver bioassay data and bioassay data from two locations near the upper end of the Study Area that could be used to characterize background conditions in the Lower Willamette River (EPA 2009). At each of these sites, the level of negative control-adjusted growth and survival of *Chironomus dilutus* and *Hyalella azteca* was calculated and, for each test endpoint an REV was calculated. Procedures used to calculate REVs were derived from the Calcasieu BERA

(MacDonald Environmental 2002). Procedures used to calculate REVs were based on the instructions EPA provided in July 17 and 31, 2009, e-mails to the LWG, and refined during the August 26, 2009, meeting between EPA and LWG ecological risk assessors. Table 1-13 summarizes the methods used to develop REVs.

Toxicity test results will be statistically compared to negative control results (using one-sided t-test with alpha = 0.05) and numerically compared to four effects thresholds to define the potential for toxicity. Effects levels were based on relative differences from REVs and were defined in the *Benthic Reanalysis Technical Memorandum* (Windward 2009a) based on Calcasieu/Draft BERA/EPA 2009 methods as:

- **Level 0 –** mean response not significantly different from the negative control mean or mean negative control-adjusted response greater than REV
- **Level 1 –** mean response significantly different from the negative control mean and REV greater than mean negative control-adjusted response greater than 0.9*REV
- **Level 2 –** mean response significantly different from the negative control mean and 0.9*REV greater than mean negative control-adjusted response greater than 0.8*REV
- **Level 3 –** mean response significantly different from the negative control mean and 0.8*REV greater than mean negative control-adjusted response

Table 1-8 shows the REVs that will be used in the evaluation of sediment toxicity to benthic organisms. These levels will be modified to be consistent with those agreed upon between LWG and EPA for the Portland Harbor site, should such levels be available at the time of bioassay testing. Results from reference sediment samples collected in this sampling plan will be compared to the existing REVs to corroborate the validity of the previously defined REVs for use at the site. The three reference sediment samples will be chosen from the 22 reference sample locations jointly selected by the EPA and LWG in the Draft BERA. Reference sample location will be selected by sediment physical parameters (grain size, percent TOC content, etc.) matching current site sediment conditions to the greatest extent possible.

5.2 Sediment and Soil Samples

Sediment and soil samples will be submitted for a variety of tests prepared by different methods including bulk chemistry, geotechnical parameters, DRET, Sequential Batch Leach Test (SBLT), and Toxic Characteristic Leaching Procedure (TCLP) analysis. The following sections discuss each type of testing in more detail.

5.2.1.1 Bulk Chemistry and Geotechnical Testing

Subsurface sediment and soil samples collected will be submitted for bulk sediment and soil analysis and analyzed for the conventional, geotechnical, and chemical parameters shown in Table 1-1. Geotechnical testing will include moisture content, Atterberg limit, grain size analysis, specific gravity, and CU Triaxial test. Table 1-6 shows the anticipated frequency of the different tests.

5.2.1.2 DRET

Eight sediment cores were selected to be subjected to a DRET procedure (see Figure 1-2), which is designed to estimate the potential for water quality impacts during dredging of contaminated sediments. The samples will be prepared following the U.S. Army Corps of Engineers (USACE) DRET (DiGiano et al. 1995) guidance. This procedure involves placement and agitation of sediment samples in water collected from the site and then analyzing the resulting clarified elutriate water for chemicals of interest. The elutriate water samples obtained from the DRET procedures will be analyzed for the parameters in Table 1-2.

Because elutriate testing will include volatile chemicals, a separate container will be collected without field homogenization and with zero headspace. Thus, the laboratory will analyze two separate samples (homogenized and non-homogenized with zero-headspace) per elutriate sample.

5.2.1.3 SBLT

SBLT analysis will generally follow the method in Appendix D of the *Upland Testing Manual* which involves exposing anaerobic dredged material to four successive aliquots of anaerobic distilled-deionized water to estimate dredged material-specific equilibrium distribution coefficients (USACE 2003). The leachate samples will be analyzed for the parameters in Table 1-14, which summarizes the specific analytes, methods, reporting limits, and detection limits. ARI, the analytical laboratory proposed for this data gaps sampling was also used to complete the SBLT analysis conducted by the LWG in February 2009 (Anchor 2008) to support the Portland Harbor Site Feasibility Site (FS) evaluations so the methods between these investigations will be consistent.

A water-to-sediment ratio of 4-to-1 will be used to prepare the SBLT slurry as recommended in the SBLT test procedure. The sediment-water mixture will then be tumbled for a 24-hour period to ensure intimate contact and encourage chemical equilibrium between sediment and water phases. The leachate will then be drawn off and processed to recover dissolved and colloidal constituents. Four consecutive leaching cycles will be performed to generate four leachate samples per SBLT test. The description of test protocols in the USACE (2003) guidance will be followed by ARI except as noted in the ARI established SBLT procedures, which are described in ARI SOP 1125 and provided as Appendix B.

5.2.1.4 Waste Characterization

TCLP (used to evaluate toxicity) testing will follow SW-846 test method 1311 which involves tumbling a specified volume of sediment or soil in a buffered extraction fluid to generate a simulated leachate, which is then analyzed for organic and inorganic constituents specified in the regulations (EPA 1993). Table 1-3 includes the proposed parameters for TCLP testing. ARI, the analytical laboratory proposed for this data gap sampling was, also used to complete the TCLP analysis conducted by the LWG in August 2008 (Anchor 2008) to support the Portland Harbor Site FS evaluations so the methods between these investigations will be consistent.

A separate aliquot for volatiles analysis is required; however, this aliquot will be collected after homogenization to mimic the conditions that would occur during sediment removal (e.g. mixing and air exposure). Test methods ASTM D93 and SW-846 will be used to analyze samples for the RCRA characteristics of ignitability and reactivity, respectively. These results will be used to make a preliminary determination of the presence and extent of RCRA hazardous waste or special waste in the Project Area.

5.2.1.5 Disposal Suitability Bench Scale Treatment Testing

For any samples that fail the TCLP criteria, additional archived sample volume for those stations may be amended with variable proportions by weight of Portland cement, quick lime, lime kiln dust, and/or cement kiln dust to attempt to reduce the contaminant leachability. Based on the results of the bench scale treatability testing performed during the tar body removal action characterization, it is anticipated that each of the above amendments will be added to the test sediments using between 5 to 10 percent and 10 to 15 percent by weight. Upon opening of the archived sample volume containers (anticipated to be a 5 gallon bucket for non-volatile compounds and a zero headspace container for volatile compounds analyses), any standing water in each container will be mixed into the sediment using either a spoon or hand drill with mixer paddle attachment. The mixed sediment will then be weighed out separately for the non-volatile and volatile containers and the appropriate amount by weight of admixture will be added and mixed separately into these containers. TCLP testing will be conducted separately on the resulting non-volatile and volatile sediment-admixture sample following the methods described in Appendix D of the *Upland Testing Manual* (USACE 2003).

Additional testing to determine the ability to remove free liquid and/or meet bearing strength requirements of potential disposal facilities may also be performed on the mixed sediment.

5.2.2 TZW and Groundwater Sampling

The transition zone groundwater samples will be analyzed for VOCs by EPA Method 8260B.

Laboratory-specific reporting limits for TCE and its degradation products in water are compared to the screening level values (SLVs) presented in the AIR. The reporting limits are generally below the SLVs, with the exception of the DEQ Residential tap RBC for TCE (0.022 ug/L) and the EPA regional screening level (RSL) for vinyl chloride (0.016 ug/L). The limits could be elevated if a sample requires dilution due to high analyte concentrations or if there are matrix interferences. If the reporting limit for vinyl chloride is greater than 2.4 µg/L in water, the laboratory will advise the MFA project manager to evaluate the need for further, lower-level analysis.

The QAPP describes the analytical methods and relevant quality QA/QC requirements for the work and the sampling described in this FSP.

6 FIELD SAMPLING SCHEDULE

The field sampling program is projected to begin within 14 days after EPA approval of the AIR, QAPP, and associated documents, and is expected to be completed within 60 working days. The actual start and end dates for the sampling event will depend on EPA approval of the project plans and coordination with subcontractors. Other conditions that may affect the sampling schedule are weather, sub-consultant availability, and equipment availability.

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TABLES

Table 1-1
Analytes, Analysis Methods, and Targeted Reporting Limits – Bulk Sediments and Soil

Parameter	Recommended Preparation	Recommended Analytical	Units	MDL	Reporting Limit [2]
Conventional/Physical Parameters					
Total organic carbon	EPA 9060	EPA 9060	%	0.0029	0.1
Total solids	EPA 160.3	EPA 160.3	% wet wt	--	0.1
Total cyanide	SM4500-CN	SM4500-CN	mg/kg dry wt	0.001	1
Ammonia	SM4500-NH3 G	SM4500-NH3 G	mg/kg dry wt	0.122	1
Sulfide	SM4500-S2 D	SM4500-S2 D	mg/kg dry wt	0.348	1
pH	9040C	9040C	SU	--	--
Corrosivity	1110A	1110A	mmpy	--	--
Ignitability	ASTM D93	ASTM D93	°C	--	--
Grain size (with hydrometer)	ASTMD422	ASTMD422	% retained	--	0.1
Moisture content	ASTMD2216	ASTMD2216	%	--	0.1
Atterberg Limits	ASTMD4318	ASTMD4318	--	--	--
Specific Gravity	ASTMD854	ASTMD854	--	--	--
Cu-Triaxial Test	ASTMD4767	ASTMD4767	--	--	--
Metals					
Arsenic	3050B	6010B	mg/kg dry wt	0.31	5
Cadmium	3050B	6010B	mg/kg dry wt	0.02	1
Chromium	3050B	6010B	mg/kg dry wt	0.26	1
Copper	3050B	6010B	mg/kg dry wt	0.04	1
Lead	3050B	6010B	mg/kg dry wt	0.18	2
Silver	3050B	6010B	mg/kg dry wt	0.04	1
Mercury	3050B	7471A	mg/kg dry wt	0.002	0.1
Nickel	3050B	6010B	mg/kg dry wt	0.86	1
Zinc	3050B	6010B	mg/kg dry wt	0.37	5
Semi-Volatile Organics					
Acenaphthene	3550B	8270D	µg/kg dry wt	12.5	63
Acenaphthylene	3550B	8270D	µg/kg dry wt	8.21	63
Anthracene	3550B	8270D	µg/kg dry wt	9.05	63
Benzo(a)anthracene	3550B	8270D	µg/kg dry wt	10.6	63
Benzo(a)pyrene	3550B	8270D	µg/kg dry wt	10.3	63
Benzo(b)fluoranthenes	3550B	8270D	µg/kg dry wt	7.81	63
Benzo(g,h,i)perylene	3550B	8270D	µg/kg dry wt	9.36	63
Benzo(k)fluoranthenes	3550B	8270D	µg/kg dry wt	13.2	63
Chrysene	3550B	8270D	µg/kg dry wt	10.72	63
Dibenz(a,h)anthracene	3550B	8270D	µg/kg dry wt	10.5	63
Fluoranthene	3550B	8270D	µg/kg dry wt	9.02	63
Fluorene	3550B	8270D	µg/kg dry wt	9.58	63
Indeno(1,2,3-cd)pyrene	3550B	8270D	µg/kg dry wt	10.3	63
Naphthalene	3550B	8270D	µg/kg dry wt	12.6	63
Perylene	3550B	8270D	µg/kg dry wt	TBD	63
Phenanthrene	3550B	8270D	µg/kg dry wt	9.91	63
Pyrene	3550B	8270D	µg/kg dry wt	8.16	63
1-Methylnaphthalene	3550B	8270D	µg/kg dry wt	9.85	63
2-Methylnaphthalene	3550B	8270D	µg/kg dry wt	15.3	63
Dibenozfuran	3550B	8270D	µg/kg dry wt	15.8	63
Carbazole	3550B	8270D	µg/kg dry wt	6.39	63

