REPORT

FINAL PROJECT AREA IDENTIFICATION REPORT AND DATA GAPS QAPP

GASCO SEDIMENTS CLEANUP ACTION

Prepared for

U.S. Environmental Protection Agency, Region 10

Prepared by

Anchor QEA, LLC

On behalf of

NW Natural

July 2010

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Prepared for

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LIST OF ACRONYMS AND ABBREVIATIONS

1,1-DCE	1,1-dichloroethylene
AIR	Project Area Identification Report
AOC	Administrative Settlement Agreement and Order on Consent
AOPC	area of potential concern
ARARs	applicable and relevant and appropriate requirements
AWBZ	alluvial water bearing zone
AWQC	Ambient Water Quality Criteria
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
BHC	benzene hexachloride
BLRA	Baseline Risk Assessment
BTEX	benzene, toluene, ethylbenzene, xylenes
CCC	criteria chronic concentration
CDF	confined disposal facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-DCE	cis-1,2-dichloroethylene
CLP	Contract Laboratory Program
CMC	criteria maximum concentration
COC	chemical of concern
COPC	chemical of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CVOC	chlorinated volatile organic compounds
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DEQ	Oregon Department of Environmental Quality
DMMU	dredged material management unit
DNAPL	dense non-aqueous phase liquid
DRET	Dredging Elutriate Test
DQOs	data quality objectives
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency

Final Work Plan	Final Work Plan: Gasco Sediments Cleanup Action
FSP	Field Sampling Plan
g/day	grams per day
HCH	Hexachlorocyclohexane
HPAH	high molecular weight polycyclic aromatic hydrocarbon
JSCS	Joint Source Control Strategy
LOAEL	lowest observed adverse effect level
LPAH	low molecular weight polycyclic aromatic hydrocarbon
LWG	Lower Willamette Group
MCL	maximum contaminant level
MFA	Maul Foster & Alongi, Inc.
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µm	Micrometers
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MHW	mean high water
MNR	monitored natural recovery
NAPL	Non-aqueous phase liquid
NAVD88	North American Vertical Datum of 1988
NCP	National Contingency Plan
ng/kg	nanograms per kilogram
ng/L	nanograms per liter
NOAEL	no observed adverse affect level
NPL	National Priorities List
NRDA	Natural Resource Damage Assessment
NRWQC	National Recommended Water Quality Criteria for Priority Toxic Pollutants
OHW	ordinary high water
PAH	polycyclic aromatic hydrocarbon
PBTs	persistent bioaccumulative toxins
PCBs	polychlorinated biphenyls
PCE	Tetrachloroethene
PEC	Probable Effects Concentration
pg/L	picograms per liter

Portland Harbor Site	Portland Harbor Superfund Site
PRGs	preliminary remediation goals
QA/QC	quality control/quality assurance
QAPP	Data Gaps Quality Assurance Project Plan
RAOs	Remedial Action Objectives
RBCs	risk-based concentrations
RBDM	risk-based decision making
REV	reference envelope value
RI/FS	Remedial Investigation/Feasibility Study
RM	river mile
ROD	Record of Decision
RSL	regional screening level
SBLT	sequential batch leachate test
SDWA	Safe Drinking Water Act
Siltronic	Siltronic Corporation
SLV	screening level value
SOW	Statement of Work
SQG	sediment quality guideline
SVOC	semivolatile organic compounds
SWAC	surface-area weighted average concentration
TBCs	to-be-considered initiatives
TBT	tributyltin
TCE	trichloroethene
TCLP	toxic characteristic leaching procedure
TEF	toxic equivalency factor
TEQ	toxic equivalent concentration
Total DDD	Sum of 2,4′-DDD and 4,4′-DDD
Total DDE	Sum of 2,4′-DDE and 4,4′-DDE
Total DDT	Sum of 2,4′-DDT and 4,4′-DDT
TPH	total petroleum hydrocarbons
trans-DCE	trans-dichloroethylene
tsf	ton per square foot
TRV	toxicity reference value
TSC	threshold sediment concentration
TTC	threshold tissue concentration

TZW	transition zone water
UCL	upper confidence limit
UPL	upper prediction limit
USACE	U.S. Army Corps of Engineers
VOCs	volatile organic compounds
WQC	water quality criteria

1 BACKGROUND

In 2000, the U.S. Environmental Protection Agency (EPA) added the Portland Harbor Superfund Site (Portland Harbor Site) to the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, 42 U.S.C. § 9601, et seq. The Portland Harbor Site Study Area currently encompasses approximately 10 miles (river mile [RM] 1.9 to 11.8) of the Lower Willamette River in Portland, Oregon, and including the offshore areas adjacent to the NW Natural "Gasco" and Siltronic Corporation (Siltronic) properties (Figure 1). In fall 2001, EPA and 10 parties, including NW Natural, entered into an Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study (RI/FS; CERCLA-10-2001-0240; EPA 2001) for the Portland Harbor Site. The RI/FS will characterize the nature and extent of contamination, assess the ecological and human health risks at the Portland Harbor Site, and evaluate feasibility alternatives for cleanup.