Table 1-1
Analytes, Analysis Methods, and Targeted Reporting Limits – Bulk Sediments and Soil

Parameter	Recommended Preparation	Recommended Analytical	Units	MDL	Reporting Limit [2]
Volatile Organics					
Benzene	5035 [1]	8260B/8260C	µg/kg dry wt	0.218	1
Ethylbenzene	5035 [1]	8260B/8260C	µg/kg dry wt	0.087	1
Toluene	5035 [1]	8260B/8260C	µg/kg dry wt	0.225	1
m,p-Xylene	5035 [1]	8260B/8260C	µg/kg dry wt	0.263	1
o-Xylene	5035 [1]	8260B/8260C	µg/kg dry wt	0.205	1
Trichloroethene (TCE)	5035 [1]	8260B/8260C	µg/kg dry wt	0.51	1
cis-1,2-Dichloroethene (cis-DCE)	5035 [1]	8260B/8260C	µg/kg dry wt	0.11	1
trans-1,2-Dichoroethene (trans-DCE)	5035 [1]	8260B/8260C	µg/kg dry wt	0.208	1
1,1-Dichloroethene (1,1-DCE)	5035 [1]	8260B/8260C	µg/kg dry wt	0.184	1
Vinyl chloride	5035 [1]	8260B/8260C	µg/kg dry wt	0.157	1
Polychlorinated Biphenyls					
Aroclor 1016	3550B	8082	µg/kg dry wt	1.02	33
Aroclor 1242	3550B	8082	µg/kg dry wt	1.02	33
Aroclor 1248	3550B	8082	µg/kg dry wt	1.02	33
Aroclor 1254	3550B	8082	µg/kg dry wt	1.02	33
Aroclor 1260	3550B	8082	µg/kg dry wt	1.36	33
Aroclor 1221	3550B	8082	µg/kg dry wt	1.36	33
Aroclor 1232	3550B	8082	µg/kg dry wt	1.36	33
Pesticides					
2,4-DDD	3550B	8081	µg/kg dry wt	0.879	3.3
2,4-DDE	3550B	8081	µg/kg dry wt	0.701	3.3
2,4-DDT	3550B	8081	µg/kg dry wt	0.536	3.3
4,4-DDD	3550B	8081	µg/kg dry wt	0.415	3.3
4,4-DDE	3550B	8081	µg/kg dry wt	0.408	3.3
4,4-DDT	3550B	8081	µg/kg dry wt	0.409	3.3
alpha-BHC	3550B	8081	µg/kg dry wt	0.164	1.7
beta-BHC	3550B	8081	µg/kg dry wt	0.295	1.7
alpha-chlordane[3]	3550B	8081	µg/kg dry wt	0.335	1.7
gamma-chlordane[3]	3550B	8081	µg/kg dry wt	0.993	1.7
cis-nonachlor[3]	3550B	8081	µg/kg dry wt	0.541	2
trans-nonachlor[3]	3550B	8081	µg/kg dry wt	0.529	2
oxychlordane[3]	3550B	8081	µg/kg dry wt	0.825	2
gamma-BHC (Lindane)	3550B	8081	µg/kg dry wt	0.187	1.7
delta-BHC	3550B	8081	µg/kg dry wt	0.358	1.7
Dieldrin	3550B	8081	µg/kg dry wt	0.41	3.3
Endrin	3550B	8081	µg/kg dry wt	0.406	3.3
Endrin ketone	3550B	8081	µg/kg dry wt	0.515	3.3
Heptachlor Epoxide	3550B	8081	µg/kg dry wt	0.179	1.7
Hexachlorobenzene	3550B	8081	µg/kg dry wt	0.132	3.3
Total Petroleum Hyrdocarbons					
Diesel range hydrocarbons	3546	NWTPHDX	mg/kg dry wt	0.742	5
Residual range hydrocarbons	3546	NWTPHDX	mg/kg dry wt	1.31	10

Notes:
1 Due to high moisture content of sediment and core processing constraints, a 2-ounce teflon-lined jar will be utilized.
2 Reporting limits may vary due to moisture content of sample.
3 alpha-chlordane, gamma-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane will be summed to calculate "total chlordane."

Table 1-2
Analytes, Analysis Methods, and Targeted Reporting Limits – DRET

Parameter	Recommended Preparation Method	Recommended Analytical	Units	MDL	Reporting Limit
Conventional/Physical Parameters					
Total cyanide	USACOE	SM4500-CN	mg/L	0.001	0.01
Free cyanide	USACOE	ASTM D4282-02	mg/L	0.001	0.01
Available cyanide	USACOE	OIA-1677	mg/L	0.001	0.002
Metals					
Zinc	USACOE/3010A	6010B	µg/L	3.94	10
Semi-Volatile Organics					
Acenaphthene	USACOE/3510 or 3520	8270D	µg/L	0.202	1
Acenaphthylene	USACOE/3510 or 3520	8270D	µg/L	0.21	1
Anthracene	USACOE/3510 or 3520	8270D	µg/L	0.217	1
Benzo(a)anthracene	USACOE/3510 or 3520	8270D	µg/L	0.219	1
Benzo(a)pyrene	USACOE/3510 or 3520	8270D	µg/L	0.205	1
Benzo(b)fluoranthenes	USACOE/3510 or 3520	8270D	µg/L	0.577	1
Benzo(g,h,i)perylene	USACOE/3510 or 3520	8270D	µg/L	0.15	1
Benzo(k)fluoranthenes	USACOE/3510 or 3520	8270D	µg/L	0.19	1
Chrysene	USACOE/3510 or 3520	8270D	µg/L	0.181	1
Dibenz(a,h)anthracene	USACOE/3510 or 3520	8270D	µg/L	0.163	1
Fluoranthene	USACOE/3510 or 3520	8270D	µg/L	0.22	1
Fluorene	USACOE/3510 or 3520	8270D	µg/L	0.189	1
Indeno(1,2,3-cd)pyrene	USACOE/3510 or 3520	8270D	µg/L	0.214	1
Naphthalene	USACOE/3510 or 3520	8270D	µg/L	0.553	1
Perylene	USACOE/3510 or 3520	8270D	µg/L	TBD[2]	1
Phenanthrene	USACOE/3510 or 3520	8270D	µg/L	0.18	1
Pyrene	USACOE/3510 or 3520	8270D	µg/L	0.2	1
1-Methylnaphthalene	USACOE/3510 or 3520	8270D	µg/L	0.541	1
2-Methylnaphthalene	USACOE/3510 or 3520	8270D	µg/L	0.185	1
Dibenozfuran	USACOE/3510 or 3520	8270D	µg/L	0.157	1
Carbazole	USACOE/3510 or 3520	8270D	µg/L	0.103	1
Volatile Organics [1]					
Benzene	USACOE/5030	8260B/8260C	µg/L	0.138	1
Ethylbenzene	USACOE/5030	8260B/8260C	µg/L	0.185	1
Toluene	USACOE/5030	8260B/8260C	µg/L	0.1	1
m,p-Xylene	USACOE/5030	8260B/8260C	µg/L	0.273	1
o-Xylene	USACOE/5030	8260B/8260C	µg/L	0.178	1
Trichloroethene (TCE)	USACOE/5030	8260B/8260C	µg/L	0.186	1
cis-1,2-Dichloroethene (cis-DCE)	USACOE/5030	8260B/8260C	µg/L	0.122	1
trans-1,2-Dichoroethene (trans-DCE)	USACOE/5030	8260B/8260C	µg/L	0.12	1
1,1-Dichloroethene (1,1-DCE)	USACOE/5030	8260B/8260C	µg/L	0.18	1
Vinyl chloride	USACOE/5030	8260B/8260C	µg/L	0.187	1
Polychlorinated Biphenyls					
Aroclor 1016	USACOE/3510 or 3520	8082	µg/L	0.173	1
Aroclor 1242	USACOE/3510 or 3520	8082	µg/L	0.173	1
Aroclor 1248	USACOE/3510 or 3520	8082	µg/L	0.173	1
Aroclor 1254	USACOE/3510 or 3520	8082	µg/L	0.173	1
Aroclor 1260	USACOE/3510 or 3520	8082	µg/L	0.108	1
Aroclor 1221	USACOE/3510 or 3520	8082	µg/L	0.108	1
Aroclor 1232	USACOE/3510 or 3520	8082	µg/L	0.108	1

Table 1-2
Analytes, Analysis Methods, and Targeted Reporting Limits – DRET

Parameter	Recommended Preparation Method	Recommended Analytical	Units	MDL	Reporting Limit
Pesticides					
2,4-DDD	USACOE/3510 or 3520	8081	µg/L	0.0173	0.1
2,4-DDE	USACOE/3510 or 3520	8081	µg/L	0.0266	0.1
2,4-DDT	USACOE/3510 or 3520	8081	µg/L	0.0164	0.1
4,4-DDD	USACOE/3510 or 3520	8081	µg/L	0.0186	0.1
4,4-DDE	USACOE/3510 or 3520	8081	µg/L	0.0184	0.1
4,4-DDT	USACOE/3510 or 3520	8081	µg/L	0.0169	0.1
alpha-BHC	USACOE/3510 or 3520	8081	µg/L	0.0085	0.05
beta-BHC	USACOE/3510 or 3520	8081	µg/L	0.0098	0.05
gamma-BHC (Lindane)	USACOE/3510 or 3520	8081	µg/L	0.0159	0.05
delta-BHC	USACOE/3510 or 3520	8081	µg/L	0.0087	0.05
Endrin ketone	USACOE/3510 or 3520	8081	µg/L	0.0151	0.1
Total Petroleum Hyrdocarbons					
Diesel range hydrocarbons	USACE/WA-Ecology	NWTPHDX	mg/L	0.016	0.25
Residual range hydrocarbons	USACE/WA-Ecology	NWTPHDX	mg/L	0.049	0.5

Notes:

1 Only the total fraction will be calculated due to loss of volatiles during filtration.

2 MDL studies are currently underway for this compound.

Table 1-3
Analytes, Analysis Methods, and Targeted Reporting Limits – TCLP

Parameter	Recommended Preparation Method	Recommended Analytical	Units	MDL	Reporting Limit
Metals					
Arsenic	1311/3010A	6010B	µg/L	28.84	200
Barium	1311/3010A	6010B	µg/L	7.92	12
Cadmium	1311/3010A	6010B	µg/L	1.24	8
Chromium	1311/3010A	6010B	µg/L	13.16	20
Lead	1311/3010A	6010B	µg/L	7.68	80
Mercury	1311/3010A	7470A	µg/L	0.0356	0.4
Selenium	1311/3010A	6010B	µg/L	24.4	200
Silver	1311/3010A	6010B	µg/L	2.2	12
Semi-Volatile Organics					
1,4-Dichlorobenzene	1311/3510 or 3520	8270D	µg/L	4.18	10
2,4-Dinitrotoluene	1311/3510 or 3520	8270D	µg/L	10.25	50
2,4,5-Trichlorophenol	1311/3510 or 3520	8270D	µg/L	6.65	50
2,4,6-Trichlorophenol	1311/3510 or 3520	8270D	µg/L	8.45	50
m-Cresol	1311/3510 or 3520	8270D	µg/L	1.85	10
p-Cresol	1311/3510 or 3520	8270D	µg/L	1.85	10
o-Cresol	1311/3510 or 3520	8270D	µg/L	2.27	10
Hexachlorobenzene	1311/3510 or 3520	8270D	µg/L	1.94	10
Hexachlororbutadiene	1311/3510 or 3520	8270D	µg/L	3.48	10
Hexachloroethane	1311/3510 or 3520	8270D	µg/L	3.92	10
Nitrobenzene	1311/3510 or 3520	8270D	µg/L	5.51	10
Pentachlorophenol	1311/3510 or 3520	8270D	µg/L	6.47	50
Pyridine	1311/3510 or 3520	8270D	µg/L	10.73	50
Volatile Organics					
Benzene	1311/ 5030	8260B/8260C	µg/L	1.38	10
Carbon tetrachloride	1311/ 5030	8260B/8260C	µg/L	1.26	10
Chlorobenzene	1311/ 5030	8260B/8260C	µg/L	1.27	10
Chloroform	1311/ 5030	8260B/8260C	µg/L	1.41	10
1,2-Dichloroethane	1311/ 5030	8260B/8260C	µg/L	1.64	10
1,1-Dichloroethene (1,1-DCE)	1311/ 5030	8260B/8260C	µg/L	1.8	10
2-Butanone	1311/ 5030	8260B/8260C	µg/L	8.89	50
Tetrachloroethene (PCE)	1311/ 5030	8260B/8260C	µg/L	1.87	10
Trichloroethene (TCE)	1311/ 5030	8260B/8260C	µg/L	1.86	10
Vinyl chloride	1311/ 5030	8260B/8260C	µg/L	1.87	10
Polychlorinated Biphenyls					
Aroclor 1016	1311/3510 or 3520	8082	µg/L	1.73	10
Aroclor 1242	1311/3510 or 3520	8082	µg/L	1.73	10
Aroclor 1248	1311/3510 or 3520	8082	µg/L	1.73	10
Aroclor 1254	1311/3510 or 3520	8082	µg/L	1.73	10
Aroclor 1260	1311/3510 or 3520	8082	µg/L	1.08	10
Aroclor 1221	1311/3510 or 3520	8082	µg/L	1.08	10
Aroclor 1232	1311/3510 or 3520	8082	µg/L	1.08	10
Pesticides					
alpha chlordane[1]	1311/3510 or 3520	8081	µg/L	0.22	0.5
gamma chlordane[1]	1311/3510 or 3520	8081	µg/L	0.22	0.5
Endrin	1311/3510 or 3520	8081	µg/L	0.167	1
Heptachlor	1311/3510 or 3520	8081	µg/L	0.113	0.5
gamma-BHC (Lindane)	1311/3510 or 3520	8081	µg/L	0.159	0.5
Methyoxyclor	1311/3510 or 3520	8081	µg/L	0.744	5

Table 1-3
Analytes, Analysis Methods, and Targeted Reporting Limits – TCLP

Parameter	Recommended Preparation Method	Recommended Analytical	Units	MDL	Reporting Limit
Toxaphene	1311/3510 or 3520	8081	µg/L	2.2	50
Herbicides					
2,4-D	1311/3510 or 3520	8151	µg/L	0.79	25
2,4,5-TP (Silvex)	1311/3510 or 3520	8151	µg/L	0.69	6.25
Total Petroleum Hyrdocarbons					
Gasoline range hydorcarbons	1311/5030	NWTPHG	mg/L	0.49	25
Diesel range hydrocarbons	1311/3510 or 3520	NWTPHDX	mg/L	0.4	6.25
Residual range hydrocarbons	1311/3510 or 3520	NWTPHDX	mg/L	1.225	12.5

Table 1-4
Guidelines for Sample Handling and Storage

Parameter	Method	Sample Size	Container Size and Type	Holding Time	Sample Preservation Technique
Total metals	EPA 6010B	50 g	4-oz Glass	6 months; 28 days for Hg	Cool/4° C
				2 years (except Hg)	Freeze -18°C
VOCs (water)	EPA 8260B/8260C	40mL	3x 40mL VOA vial with PTFE-lined septum caps	14 days	Zero head space/ Cool 4° C/ HCL to pH<2
VOCs	EPA 8260C	100 g	2-oz Glass	14 days	Zero head space/ Cool/4° C
SVOC/PCB/Pest/TPH-DX	EPA 8270D/8082/8081/ NWTPH-DX	150 g	2 x 16-oz Glass	14 days until extraction	Cool/4° C
				1 year until extraction	Freeze -18°C
				40 days after extraction	Cool/4° C
Total solids	EPA 160.3	50 g	16-oz Glass	14 days	Cool/4° C
				6 months	Freeze -18°C
Total organic carbon	EPA 9060	50 g	from TS container	14 days	Cool/4° C
				6 months	Freeze -18°C
Ammonia	SM 4500-NH3	50 g	from TS container	14 days	Cool/4° C
Total Cyanide	SM 4500-CN	50 g	from TS container	14 days	Cool/4° C
pH	EPA 9040C	10 g	from TS container	7 days	Cool/4° C
Sulfides	SM 4500-S2	10 g	4-oz Glass	7 days	Cool/4° C, Zinc acetate
Flashpoint	ASTM D93	25 g	4-oz Glass	7 days	Cool/4° C
Cu- Triaxial Test	ASTMD4767	core	Shelby Tube	No hold time	ambient temperature

Table 1-4
Guidelines for Sample Handling and Storage

Parameter	Method	Sample Size	Container Size and Type	Holding Time	Sample Preservation Technique
Grainsize /Moisture content	ASTMD422/ASTMD2216	300 g	16-oz HDPE	No hold time	ambient temperature
Atterberg Limits/Specific Gravity	ASTMD4318/ASTMD854	300 g	16-oz HDPE	No hold time	ambient temperature
TCLP Test (except VOCs)	EPA 1311	100 g dry wt.	16-oz Glass	14 days to extraction (except metals is 6 months; Hg is 28 days)	Cool/4^{o} C; metals add HNO3 after extraction
				40 days to analysis (except metals is 6 months; Hg is 28 days)	
				1 year until extraction (except VOCs & GRO)	Freeze -18°C
TCLP Test (VOCs & GRO)	EPA 1311	25 g dry wt.	4-oz Glass	14 days to extraction	Zero head space/ Cool/4° C (add HCL after extraction)
				14 days to analysis	
Dredging Elutriate Test	DiGiano 1995	150 g dry wt.	8-oz Glass/ 15 L elutriate	14 days to elutriate preparation (except metals is 6 months)	Cool/4^{o} C; metals add HNO3 after elutriate preparation
				40 days to analysis (metals is 6 months to analysis)	
				1 year until elutriate preparation (except VOCs)	Freeze -18°C
Dredging Elutriate Test (VOCs)	DiGiano 1995	10 g dry wt.	2-oz Glass / 1L elutriate	14 days from elutriate preparation	Zero head space/ Cool/4° C (add HCL after elutriate preparation)
				14 days to analysis	

Table 1-4
Guidelines for Sample Handling and Storage

Parameter	Method	Sample Size	Container Size and Type	Holding Time	Sample Preservation Technique
Sequential Batch Leach Test	ACOE 2003	4000 g dry wt.	3-L Glass/ 25L	14 days to elutriate preparation (except metals is 6 months; Hg is 28 days)	Cool/4° C; metals add HNO3 after elutriate preparation
				40 days to analysis (metals is 6 months to analysis; Hg is 28 days)	
				1 year until elutriate preparation (except VOCs)	Freeze -18°C
Sequential Batch Leach Test (VOCs)	ACOE 2003	70 g dry wt.	2-oz Glass/ 2L	14 days from elutriate preparation	Zero head space/ Cool/4° C (add HCL after elutriate preparation)
				14 days to analysis	
Sediment Toxicity Test	ASTM E 1706-00 and EPA 600/R-99/064	4L (8L for reference)	1 Gallon HDPE	56 days	Cool/4° C/ dark/Nitrogen filled headspace