On September 9, 2009, NW Natural and Siltronic entered into an Administrative Settlement Agreement and Order on Consent (AOC; Docket No. CERCLA 10-2009-0255) with the 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. 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 actions through a separate order.

As described in the Statement of Work (SOW) attached to the AOC, the Project Area will be determined in a series of iterative evaluation steps that are intended to make the remedial design for the Project Area consistent with EPA's proposed remedy for the Portland Harbor Site. Figure 2 depicts the preliminary Project Area for the Gasco Sediments Site (referred to as the "Area of Interest" on Figure 2), which was identified in the *Final Work Plan: Gasco Sediments Cleanup Action* (Final Work Plan; Anchor QEA 2010a). The preliminary Project Area is generally defined as those in-water sediments and riverbank on or adjacent to the Gasco and Siltronic properties where manufactured gas plant (MGP) wastes and chlorinated volatile organic compounds (CVOCs) are present in the Lower Willamette River, based on existing data. This Project Area Identification Report (AIR) refines the "Area of Interest" into an initial Project Area (described in Section 4), representing the preliminary lateral and vertical extent of the remedial action area. The initial Project Area is also used to identify data gaps necessary to further refine the Project Area for evaluation of remedial alternatives. A further refinement of the Project

Area, termed the "interim Project Area," will be presented in the next deliverable required under the SOW, the EE/CA. The "final Project Area" will be determined after the Portland Harbor FS is available and this proposed final area will be presented in the preliminary design report.

The selected remedy will be included in the Portland Harbor Site ROD for the Project Area. Therefore, the Project Area remedy design will be refined as necessary to address future changes to the Portland Harbor Site Remedial Action Objectives (RAOs) and information presented in the Portland Harbor Site FS, EPA's proposed plan and the ROD. This process will provide a remedial design that is consistent and fully integrated with the Portland Harbor Site remedy.

1.1 Introduction and Goals

This AIR has been prepared on behalf of NW Natural in coordination with Siltronic to fulfill the requirements of Section 3.4 of the SOW. The objective of this AIR is to build upon the existing information summary in the Final Work Plan (Anchor QEA 2010a) to:

- Refine the Gasco Sediments Site Area of Interest presented in the Final Work Plan into an initial Project Area that is based on a risk framework consistent with the Portland Harbor Site RI/FS process
- Identify data gaps relevant to further refinement of the Project Area, conducting the EE/CA, and completing the design
- Describe field sampling, analytical, and QA/QC procedures for filling identified data gaps (in the Data Gaps Quality Assurance Project Plan [QAPP], presented as Appendix A to this AIR)

As described in Section 3.4.1.1 of the SOW, the Project Area shall be identified in an iterative fashion through the course of data gathering, alternatives evaluation, and design. Described later in this document are the iterative Project Area identification process, preliminary lines of evidence used to develop the initial Project Area identified in this AIR, process for determining the cleanup work needed in the riverbank areas adjacent to the Gasco and Siltronic properties, and process for identifying data gaps.

This AIR was submitted in draft form to EPA in March 2010. EPA provided comments on the Draft AIR, Draft QAPP (Appendix A), and associated attachments in a letter dated May 4, 2010.

Although the SOW does not call for a revised AIR, the comment letter required NW Natural and Siltronic to address these comments through submittal of a Final AIR. NW Natural agreed to EPA's requested change to the SOW process. NW Natural and Siltronic received clarifications on these comments during a June 3, 2010, coordination meeting with EPA and DEQ. The remainder of this AIR incorporates NW Natural and Siltronic's responses to these comments as described in their response to comments letter dated July 16, 2010.

1.2 RAOs, ARARs, and TBCs

The SOW and Final Work Plan (Anchor QEA 2010a) describe in detail the RAOs for the project, as well as the potential applicable or relevant and appropriate requirements (ARARs) and to-be-considered initiatives (TBCs) that will be used to develop preliminary remedial goals and evaluate remedial alternatives. Information from these documents is briefly summarized in this section.

Because the goal of this project is to design a final remedial alternative that can be included in the Portland Harbor Proposed Plan, the RAOs for this project will be consistent with the RAOs for the Portland Harbor Site. Section 3.2 of the SOW presents RAOs for the Project Area consistent with the draft Portland Harbor Site RAOs at the time of SOW development. The Portland Harbor Site FS will also consider "background" using the following documents as guidance:

- Role of Background in the CERCLA Cleanup Program (OSWER 9285.6-07P; EPA 2002)
- EPA Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites (EPA 540-R-01-003)
- Oregon Cleanup Rules (OAR 340-122-0040)
- Other relevant EPA Superfund guidance

Per the SOW, if the RAOs for the Portland Harbor Site are changed or revised through the Portland Harbor Site RI/FS process, then RAOs for this project will be revised. Preliminary RAOs for Portland Harbor have been developed but are subject to refinement in the FS. NW Natural anticipates that the SOW RAOs will need to be revisited and potentially revised in the EE/CA. The goal of any such revision would be to follow the intent of the SOW RAOs and at the same time make them as consistent as possible with the Portland Harbor Site RAOs.