Notes:

VOC	volatile organic compounds
SVOC	semi-volatile organic compounds
PCB	polychlorinated biphenyls
Pest	pesticides
PTFE	Polytetrafluoroethylene (Teflon)
TPH-DX	total petroleum hydrocarbon- diesel and extended range
TS	total solids
TCLP	toxic characteristic leaching prodedure
oz	ounce
HDPE	high density polyetheylene

Table 1-5
Proposed Sediment Sampling and Soil Sampling Station Coordinates

Sample ID	X Coordinates[a]	Y Coordinates[a]	Testing Parameters
Surface Grabs			
DGS-01	7623280.676	706385.046	bioassay, bulk sediment
DGS-02	7623225.013	706287.450	bioassay, bulk sediment
DGS-04	7623216.875	706087.897	bioassay, bulk sediment
DGS-05	7623539.542	706230.992	bioassay, bulk sediment
DGS-06	7623486.276	706131.115	bioassay, bulk sediment
DGS-08	7623732.978	706111.786	bioassay, bulk sediment
DGS-09	7623679.379	706015.087	bioassay, bulk sediment
DGS-12	7624008.788	705948.315	bioassay, bulk sediment
DGS-13	7623953.539	705850.355	bioassay, bulk sediment
DGS-16	7624275.993	705822.232	bioassay, bulk sediment
DGS-17	7624198.360	705700.471	bioassay, bulk sediment
DGS-20	7624444.752	705721.260	bioassay, bulk sediment
DGS-21	7624375.505	705596.812	bioassay, bulk sediment
DGS-25	7624752.537	705538.876	bioassay, bulk sediment
DGS-26	7624660.608	705425.505	bioassay, bulk sediment
DGS-30	7625039.539	705365.388	bioassay, bulk sediment
DGS-31	7624931.923	705262.482	bioassay, bulk sediment
DGS-33	7625204.076	705266.943	bioassay, bulk sediment
DGS-34	7625255.557	705069.017	bioassay, bulk sediment
DGS-35	7625263.042	704939.315	bioassay, bulk sediment
Sediment Cores			
DGS-03	7623185.828	706210.934	bulk sediment
DGS-06	7623486.276	706131.115	bulk sediment, DRET
DGS-07	7623496.959	705918.438	bulk sediment
DGS-08	7623732.978	706111.786	bulk sediment
DGS-11	7623839.107	705919.113	bulk sediment
DGS-13	7623953.539	705850.355	bulk sediment, DRET, TCLP
DGS-19	7624258.119	705616.012	bulk sediment
DGS-20	7624444.752	705721.260	bulk sediment
DGS-22	7624228.600	705435.558	bulk sediment, DRET, TCLP
DGS-23	7624593.541	705631.429	bulk sediment, DRET
DGS-24	7624476.530	705325.789	bulk sediment, DRET, TCLP
DGS-25	7624752.537	705538.876	bulk sediment
DGS-26	7624660.608	705425.505	bulk sediment, DRET, TCLP
DGS-28	7624900.371	705456.497	bulk sediment
DGS-30	7625039.539	705365.388	bulk sediment
DGS-31	7624931.923	705262.482	bulk sediment, DRET, TCLP
DGS-32	7624916.323	705150.557	bulk sediment, DRET, TCLP
DGS-36	7623072.754	706050.5879	bulk sediment

Table 1-5
Proposed Sediment Sampling and Soil Sampling Station Coordinates

Sample ID	X Coordinates[a]	Y Coordinates[a]	Testing Parameters
Contingency Sediment Cores			
DGS-02	7623225.013	706287.450	visual observations[b]
DGS-10	7623892.986	706017.775	visual observations[b]
DGS-12	7624008.788	705948.315	visual observations[b]
DGS-14	7624160.130	705857.539	visual observations[b]
DGS-15	7624104.525	705759.634	visual observations[b]
DGS-18	7624342.956	705703.009	visual observations[b]
DGS-27	7624867.591	705596.422	visual observations[b]
DGS-29	7625094.030	705449.931	visual observations[b]
DGS-33	7625204.076	705266.943	visual observations[b]

Notes:

a Coordinates are provided in northing and easting in Oregon HARN State Plane North, International Feet

b Sampling will be conducted at contingent locations if substantial product is observed in the adjacent primary coring station

Table 1-6
Riverbank Testing Program

Proposed Locations	X coordinates[1]	Y Coordinates[1]	Target Boring Elevation	Approximate Depth	Contingent Location[2]	Chemical Analysis	Disposal Characteristic Testing[3]	Bulk Geotechnical Testing[4]	Undisturbed Core Geotechnical Testing[5]
Top of Riverbank Slope			**NAVD (88)**	**Feet**		**Depth Intervals**	**Depth Intervals**	**Depth Intervals**	**Depth Intervals**
GST-01	7623046.26	705976.07	0	25	--	0-5, 20-25	TBD	All	TBD
GST-02	7623230	705945.23	0	25	--	0-5, 20-25	TBD	All	TBD
GST-03	7623349.46	705860.62	+5	20	--	0-5, 15-20	TBD	All	TBD
GST-04	7623530.23	705737.47	+5	20	--	0-5, 15-20	TBD	All	TBD
GST-05	7623709.31	705645.27	+5	15	--	0-5, 10-15	TBD	All	TBD
GST-06	7623915.03	705518.92	+5	25	--	0-5, 20-25	TBD	All	TBD
GST-09	7624429.39	705232.14	-5	30	--	0-5, 25-30	TBD	All	TBD
GST-11	7624795	705065.37	-10	40	--	0-5, 35-40	TBD	All	TBD
GST-13	7625108	704867.83	-10	40	--	0-5, 35-40	TBD	All	TBD
Middle of Riverbank Slope									
GSM-01	7623067.13	706014.04	0	20	X	0-5, 15-20	TBD	All	TBD
GSM-02	7623244.5	705971.62	0	20	X	0-5, 15-20	TBD	All	TBD
GSM-03	7623365.23	705889.31	+5	15	X	0-5, 10-15	TBD	All	TBD
GSM-04	7623549.62	705772.73	+5	15	X	0-5, 10-15	TBD	All	TBD
GSM-05	7623722.16	705668.63	+5	10	X	0-5, 5-10	TBD	All	TBD
GSM-07	7624113.86	705442.36	-5	25	--	0-5, 20-25	TBD	All	TBD
GSM-08	7624301.84	705352.8	0	20	--	0-5, 15-20	TBD	All	TBD
GSM-09	7624444.2	705259.07	-5	25	X	0-5, 20-25	TBD	All	TBD
GSM-10	7624637.67	705205.3	-10	35	--	0-5, 30-35	TBD	All	TBD
GSM-11	7624809	705091.69	-10	35	X	0-5, 30-35	TBD	All	TBD
GSM-12	7624984	704981.71	-10	35	--	0-5, 30-35	TBD	All	TBD
GSM-13	7625122	704894.11	-10	35	X	0-5, 30-35	TBD	All	TBD
GSM-14	7625308	704780.91	-10	35	--	0-5, 30-35	TBD	All	TBD

Notes:

1 Coordinates are provided in northing and easting in Oregon HARN State Plane North, International Feet.

2 Sampling will be conducted at contingent locations if substantial product is observed in the adjacent primary location on each transect. For instance, if substantial product is observed in GST-09, sampling will be performed at GSM-09.

3 Disposal characteristic testing (i.e., TCLP testing and analysis for ignitability and corrosivity) will be performed at three locations identified in the field where substantial product is observed which represent the range of substantial product observed and the worst case scenario with respect to disposability. The exact intervals tested will be determined by the field geologist based on field obsevations.

4 Bulk geotechnical testing will be performed on all intervals as follows: Moisture content (all), Atterberg Limits (every other interval), Grain Size (every other interval [intervals that Atterberg Limits are not performed on]). Specific Gravity will be performed on at least 3 intervals site wide representing the range of materials observed.

5 Undisturbed soil (Shelby tube) geotechnical testing will include CU triaxal testing. The exact intervals tested will be determined by the field geologist based on field obsevations. One Shelby tube will be obtained along each shoreling transect (14 total) at the lowest interval where cohesive soils are expected to be present. CU triaxial testing will be performed on four of the Shelby tubes. Selection of the locations to be tested will be decided by the field geologist with the objective of obtaining representative data for the site.

Table 1-7

Analytes, Analysis Methods, and Targeted Reporting Limits – TZW and GW

Parameter	Recommended Preparation Method	Recommended Analytical	Units	Reporting Limit [a]
Volatile Organics				
Volatile Organic Compounds [b]	5030	8260	µg/L	0.2

Notes:

a Detection limits will be elevated if sample requires dilution or if there are matrix interferences.

b SW-846 (EPA's *Test methods for evaluating solid waste* [EPA 1986]) provides routine analyses for these substances.

Table 1-8
Toxicity Thresholds Based on Calcasieu/Draft Bera/EPA 2009 Methods

	Calcasieu[a]			Draft BERA[a]			EPA 2009[a]		
Test and Endpoint	**REV (L1) Threshold (%)**	**REV (L2) Threshold (%)[b]**	**REV (L3) Threshold (%)[c]**	**REV (L1) Threshold (%)[d]**	**REV (L2) Threshold (%)[b,d]**	**REV (L3) Threshold (%)[c,d]**	**REV (L1) Threshold (%)**	**REV (L2) Threshold (%)[a]**	**REV (L3) Threshold (%)[c]**
Chironomus dilutus survival	89.8	80.8	71.8	91.9	81.9	71.9	93.9	84.5	75.1
Chironomus dilutus biomass	83.4	75.1	66.7	88.7	78.7	68.7	91	81.9	72.8
Hyalella azteca survival	87.2	78.5	69.8	86.7	76.7	66.7	88.1	79.3	70.5
Hyalella azteca biomass	64.7	58.2	51.7	67.1	57.1	47.1	73.6	66.2	58.9

Notes:

Sources: *Calcasieu Estuary remedial investigation/feasibility study (RI/FS): Baseline ecological risk assessment* (MacDonald Environmental 2002), *Benthic Toxicity Reanalysis Technical Memorandum(* Windward 2009b), and EPA's July 17, 2009, email to LWG regarding Portland Harbor RI/FS: interpretation of sediment bioassay results (EPA 2009).

a The toxicity threshold method was being negotiated by LDWG and EPA during prepation of this FSP so all potential methods are presented. The data gaps bioassay results will be evaluated using the future EPA-approved method.

b The negative control-adjusted survival and biomass endpoints must be less than the corresponding low threshold (0.9*REV for alternative methods; REV-10% for the Draft BERA), and the mean test response must be statistically less than the mean negative control response using a one-tailed t-test ($p < 0.05$) for the sediment to be considered as having an adverse effect on benthic invertebrates.

c The negative control-adjusted survival and biomass endpoints must be less than the corresponding high threshold (0.8*REV for alternative methods and REV-20% for the Draft BERA), and the mean test response must be statistically less than the mean negative control response using a one-tailed t- test ($p < 0.05$) for the sediment to be considered the sediment as having an adverse effect on benthic invertebrates.

d Values have been expressed as survival and biomass to be comparable with the Calcasieu and EPA 2009 thresholds.

L1 Level 1

L2 Level 2

L3 Level 3

Table 1-9
Test Conditions for the 28-day Chronic H. azteca Sediment Toxicity Test

Parameter	Specification
1. Test type	Whole sediment toxicity test with renewal of overlying water
2. Test duration	28 days
3. Temperature	23 ± 1°C
4. Light quality	Daylight fluorescent light
5. Illuminance	100 to 1,000 lux
6. Photoperiod	16L:8D
7. Test chamber size	300-mL high-form lipless beakers (Pyrex® 1040 or equivalent)
8. Sediment volume	100 mL
9. Overlying water volume	175 mL
10. Renewal overlying water	Two volume additions/day (static renewal)
11. Age of test organisms	7 to 8 days old at test initiation
12. Organisms per test chamber	10
13. Replicates per treatment	8
14. Organisms per treatment	80
15. Feeding regime	YCT food, fed 1.0 mL daily per chamber
16. Cleaning	If screens are used, clean as needed
17. Aeration	None, unless dissolved oxygen falls below 2.5 mg/L
18. Overlying (test) water	Dechlorinated city water with hardness adjusted to 30 mg/L
19. Overlying water quality	Hardness, alkalinity, conductivity, ammonia-N beginning and end; temperature daily; conductivity weekly; DO and pH three times per week
20. Pore water	Pore water ammonia taken from the bulk homogenized sediment prior to initiating the tests (day -1)
21. Endpoints	Survival and growth (based on dry weight)
22. Test acceptability criteria	Minimum control survival of 80%
23. Sample holding	< 8 weeks at 4°C in the dark, preferably 2 weeks
24. Sample volume required	1 L (800 mL per sediment)
25. Reference toxicant	Concurrent testing required with cadmium as toxicant

Table 1-10
Test Conditions for the 10-day Acute C. dilutus Sediment Toxicity Test

Parameter	Specification
1. Test type	Whole sediment toxicity test with renewal of overlying water
2. Test duration	10 days
3. Temperature	23 ± 1°C
4. Light quality	Daylight fluorescent light
5. Illuminance	100 to 1,000 lux
6. Photoperiod	16L:8D
7. Test chamber size	300-mL high-form lipless beakers (Pyrex® 1040 or equivalent)
8. Sediment volume	100 mL
9. Overlying water volume	175 mL
10. Renewal overlying water	Two volume additions/day (static renewal)
11. Age of test organisms	Second to third instar or younger larvae (≥ 50% of organisms must be third instar)
12. Organisms per test chamber	10
13. Replicates per treatment	8
14. Organisms per treatment	80
15. Feeding regime	Fish food flakes, fed 1.5 mL chamber (1.5 mL contains 6.0 mg of dry solids) daily on days 0 to 9
16. Aeration	None, unless dissolved oxygen falls below 2.5 mg/L
17. Overlying (test) water	Dechlorinated city water with hardness adjusted as close to 30 mg/L as the organisms can tolerate
18. Overlying water quality	Hardness, alkalinity, conductivity, pH, ammonia-N beginning and end; temperature and DO daily
19. Pore water	Pore water ammonia taken from the bulk homogenized sediment prior to initiating the tests (day -1)
20. Endpoints	Survival and growth (based on ash-free dry weight)
21. Test acceptability criteria	Minimum control survival of 70%; mean weight of surviving control organisms 0.48 mg as free dry weight (AFDW)
22. Sample holding	< 8 weeks at 4°C in the dark, preferably 2 weeks
23. Sample volume required	1 L (800 mL per sediment)
24. Reference toxicant	Concurrent testing required with potassium chloride as toxicant

Table 1-11
Test Acceptability Requirements for the 28-day Chronic H. azteca Sediment Toxicity Test

Testing Requirements
1. Age of *H. azteca* at test initiation should be 7 to 8 days old.
2. Average survival of *H. azteca* in the negative control sediment should be greater than or equal to 80%.
3. All organisms in a test must be from the same source.
4. Negative-control sediment must be included in a test.
5. Test organisms must be cultured at 23°C (± 3°C) and tested at 23°C (± 1°C).
6. The mean of the daily test temperature must be within ± 1°C of 23°C. The instantaneous temperature must always be within ± 3°C of 23°C.
7. All test chambers should be identical and should contain the same amount of sediment and overlying water.
8. Hardness, alkalinity, and ammonia in the overlying water typically should not vary more than 50% during the sediment exposure, and dissolved oxygen should be maintained above 2.5 mg/L in the overlying water.
9. Sediment collected in the field should be stored less than or equal to 8 weeks, preferably less than or equal to 2 weeks.
10. Natural physico-chemical characteristics of sediment collected from the field should be within tolerance limits of the test

Table 1-12

Test Acceptability Requirements for the 10-day Acute C. dilutus Sediment Toxicity Test

Testing Requirements
1. Test must start with second- to third-instar larvae.
2. Average survival of *C. dilutus* in the negative control sediment must be greater than or equal to 70% at the end of the test.
3. Average size of *C. dilutus* in the negative control must be at least 0.48 mg AFDW at the end of the test.
4. All organisms in a test must be from the same source.
5. Negative-control sediment must be included in a test.
6. Test organisms must be cultured at 23°C (± 3°C) and tested at 23°C (± 1°C).
7. The mean of the daily test temperature must be within ± 1°C of 23°C. The instantaneous temperature must always be within ± 3°C of 23°C.
8. All test chambers should be identical and should contain the same amount of sediment and overlying water.
9. Hardness, alkalinity, and ammonia in the overlying water typically should not vary more than 50% during the sediment exposure, and dissolved oxygen should be maintained above 2.5 mg/L in the overlying water.
10. Sediment collected in the field should be stored less than or equal to 8 weeks, preferably less than or equal to 2 weeks.
11. Natural physico-chemical characteristics of sediment collected from the field should be within tolerance limits of the test organisms.

Table 1-13
Reference Envelope Procedures

Risk Assessment Step	Calcasieu	Draft BERA	EPA 2009
Treatment of sample and reference duplicates	Averaged duplicates	Retained as individual samples and used most conservative hit designation of replicates	Averaged duplicates
Mortality endpoint	Expressed as % survivors	Expressed as % mortality	Expressed as % survivors
Negative control normalization	Calculated as ratio of test/ negative control	Calculated as difference of test minus negative control	Calculated as ratio of test/ negative control
Reference envelope calculations	Calculated as back-transformed lower (2.5%) prediction limit of log-transformed negative control-adjusted bioassay data	Calculated as lower 5th percentile for biomass/upper 95th percentile for mortality using best-fit distribution, which varied by endpoint[a]	Used best-fit distribution for a given endpoint (survival or biomass); calculated lower 5th percentile of distribution that best fit lower tail, following EPA approval of distribution[b]
Data transformation	Log-transformed data; then back-transformed data	No transformation	No transformation per August clarification

Notes:

Sources: *Calcasieu Estuary remedial investigation/feasibility study (RI/FS): Baseline ecological risk assessment* (MacDonald Environmental 2002), *Benthic Toxicity Reanalysis Technical Memorandum* (Windward 2009b), and EPA's email July 17, 2009, to LWG regarding Portland Harbor RI/FS: interpretation of sediment bioassay results (EPA 2009).

a The BERA used a lognormal distribution as the best fit for *Chironomus* mortality, the Weibull distribution for Chironomus biomass, and a log-logistic distribution for both Hyalella mortality and biomass.

b EPA selected the logistic distribution for *Chironomus* survival, the Weibull distribution for *Chironomus biomass, a beta distribution for Hyalella survival, and an exponential distribution for Hyalella biomass.*