EPA's currently-proposed eight RAOs for the Portland Harbor Site FS, as identified in its letter to the Lower Willamette Group (LWG) dated September 30, 2009, are presented in the Final Work Plan (Anchor QEA 2010a). These RAOs include a groundwater RAO for addressing risks to human health, and a groundwater RAO focused on ecological receptors. EPA notes that these groundwater RAOs will be refined based on the results of the Baseline Ecological Risk Assessment (BERA) and Baseline Human Health Risk Assessment (BHHRA). The RAOs will be used to evaluate remedial action alternatives in the Portland Harbor Site FS and as the basis for the evaluation, design, and implementation of upland source control actions being performed under Oregon Department of Environmental Quality (DEQ) oversight.

EPA also defined three management goals (identified in EPA's RAOs letter to LWG, dated September 30, 2009) to be evaluated in the Portland Harbor Site FS, because a successful Portland Harbor Site remedy will require integration with other regulatory mechanisms. These goals address the need for integration of remedial actions with upland source control efforts, FS evaluations of the potential for downstream transport of contaminants under various potential alternatives, and habitat improvement programs generally within the Willamette River. EPA expects that upland source control measures will be the primary actions for protecting beneficial uses of groundwater, including potential water supply use, and that such controls will be conducted to achieve RAOs established for the in river portion of the Portland Harbor Site.

Portland Harbor Site ARARs and TBCs will be used for this project. EPA recently provided a table of preliminary ARARs and TBCs to LWG in a letter dated January 6, 2010. EPA's letter states that further refinement of Portland Harbor Site ARARs is expected and any revisions will be included in future documents for this project. Numeric and narrative criteria contained in these ARARs will be used for the project. For the screening exercise presented in Section 4 of this AIR, all of the preliminary ARARs containing numeric criteria were used in the quantitative screening process. In addition, other screening levels that are not necessarily ARARs but were used in the Draft BERA and BHHRA screening were also used in Section 4. Also, given that the evaluation of the need for riverbank work involves upland source control issues, additional upland source criteria may be identified in the EE/CA that are not relevant to the in-river Portland Harbor Site process. The EE/CA is the appropriate place to identify this complete list of ARARs and other criteria, but for screening in Section 4, readily available DEQ soils screening levels have been used.

1.3 Risk Management Framework

Per the SOW and Final Work Plan (Anchor QEA 2010a), the Project Area cleanup goal is to design a remedy consistent with the ROD that:

- "Will cost-effectively reduce key human and ecological risks in consideration of Project Area characteristics
- "Is consistent with the risk management framework in EPA's foundational guidance for sediment sites (EPA 1988 and 2005)
- "Results in a cleanup that is protective of human health and the environment and meets ARARs" [1]

The Project Area cleanup goal is the guiding concept for the project and reflects the common understanding of EPA, NW Natural, and Siltronic.

The risk lines of evidence used in the Portland Harbor Site ROD will guide risk management for the Project Area. The design will also use a risk management framework consistent with EPA guidance (EPA 1988 and 2005) on developing sediment remedies and specifically recognizes the risk management goals for the project throughout the evaluation and design process. Per the SOW, the risk management-related approaches that are specifically important to this project and are consistent with guidance include:

- "The Project Area cleanup boundary will be consistent with the Portland Harbor Site EPA-approved Baseline Risk Assessment (BLRA).[2]
- "Remedial alternatives will be evaluated with regard to total net risk reduction within the overall framework of the National Contingency Plan (NCP) remedy selection criteria.
- "The Portland Harbor risk assessment protocols, procedures, data, and outcomes will be used whenever possible to set cleanup boundaries and evaluate risk reduction, unless their use would cause an unacceptable delay.
- "Remedial alternatives will be evaluated for long-term effectiveness for a range of technologies including dredging, capping, enhanced monitored natural recovery (MNR) and MNR.
- "Remedial alternatives will include combinations of technologies that are tailored to physical, chemical, and other conditions of the Project Area.

1 EPA 1998 and EPA 2005 are references from the Final Work Plan, not this AIR.
2 Note that this bullet is slightly different than the SOW text, per EPA's request.