Table 1-14
Analytes, Analysis Methods, and Targeted Reporting Limits – SBLT

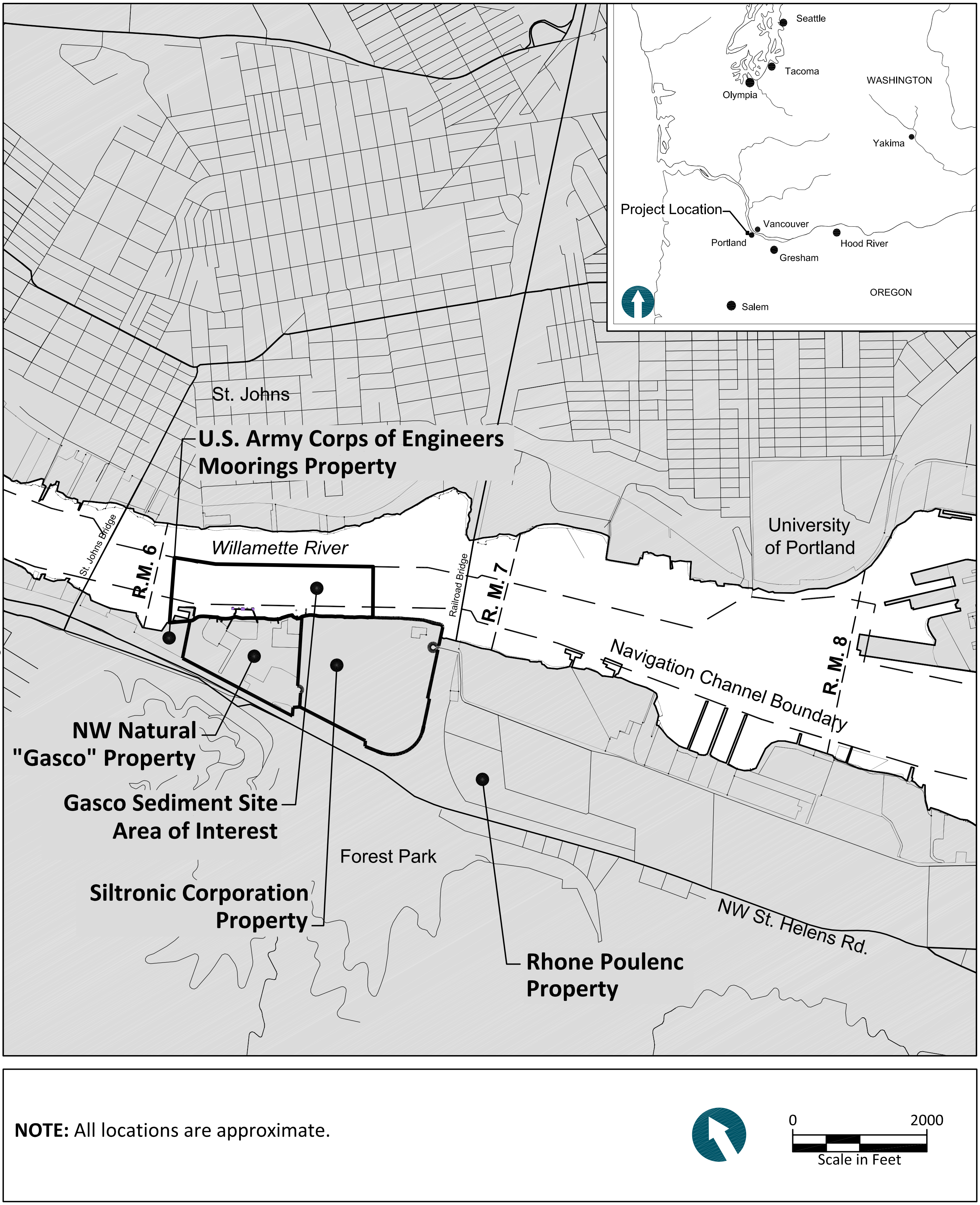
Parameter	Recommended Preparation Method	Recommended Analytical	Units	MDL	Reporting Limit
Conventional/Physical Parameters					
Total cyanide	USACOE	SM4500-CN	mg/L	0.001	0.01
Free cyanide	USACOE	ASTM D4282-02	mg/L	0.001	0.01
Available cyanide	USACOE	OIA-1677	mg/L	0.001	0.002
Metals					
Arsenic	USACOE/3010A	6020	µg/L	0.066	0.2
Cadmium	USACOE/3010A	6020	µg/L	0.022	0.2
Chromium	USACOE/3010A	6020	µg/L	0.053	0.5
Copper	USACOE/3010A	6020	µg/L	0.232	0.5
Lead	USACOE/3010A	6020	µg/L	0.298	1
Silver	USACOE/3010A	6020	µg/L	0.009	0.2
Mercury	USACOE/3010A	6020	µg/L	0.0037	0.05
Nickel	USACOE/3010A	6020	µg/L	0.081	0.5
Zinc	USACOE/3010A	6020	µg/L	3.94	4
Semi-Volatile Organics					
Acenaphthene	USACOE/3510 or 3520	8270D	µg/L	0.202	1
Acenaphthylene	USACOE/3510 or 3520	8270D	µg/L	0.21	1
Anthracene	USACOE/3510 or 3520	8270D	µg/L	0.217	1
Benzo(a)anthracene	USACOE/3510 or 3520	8270D	µg/L	0.219	1
Benzo(a)pyrene	USACOE/3510 or 3520	8270D	µg/L	0.205	1
Benzo(b)fluoranthenes	USACOE/3510 or 3520	8270D	µg/L	0.577	1
Benzo(g,h,i)perylene	USACOE/3510 or 3520	8270D	µg/L	0.15	1
Benzo(k)fluoranthenes	USACOE/3510 or 3520	8270D	µg/L	0.19	1
Chrysene	USACOE/3510 or 3520	8270D	µg/L	0.181	1
Dibenz(a,h)anthracene	USACOE/3510 or 3520	8270D	µg/L	0.163	1
Fluoranthene	USACOE/3510 or 3520	8270D	µg/L	0.22	1
Fluorene	USACOE/3510 or 3520	8270D	µg/L	0.189	1
Indeno(1,2,3-cd)pyrene	USACOE/3510 or 3520	8270D	µg/L	0.214	1
Naphthalene	USACOE/3510 or 3520	8270D	µg/L	0.553	1
Perylene	USACOE/3510 or 3520	8270D	µg/L	TBD[1]	1
Phenanthrene	USACOE/3510 or 3520	8270D	µg/L	0.18	1
Pyrene	USACOE/3510 or 3520	8270D	µg/L	0.2	1
1-Methylnaphthalene	USACOE/3510 or 3520	8270D	µg/L	0.541	1
2-Methylnaphthalene	USACOE/3510 or 3520	8270D	µg/L	0.185	1
Dibenozfuran	USACOE/3510 or 3520	8270D	µg/L	0.157	1
Carbazole	USACOE/3510 or 3520	8270D	µg/L	0.103	1
Volatile Organics					
Benzene	USACOE/5030	8260B/8260C	µg/L	0.138	1
Ethylbenzene	USACOE/5030	8260B/8260C	µg/L	0.185	1
Toluene	USACOE/5030	8260B/8260C	µg/L	0.1	1
m,p-Xylene	USACOE/5030	8260B/8260C	µg/L	0.273	1
o-Xylene	USACOE/5030	8260B/8260C	µg/L	0.178	1
Trichloroethene (TCE)	USACOE/5030	8260B/8260C	µg/L	0.186	1
cis-1,2-Dichloroethene (cis-DCE)	USACOE/5030	8260B/8260C	µg/L	0.122	1
trans-1,2-Dichoroethene (trans-DCE)	USACOE/5030	8260B/8260C	µg/L	0.12	1
1,1-Dichloroethene (1,1-DCE)	USACOE/5030	8260B/8260C	µg/L	0.18	1
Vinyl chloride	USACOE/5030	8260B/8260C	µg/L	0.187	1

Table 1-14
Analytes, Analysis Methods, and Targeted Reporting Limits – SBLT

Parameter	Recommended Preparation Method	Recommended Analytical	Units	MDL	Reporting Limit
Polychlorinated Biphenyls					
Aroclor 1016	USACOE/3510 or 3520	8082	µg/L	0.173	1
Aroclor 1242	USACOE/3510 or 3520	8082	µg/L	0.173	1
Aroclor 1248	USACOE/3510 or 3520	8082	µg/L	0.173	1
Aroclor 1254	USACOE/3510 or 3520	8082	µg/L	0.173	1
Aroclor 1260	USACOE/3510 or 3520	8082	µg/L	0.108	1
Aroclor 1221	USACOE/3510 or 3520	8082	µg/L	0.108	1
Aroclor 1232	USACOE/3510 or 3520	8082	µg/L	0.108	1
Pesticides					
2,4-DDD	USACOE/3510 or 3520	8081	µg/L	0.0173	0.1
2,4-DDE	USACOE/3510 or 3520	8081	µg/L	0.0266	0.1
2,4-DDT	USACOE/3510 or 3520	8081	µg/L	0.0164	0.1
4,4-DDD	USACOE/3510 or 3520	8081	µg/L	0.0186	0.1
4,4-DDE	USACOE/3510 or 3520	8081	µg/L	0.0184	0.1
4,4-DDT	USACOE/3510 or 3520	8081	µg/L	0.0169	0.1
alpha-BHC	USACOE/3510 or 3520	8081	µg/L	0.0085	0.05
beta-BHC	USACOE/3510 or 3520	8081	µg/L	0.0098	0.05
alpha-chlordane[1]	USACOE/3510 or 3520	8081	µg/L	0.0082	0.05
gamma-chlordane[1]	USACOE/3510 or 3520	8081	µg/L	0.0082	0.05
cis-nonachlor[1]	USACOE/3510 or 3520	8081	µg/L	0.0172	0.1
trans-nonachlor[1]	USACOE/3510 or 3520	8081	µg/L	0.022	0.1
oxychlordane[1]	USACOE/3510 or 3520	8081	µg/L	0.0152	0.1
gamma-BHC (Lindane)	USACOE/3510 or 3520	8081	µg/L	0.0159	0.05
delta-BHC	USACOE/3510 or 3520	8081	µg/L	0.0087	0.05
Dieldrin	USACOE/3510 or 3520	8081	µg/L	0.0168	0.1
Endrin	USACOE/3510 or 3520	8081	µg/L	0.0167	0.1
Endrin ketone	USACOE/3510 or 3520	8081	µg/L	0.0151	0.1
Heptachlor Epoxide	USACOE/3510 or 3520	8081	µg/L	0.0079	0.05
Hexachlorobenzene	USACOE/3510 or 3520	8081	µg/L	0.0101	0.1
Total Petroleum Hyrdocarbons					
Diesel range hydrocarbons	USACE/WA-Ecology	NWTPHDX	mg/L	0.016	0.25
Residual range hydrocarbons	USACE/WA-Ecology	NWTPHDX	mg/L	0.049	0.5

Notes:
1 alpha-chlordane, gamma-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane will be summed to calculate "total chlordane."

FIGURES



K:\Jobs\000029-GASCO\00002902\00002902-RP-054.dwg FIG 1-1 FSP

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NOTE: All locations are approximate.