- "The short-term risks (e.g., sediment resuspension, waterborne releases, and dredge residuals) posed by different dredge methods (i.e., hydraulic and clam shell) and the installation and removal of various containment systems (i.e., sheet pile and coffer dam) will be evaluated.
- "Because some of the risk is related to biota exposures, factors such as migration pathways, bioavailability, and future exposure (e.g., sediment stability under various river current and vessel propeller scour conditions), will be evaluated when predicting risk reduction.
- "Future exposures and risks posed by the potential presence of mobile product in sediment will be evaluated.
- "Physical removal of 'substantial product' (as defined in Section 4.6.3.1 of the SOW) from the Project Area for off-site disposal, where consistent with the other risk management framework approaches, will be preferred."

1.4 Report Organization

The remainder of this Work Plan is organized into the following sections:

- Section 2 – Overview Initial Project Area and Data Gaps Identification Process
- Section 3 – Initial Project Area Identification Process Methods
- Section 4 – Screening and Initial Project Area Identification Results
- Section 5 – Engineering Design Existing Data Review
- Section 6 – Data Gaps Identification
- Section 7 – Summary of Proposed Data Gap Investigations
- Section 8 – References

2 OVERVIEW OF INITIAL PROJECT AREA AND DATA GAPS IDENTIFICATION PROCESS

This section presents an overview of the process used to identify the initial Project Area and data gaps relevant to further refining the Project Area, conducting the EE/CA, and conducting the design. More details on initial Project Area identification process methods are provided in Section 3. The results of the Initial Project Area Identification are presented in Section 4 and results of the Data Gap Identification are presented in Section 6.

As described in Section 3.4.1.2 of the SOW, the Project Area will be identified in an iterative fashion through the course of data gathering, alternatives evaluation, and design. The initial Project Area identification is based on currently available lines of evidence from the Portland Harbor Site RI/FS. This version of the boundary is used to identify the preliminary lateral and vertical extent of the project cleanup area, as well as data gaps relevant to further refining the Project Area, conducting the EE/CA, and conducting the design.

A refined interim Project Area will be determined after the lines of evidence are finalized in the Portland Harbor FS and Final risk assessments. The interim area will be presented in the EE/CA following methods discussed in Section 4.6.3 of the Final Work Plan (Anchor QEA 2010a). This refined boundary will be used for the evaluation of remedial alternatives. Internal subareas within the boundary will be developed to help in the identification of combination alternatives within the overall area (e.g., capping in one subarea versus dredging in another subarea).

A proposed final Project Area will be determined after the Portland Harbor Site FS is available. This proposed final Project Area will be presented in the Project Area Preliminary Design, as described in Section 4.7.1 of the Final Work Plan (Anchor QEA 2010a). The proposed final Project Area boundary will be used for the basis of remedial design and identified for inclusion in the EPA Portland Harbor Proposed Plan. The final ROD RAOs will also apply to this proposed final Project Area.

The sampling locations and types that were available for the initial Project Area Identification process are summarized in Figure 3.

2.1 Overview Initial Project Area Identification – In-water

Currently, the Portland Harbor Site risk assessments (BERA and BHRRA) have not been finalized, and the FS is in progress. However, EPA has identified initial areas of potential concern (AOPC) based on some key lines of evidence from the risk assessments. Therefore, the initial Project Area identification includes two basic steps:

- A screening of all data against all available PRGs and screening levels derived from the draft risk assessments
- An identification of the initial Project Area using the same key lines of evidence as used in the Portland Harbor Site process

It is important to recognize that a wide range of PRGs and screening levels are available from the Portland Harbor Site process including values that are (literally) zero or well below background levels. A straight screening against this wide range of values provides little indication of the actual areas that will be the focus of cleanup in the Portland Harbor Site. Although a screening of the wide range of values is provided in this AIR to fulfill the requirements of the SOW and to provide as transparent a screening process as possible, the actual work of identifying the initial Project Area will be conducted through the application of the key lines of evidence in the second step of the process.

For the first screening step in the process, and consistent with the available Portland Harbor Site risk assessment process lines of evidence, the nature and extent of contamination is presented and mapped in this AIR for each of the chemicals of concern (COCs) identified in Section 3 of the SOW. The methods for this step in the process are described in more detail in Section 3.1 of this AIR. The results of this step are described in Sections 4.1 through 4.4. Per the SOW, the existing bulk sediment, transition zone water (TZW), and water media chemistry for each of the COCs are compared to ecological, human health, and background screening levels consistent with the in-process Portland Harbor Site risk assessments and RI/FS, including the following:

1. "Existing ecological sediment quality guidelines used in the Portland Harbor risk assessment process that represent a range of levels including low or no effects levels as well as levels at which some effects are expected.
2. "Estimated sediment PRGs from the Portland Harbor Site RI/FS process for persistent bioaccumlative toxins (PBTs) that are protective of humans and wildlife that consume aquatic biota from the Lower Willamette River.

3. "Estimated sediment PRGs from the Portland Harbor Site RI/FS process that are protective of humans from direct contact with and incidental ingestion of COCs in sediments.
4. "Estimated water PRGs and screening levels from the Portland Harbor Site RI/FS that are protective of ecological receptors and human health from direct contact with and ingestion of water media. These include those values currently under consideration for Portland Harbor Site screening values including human health and ecological ambient water quality criteria (AWQC), residential tap water screening level values (SLVs) from EPA's Regional Screening Level Tables, and Drinking Water maximum contaminant levels (MCLs).
5. "Conservative water screening levels or, if available, estimated PRGs or management goals from the Portland Harbor Site RI/FS that are protective of receptors related to groundwater plumes.
6. "Background levels in sediment and water.
7. "Empirical bioassay data and sediment quality models developed from such data."

For the second step of the initial Project Area identification process, and consistent with Section 3.4.1.2 of the SOW, the following key lines of evidence are then used to develop the preliminary lateral and vertical extents for the initial Project Area presented in this AIR:

- "The lateral and vertical extent of substantial product (as defined in Section 3.6.2.1 of the SOW) in sediment
- "The use of currently available key lines of evidence to evaluate where unacceptable risk exposure may be identified in the Portland Harbor Site ROD, but where substantial product is not present
- "The use of currently available lines of evidence for Portland Harbor Site background conditions."

The methods for this step of the initial Project Area identification process are described more in Section 3.1 and 3.2. The results for this step in the process are described in Section 4.5.

2.2 Overview of Initial Project Area Identification – Riverbank

As described in Section 3.4.1.3 of the SOW, the riverbank is included in the Project Area to facilitate consistencies between riverbank remediation, source control work, and the in-river sediment cleanup. Per the SOW, the need for riverbank work will be determined by:

1. "The need for soils remediation consistent with the upland risk assessment and upland FS
2. "The need to control sources of contaminants from the riverbank to the river including:
    a. Processes of soil erosion
    b. Leaching of chemicals due to shallow groundwater movement through the riverbank
    c. Stormwater infiltration and discharge through riverbank soils"

The in-river lines of evidence discussed in this section for use in initial Project Area identification are not relevant to identifying riverbank areas to be included in the Project Area. Rather, the SOW requires that the preliminary determination of riverbank areas included in this AIR be based on a review of existing data for COCs identified in Section 3.3 of the SOW extending landward up to (but not beyond) the top of riverbank. This area is also included in the data gaps evaluation presented in this AIR.

The SOW further states that any data or known determinations consistent with soil remediation and source control actions that extend landward of the top of riverbank should be excluded in this AIR or subsequent EE/CA and that such data and activities will be included in the DEQ determinations for uplands source controls and remediation. As discussed in Section 3.3.1.4, the existing data density along the riverbank slope limit the evaluation of the nature and extent of substantial product and chemical screening level exceedances here. Therefore, top of riverbank data are used in this AIR to provide supporting information regarding the potential for substantial product and/or chemical screening level exceedances in the riverbank soils. It is important to recognize that any and all information presented in this AIR that is landward of the top of the riverbank is specifically excluded from inclusion in riverbank soils cleanup or source controls under the SOW. Further, the definition of substantial product does not apply landward of the top of the riverbank. Information and descriptions of product from this area are provided in this AIR solely for the purpose of contextual information to help guide efforts that are within the SOW defined Project Area (i.e., shoreward of the top of riverbank).

Although the riverbank area (shoreward of the top of riverbank) is included in this AIR and data gaps evaluation, there may not be a need for remediation or source controls along all portions of the riverbank. Using the data collected as part of the proposed data gaps investigation (Section 6), the areas of riverbank that require remediation or source controls will be identified in the interim Project Area Identification portion of the EE/CA.

Similar to the in-water sediments initial Project Area identification, a key line of evidence for identification of the riverbank initial Project Area is the presence of substantial product. Unlike the sediment initial Project Area identification process, screening of soils data against readily available soils screening levels is also an important component of the riverbank initial Project Area identification process. Because DEQ on recently commented on the upland risk assessment (March 1, 2010), and no process of preliminary area of concern identification has yet been agreed upon for the upland FS, a simple soil screening process was conducted for the riverbank in the Draft AIR. As discussed in Section 3.0, the riverbank soil screening has been delayed pending ongoing negotiations between NW Natural and DEQ on the upland risk assessment. The screening results presented in this Final AIR will be revised following completion of these negotiations.

Additional detail on the methods for initial Project Area identification for the riverbank data set is presented in Section 3.2.

2.3 Data Gaps Identification

This AIR reviews existing in-water and riverbank information used to define the initial Project Area (in Section 4) and then identifies any data gaps in Section 6 that need to be filled relevant to conducting the EE/CA, conducting the design, and refining the Project Area boundary for both the EE/CA and design per the iterative approach described in Section 2.