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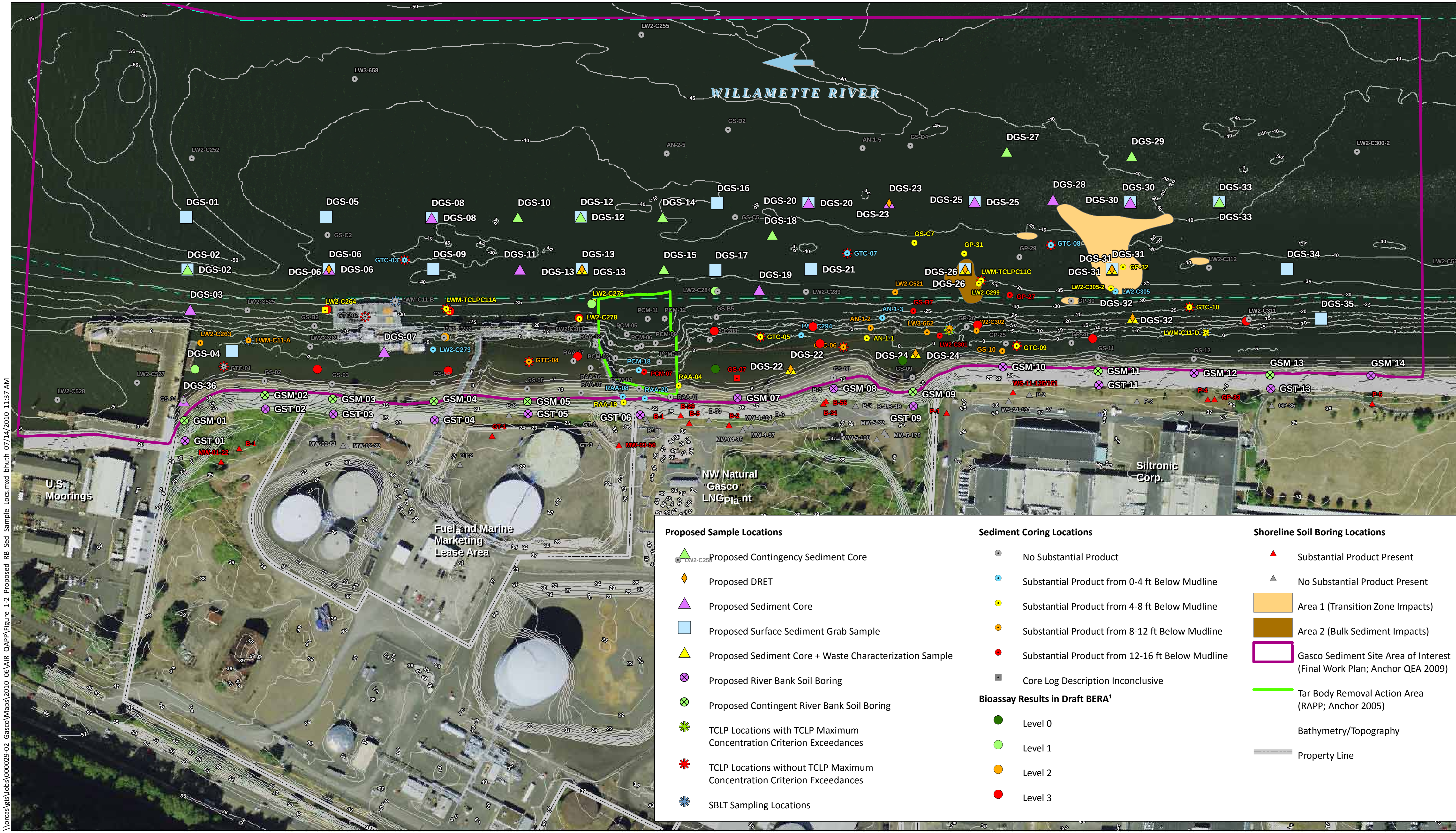
Figure 1-1
Site Vicinity Map
Final Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action



\\orcas\gis\Jobs\000029-02_Gasco\Maps\2010_06\AIR_QAPP\Figure_1-2_Proposed_RB_Sed_Sample_Locs.mxd bhuth 07/14/2010 11:37 AM

NOTES:
1. * = mudline elevation estimated based on bathymetry surveyed by LWG in 2009.
2. ~ = surface elevation estimated based on topography surveyed by Spencer B. Gross, Inc 2006.
3. Locations GTC-09 and LWM-TCLPC-11B showed substantial product at the bottom of the core.
4. The substantial product extents are estimated based on visual observations based using substantial product definition in the SOW.
5. Area 1 and Area 2 zones of impact are those shown in Figure 1 of the Statement of Work.
6. Arrow indicates direction of flow of river.
7. Aerial imagery from July 2007.

Feet
0 100 200 300 400

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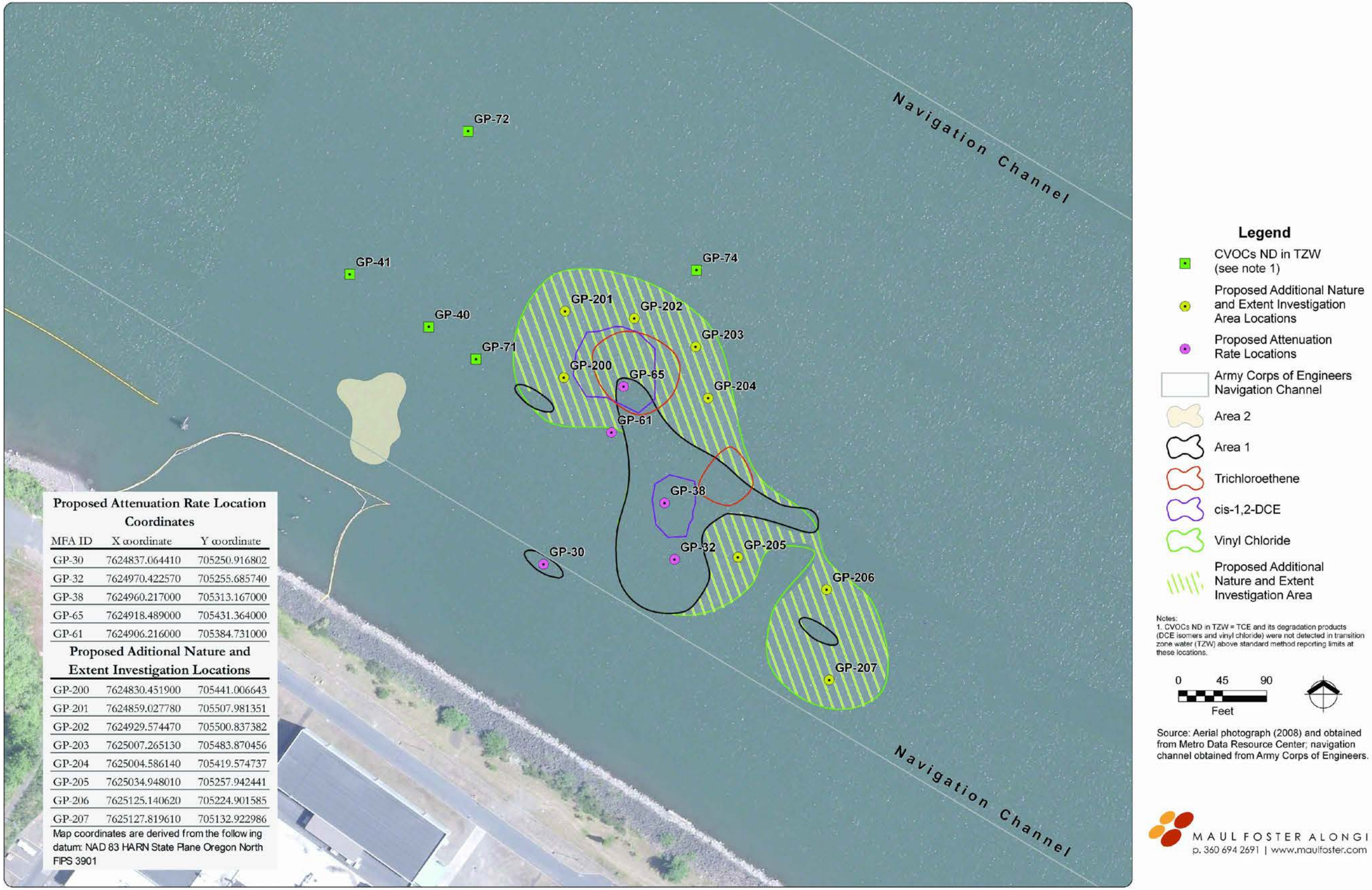
Figure 1-2
Proposed Sediment Sampling and Soil Sampling Locations
Final Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action



Proposed Attenuation Rate Location Coordinates

MFA ID	X coordinate	Y coordinate
GP-30	7624837.064410	705250.916802
GP-32	7624970.422570	705255.685740
GP-38	7624960.217000	705313.167000
GP-65	7624918.489000	705431.364000
GP-61	7624906.216000	705384.731000
Proposed Aditional Nature and Extent Investigation Locations		
GP-200	7624830.451900	705441.006643
GP-201	7624859.027780	705507.981351
GP-202	7624929.574470	705500.837382
GP-203	7625007.265130	705483.870456
GP-204	7625004.586140	705419.574737
GP-205	7625034.948010	705257.942441
GP-206	7625125.140620	705224.901585
GP-207	7625127.819610	705132.922986

Map coordinates are derived from the follow ing datum: NAD 83 HARN State Plane Oregon North FIPS 3901

Jul 14, 2010 10:57am cdavidson K:\Jobs\000029-GASCO\00002902\00002902-RP-083.dwg FIG 1-3 FSP

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Figure 1-3
Estimated Extents of Vinyl Chloride in TZW and Proposed TZW Sampling Locations
Final Data Gaps Field Sampling Plan
Gasco Sediments Cleanup Action

ATTACHMENT 1-1
SURFACE SEDIMENT COLLECTION FORM

Surface Sediment Field Sample Record

Project Name: **Project No:** **Station ID:**

Sampling Crew: ______________________

Sample Date: ______________ Sampling Method: ______________

Sampling Vessel: ______________ ______________

Subcontractor(s): ______________ Weather: ______________

Station Coordinates: N / Lat. ______________ ______________

E / Long. ______________ ______________

Datum: NAD 83 / WGS 84 zone:

Sample ID: ______________

Analysis: Metals / TBT / SVOCs / VOCs / PCBs / Pest Other: ______________

TS / TVS / Grain Size / TOC / Ammonia / Sulfides Other: ______________

(Circle Appropriate Analyses)

Grab Number: _________ Water Depth:_________ft. Grab Recovery:__________cm Time: ____________

Tide Level:___________ft. Sample Interval:__________cm

Bioassay / Chemistry Depth MLLW: ________ft.