Per Section 3.4.2 of the SOW, data gap identification focuses on problem definition and will result in collection of data of adequate quality and technical content as necessary to:

- "Determine spatial and volumetric extents of contamination posing unacceptable risk (including the extent to which docks may have limited past sampling in certain parts of the site in such a way that would impact the findings of the EE/CA)
- "Refine the initial Project Area
- "Evaluate remedial alternatives on a consistent basis in the EE/CA
- "Prepare project designs
- "Evaluate potential human health and ecological risks consistent with the Portland Harbor Site risk assessment process lines of evidence resulting from exposure to sediment, TZW, riverbank, groundwater, surface water, and biota contamination
- "Evaluate recontamination potential to the Project Area by:

  - Riverbank and in-water contaminated sediments and water media outside of the Project Area
  - Upland sources of contamination

- "Determine engineering characteristics of the Project Area sediments including consistency, dredgeability, potential slope stability issues related to dredging, and potential sediment consolidation issues associated with capping
- "Evaluate potential water quality effects associated with dredging, sheet pile installation and removal, capping, or disposal technologies
- "Evaluate technologies for sediment remediation including capping, dredging, treatment including any necessary treatability testing, and disposal (on-site and off-site)
- "Evaluate technologies for TZW remediation
- "Evaluate potential impacts to threatened or endangered species, other biological receptors, and the potential habitat benefits and impacts of the remedy"

Although the intent is to identify all data needed to complete the project, once the preferred alternative is selected via the EE/CA, there may be a need for some additional specific data collection to support design work. Per the SOW, defining spatial data gaps in this report does not rely on any specific statistical or spatial evaluation techniques; instead, professional judgment of the typical data needs for sediment EE/CAs and designs is considered. The overall objective driving spatial gap identification is whether inclusion of the additional spatial information could reasonably change the selection of the preferred alternative in the EE/CA.

2.3.1 Sampling and Analysis Procedures to Fill Data Gaps Description

Data will be collected and reported consistent with the QAPP (Appendix A). The data collection, analyses, data validation, and database development will be conducted per the schedule in the Field Sampling Plan (FSP), provided as Attachment 1 to the QAPP. The results for the Data Gaps Investigation will be reported in the EE/CA.

3 INITIAL PROJECT AREA IDENTIFICATION PROCESS METHODS

As described in Section 2, the initial Project Area identification is conducted on in-water sediments areas as well as riverbank soils areas, and the process for Project Area identification differs somewhat between the two areas as further described in the following two subsections.

EPA's May 4, 2010, comments on the Draft AIR regarding the screening levels presented in subsections 3.1.1, 3.1.2, 3.2.2, and 3.3 and in Tables 1 through 7 were discussed during the June 3, 2010, monthly coordination meeting held between NW Natural, Siltronic, EPA, and DEQ. During this discussion, EPA stated that their pending comments on the Portland Harbor Site Risk Assessment would affect the screening levels required for use in the AIR. In addition, NW Natural and DEQ are currently negotiating the upland risk assessment for the Gasco site, which may also affect the screening levels.

To facilitate incorporation of these pending screening level changes into the data screening of the existing data set, EPA approved postponement of the revised data screening until the Portland Harbor Site Risk Assessment comments are available and the upland risk assessment negotiations are complete. Because the results of the revised data screening will not affect delineation of the proposed initial Project Area and data gaps sampling, EPA also approved submittal of this Final AIR and the attached Data Gaps QAPP (Appendix A) without revision to the existing data screening. Clarifying text explaining that the data screening will occur under separate cover at a later date has been added. The screening levels, the text describing the screening process in this section, and all associated tables will be revised once pending comments on the Portland Harbor Site Risk Assessment are received and the upland risk assessment negotiations are complete. All other comments provided in EPA's May 4, 2010, comment letter relevant to this section have been addressed, as necessary.

In addition, because EPA is requiring submittal of this revised Final AIR ("Table 1: Schedule of Project Deliverables" from the SOW does not require this submittal), NW Natural has revised subsection 3.1.3.2 and Figure 5 to include delineation of the initial Project Area using the March 24, 2010, Focused PRG List (attached as Appendix B to this Final AIR) transmitted in EPA's April 21, 2010, letter to the LWG.

3.1 In-water Initial Project Area Identification Process

As described in Section 2, the initial Project Area identification process for in-water sediments areas follows a two step process:

- A screening of all data against available PRGs and screening levels,
- A focused initial Project Area identification process using key lines of evidence for the project (i.e., substantial product) and the Portland Harbor Site RI/FS (i.e., key risk-based and background levels).

These two steps are detailed in the following subsections.

3.1.1 In-water Screening Process

As described in Section 2.1, the SOW requires the screening of available media data against various available screening levels and site specific risk levels. The following subsections describe the screening process methods.