Sediment Type:	Sediment Color:	Density:	Sediment Odor:		Sheen:	Moisture:
cobble	D.O.	Very soft/Loose	none	H2S	none	Dry
gravel	gray	soft/loose	slight	Petroleum	trace	Damp
sand C M F	black	mod dense/stiff	moderate	other:	slight	Moist
silt clay	brown	dense/stiff	strong		moderate	Wet
organic matter	brown surface	very dense/stiff	overwhelming		heavy	

Comments:

Grab Number: _________ Water Depth:_________ft. Grab Recovery:__________cm Time: ____________

Tide Level:___________ft. Sample Interval:__________cm

Bioassay / Chemistry Depth MLLW: ________ft.

Sediment Type:	Sediment Color:	Density:	Sediment Odor:		Sheen:	Moisture:
cobble	D.O.	Very soft/Loose	none	H2S	none	Dry
gravel	gray	soft/loose	slight	Petroleum	trace	Damp
sand C M F	black	mod dense/stiff	moderate	other:	slight	Moist
silt clay	brown	dense/stiff	strong		moderate	Wet
organic matter	brown surface	very dense/stiff	overwhelming		heavy	

Comments:

Grab Number: _________ Water Depth:_________ft. Grab Recovery:__________cm Time: ____________

Tide Level:___________ft. Sample Interval:__________cm

Bioassay / Chemistry Depth MLLW: ________ft.

Sediment Type:	Sediment Color:	Density:	Sediment Odor:		Sheen:	Moisture:
cobble	D.O.	Very soft/Loose	none	H2S	none	Dry
gravel	gray	soft/loose	slight	Petroleum	trace	Damp
sand C M F	black	mod dense/stiff	moderate	other:	slight	Moist
silt clay	brown	dense/stiff	strong		moderate	Wet
organic matter	brown surface	very dense/stiff	overwhelming		heavy	

Comments:

Date/Time Lab Drop Off:

Recorded by:______________________________________

ATTACHMENT 1-2
SEDIMENT CORE COLLECTION FORM

Sediment Core Collection Log

Job: ____________________ **Station ID:** ____________________

Job No: ____________________ **Attempt No.** ____________________

Field Staff: ____________________ **Date:** ____________________

Contractor: ____________________ **Logged By:** ____________________

Vertical Datum: ____________________ **Horizontal Datum:** ____________________

Field Collection Coordinates:

Lat/Northing: ____________________ Long/Easting: ____________________

A. Water Depth

DTM Depth Sounder: ____________________

DTM Lead Line: ____________________

B. Tide Measurements

Time: ____________________

Height: ____________________

C. Mudline Elevation

____________________ (-A+B=C)

Core Collection Recovery Details:

Core Accepted: Yes / No

Core Tube Length: ____________________

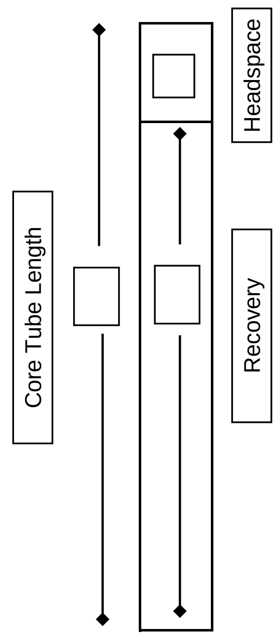
Drive Penetration: ____________________

Headspace Measurement: ____________________

Recovery Measurement: ____________________

Recovery Percentage: ____________________

Total Length of Core To Process: ____________________



Drive Notes:

Core Field Observations and Description:	Sediment type, moisture, color, minor modifier, MAJOR modifier, other constituents, odor, sheen, layering, anoxic layer, debris, plant matter, shells, biota

Samples Collected (i.e. rinsate blank)

ATTACHMENT 1-3
SOIL BORING COLLECTION FORM

Boring Location:	Boring ______ Date ______ Sheet ______ of ____
	Job ______ Job No. ______
	Logged By ______ Weather ______
	Drilled By ______
	Drill Type/ Method ______
	Sampling Method
Elevation: Datum:	Bottom of Boring ______ ATD Water Level Depth ______
Obs. Well Install. Yes No	

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

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ATTACHMENT 3
FIELD FORMS

Daily Log

ANCHOR QEA

Anchor QEA, LLC
6650 SW Redwood Lane, Suite 333
Portland, OR 97224
Phone 503.670.1108 Fax 503.670.1128

PROJECT NAME: **DATE:**

SITE ADDRESS: **PERSONNEL:**

WEATHER:	**WIND FROM:**	N	NE	E	SE	S	SW	W	NW	LIGHT	MEDIUM	HEAVY
		SUNNY		CLOUDY		RAIN			?	**TEMPERATURE:**	° F	° C

[Circle appropriate units]

TIME	COMMENTS

Signature: ______________________________

ANCHOR QEA

LOG OF EXPLORATORY BORING

CLIENT/PROJECT NAME________________________ BORING #__________

PROJECT NUMBER________________________ DATE BEGAN__________

GEOLOGIST/ENGINEER________________________ DATE COMPLETED__________

DRILLING CONTRACTOR________________________ TOTAL DEPTH__________

DRILLING METHOD________________________ SHEET______OF______

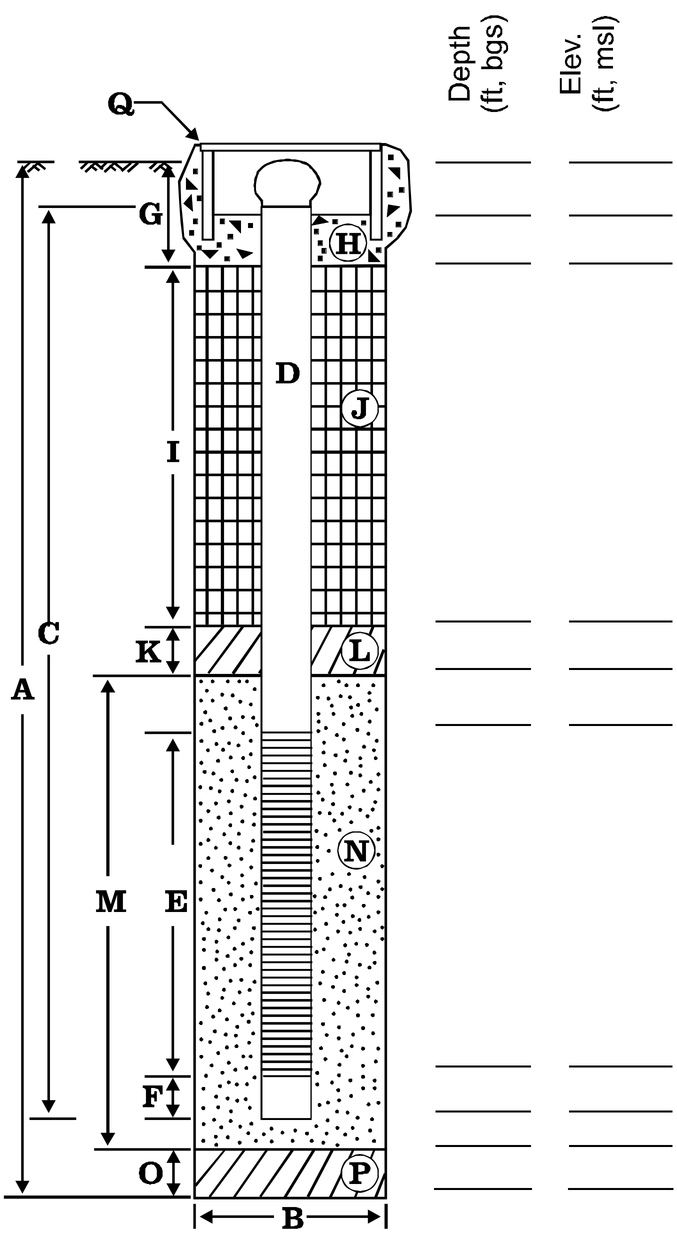
HOLE DIAMETER________________________

		SAMPLING DATA								Field location of boring
OTHER*	WELL OR PIEZOMETER DETAILS	SAMPLING METHOD	SAMPLE NUMBER	FID / PID (ppm)	RECOVERY (feet)	BLOWS / 6 INCHES	DEPTH SAMPLED	DEPTH IN FEET	SOIL GROUP SYMBOL (USCS)	**LITHOLOGIC DESCRIPTION**
								1		
								2		
								3		
								4		
								5		
								6		
								7		
								8		
								9		
								0		
								1		
								2		
								3		
								4		
								5		
								6		
								7		
								8		
								9		
								0		

Remarks:

WELL DETAILS

Project Number:	______	Boring/Well No.:	______
Client Name:	______	Top of Casing Elev.:	______
Project Name:	______	Ground Surface Elev.:	______
Location:	______	Installation Date:	______
Driller:	______	Permit/Start Card No.:	______



EXPLORATORY BORING

A. Total depth: ________**ft.**
B. Diameter ________**in.**
Drilling method: ________

WELL CONSTRUCTION

C. Well casing length: ________**ft.**
Well casing material: ________
D. Well casing diameter: ________**in.**
E. Well screen length: ________**ft.**
Well screen type: ________
Well screen slot size: ________**in.**
F. Well sump/end cap length: ________**ft.**
G. Surface seal thickness: ________**ft.**
H. Surface seal material: ________
I. Annular seal thickness: ________**ft.**
J. Annular seal material: ________
K. Filter pack seal thickness: ________**ft.**
L. Filter pack seal material: ________
M. Sand pack thickness: ________**ft.**
N. Sand pack material: ________
O. Bottom material thickness: ________**ft.**
P. Bottom material: ________
Q. Vault box type: ________
Well centralizer depths: ________**ft.**

NOTES:

Installed by: ________
Reviewed by: ________
Date: ________

WELL DEVELOPMENT FORM

ANCHOR QEA

Project No.	Date:	Well:	
Site Location:	Initial DTB:		Final DTB:
Name:	Initial DTW:		Final DTW:
Development Method:	Casing Volume:		
Total Water Removed:	Casing Diameter:		
Water Contained ?	Meter #:		
Estimate of specific capacity or recharge to well:			

Time	Cum. Vol. Removed	Sand/Silt (ml/1000ml)	Temp.	EC	pH	DTW (TOC)	Appearance/Comments