3.1.1.1 Portland Harbor Site PRGs and Additional Screening Levels

Pursuant to Section 3.4.1.2 of the SOW, data within the existing Area of Interest were compared to ecological and human health risk-based screening levels consistent with the in-progress baseline risk assessment and RI/FS for the Portland Harbor. Only chemicals on the project COC list, as defined in Section 3.3 of the SOW, were included in this data screening. Existing bulk sediment, riverbank soil, and water media chemistry data were compared to screening levels taken from the following sources:

- Draft BHHRA (Appendix F of the Draft Portland Harbor RI/FS Remedial Investigation Report [Integral et al. 2009])
- Draft BERA (Appendix G of the *Draft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009])
- *Benthic Toxicity Reanalysis Technical Memorandum (*Windward 2009a)
- *EPA Regional Screening Level Table Master April 2009* (EPA RSL; EPA 2009a)
- *EPA 816-F-03-016, National Priority Drinking Water Standards* (EPA 2003)
- *National Recommended Water Quality Criteria* (NRWQC; EPA 2009b)
- *DEQ Table 33A Water Quality Criteria Summary* (DEQ 2004)

In addition, bulk chemistry data was screened against human health and ecological screening levels derived from the interim PRGs for the Portland Harbor Site. These PRGs are presented in the Interim Revised PRG Table dated December 10, 2009, which was transmitted to EPA by Carl Stivers via e-mail on December 15, 2009.

Pursuant to Section 3.4.1.2 of the SOW, the proposed screening level values were submitted to EPA for review on January 13, 2010. EPA provided comments on the screening levels via email on February 3, 2010. The requested revisions were made and submitted to EPA on February 23, 2010; EPA responded via e-mail on February 26, 2010, that they had no additional questions or concerns. At this time, the screening levels associated with the Portland Harbor baseline risk assessment have not been approved by EPA.

The following sections present the EPA-reviewed screening levels by media type. Tables 1 through 4 present the EPA-reviewed screening levels and Table 5 contains a list of Gasco Sediment Site COCs that do not have screening levels. Table 6 presents a matrix identifying the media to which each screening level was applied.

An additional table, Table 7, summarized the proposed screening levels for each of the screening requirements identified in Section 3.4.1.2 of the SOW. This table is intended as an explanatory tool. The language for each of the Portland Harbor lines of evidence in this table is open to interpretation and therefore the various screening levels provided for each line of evidence is also open to interpretation. However, this interpretation does not affect the ultimate screening process because screening levels were identified within at least one of the lines of evidence.

3.1.1.2 Sediment Screening Levels

Surface sediment, subsurface sediment, and sediment trap bulk chemistry data were compared to screening levels derived from the Portland Harbor Site PRGs, the Draft BHHRA and Draft BERA of the *Draft Portland Harbor RI/FS Remedial Investigation Report* (Integral et al. 2009), *Benthic Toxicity Reanalysis Technical Memorandum* (Windward 2009a), and *EPA RSL Table Master April 2009* (EPA 2009a). The values used for sediment data screening are presented in Table 1 and are summarized in the following subsection by source.

As shown in Table 6, surface, subsurface, and sediment bulk chemistry data were compared to each of the screening levels described in the above sources, with the exception of the industrial

beach use sediment concentrations (from Table 2-10 of the Draft BHHRA of the *Draft Portland Harbor RI/FS Remedial Investigation Report*). Only surface and subsurface sediment data were screened against these sediment concentrations.

3.1.1.2.1 Portland Harbor PRG-based Screening Levels

Three Portland Harbor PRG-based screening levels were calculated following the AOPC rules outlined in the EPA's June 23, 2009, letter to LWG. The screening levels were calculated for AOPC 9A and 9B (which are located within the Gasco Area of Interest) using the GIS tool for hill topping provided to EPA by LWG on October 22, 2009 as follows:

1. Human health screening levels for AOPCs 9A and 9B were calculated based on the total PCB PRG for adult consumption of small mouth bass (using low ingestion rate) 10^{-4} cancer risk
2. Human health screening levels for AOPCs 9A and 9B were calculated based on the benzo(a)pyrene PRG for in-water direct contact tribal fisher 10^{-6} cancer risk. Note that while this PRG is intended to be applied in direct contact areas only (e.g., it is not applied within the navigational channel), as a preliminary step, this PRG-based screening level was applied to all samples in the initial Project Area identification data screening.
3. A Portland Harbor site-wide screening level for background total PCBs was calculated based on 17 micrograms per kilogram (µg/kg) dry weight total PCBs, which is one estimate of background.

Human health screening levels were also calculated based on the PRGs for in-water direct contact tribal fisher 10^{-6} cancer risk for the five other COCs (benzo(a)anthracene, dibenzo(a,h)anthracene, benzo(b)fluoranthene, total carcinogenic polycyclic aromatic hydrocarbons [cPAHs], and indeno(1,2,3-cd)pyrene), for which a PRG is presented for this risk level and pathway in the December 10, 2009, Interim Revised PRG Table. Although EPA has indicated that additional site-specific PRGs will need to be identified for use in the Portland Harbor Site FS processes, to date EPA has not provided a proposed risk management framework with which to identify these additional PRGs. As this framework becomes better defined additional PRGs may be identified and used for this project. These PRGs were applied on a surface weighted average concentration (SWAC) basis by river mile. Screening concentrations for each chemical were developed for AOPCs 9A and 9B using the by-river mile

hill topping approach. A replacement value equal to the PRG was used in the hill topping routine.

The December 10, 2009, Interim Revised PRG Table also contains a PRG for PCB-126 for adult consumption of small mouth bass (using low ingestion rate) 10^{-4} cancer risk. This PRG is used as a surrogate for PCB toxic equivalent concentrations (TEQ) and applied on an SWAC basis by river mile in areas of direct contact areas. Because the SWAC of PCB TEQ in AOPCs 9A and 9B is below the associated PRG, a hill top PRG-based screening level cannot be developed for PCB-126 (i.e., this area of the river is currently meeting this PRG).

An additional ecological screening level was calculated based on the total PCB PRG for mink, multispecies diet. This screening level was not included in the AOPC rules outlined in EPA's June 23, 2009, letter; however, it was incorporated into this screening approach as an indication of the potential extent of the AOPC based on ecological risk. The AOPC extent (as mapped for the June evaluation) based on the mink multispecies diet encompasses the AOPCs associated with each of the other dietary- and residue-based ecological-based PRGs. Screening concentrations based on the mink, multispecies diet total PRG were developed for AOPCs 9A and 9B using the by-river mile hill topping approach. The PRG equates to 31 μg/kg dry weight total PCBs achieved on a SWAC basis by river mile and is a refined PRG based on the multispecies diet applied in the Draft BERA, which was not applied in the March 2009 Early PRGs. A replacement value equal to the PRG was used in the hill topping routine.

3.1.1.2.2 Draft BHHRA

Screening concentrations from the following tables of the Draft BHHRA of the *Draft Portland Harbor RI/FS Remedial Investigation Report* were used for data screening:

- Table 2-10: Screening Concentrations for Industrial Use Beach Sediment
- Table 2-12: Screening Concentrations for In-water Sediments

3.1.1.2.3 Draft BERA

Threshold sediment concentrations (TSCs) from Tables 7-23, 8-14, 8-16, and 8-39 (calculated no observed adverse affect level [NOAEL] of the Draft BERA of the *Draft Portland Harbor RI/FS Remedial Investigation Report* and lowest observed adverse effect level [LOAEL] TSCs for fish chemicals of potential concern (COPC)-receptor pairs, bird COPC-receptor pairs, mammal COPC-receptor pairs, belted kingfisher COPC-receptor pairs) were incorporated into the

screening. Data were screened against the most conservative TSC for each COC, as listed in these tables.

3.1.1.2.4 *Benthic Toxicity Reanalysis Technical Memorandum*

Sediment quality guidelines (SQGs) from Table 17 of this AIR were used for data screening. The *Benthic Toxicity Reanalysis Technical Memorandum* (Windward 2009a) describes several procedures used to calculate these criteria, entitled: "EPA 2009 method," "Calcasieu BERA method," and "Draft BERA method." Table 17 lists criteria calculated using each method. The following conservative approach was used to select the *Benthic Toxicity Reanalysis Technical Memorandum* criteria used for data screening:

- Values for the low threshold are the "low threshold" value obtained using the "EPA 2009 method," as presented in Table 17
- Values for the high threshold are the "high threshold" value obtained using the BERA Procedure, except for zinc, where no number calculated through the "Draft BERA-method" or "EPA 2009 method" is available and the "Calcasieu BERA method"-calculated number is used, as presented in Table 17

3.1.1.2.5 *EPA RSL Table Master April 2009*

The EPA RSL for Industrial Soil was used for the sediment data screening.

3.1.1.3 Subsurface Sediment Screening Process

Subsurface sediment data were screened against PRG-based levels using a similar process to the surface sediment screening. Where available, the PRG-based screening levels were used to delineate the vertical extent of contamination. These include screening levels developed based on the two PRGs that EPA used to delineate AOPCs (Small Mouth Bass PRG at a 10^{-4} cancer risk and Adult Tribal Fisher Direct Contact at 10^{-6} cancer risk) and the PRGs for additional COCs that may cause risk at the same risk level and pathway (benzo(a)anthracene, dibenzo(a,h)anthracene, benzo(b)fluoranthene, cPAH, and indeno(1,2,3-cd)pyrene). As described in Section 3.1.1.1, a PRG-based screening level was not developed for PCB-126 because the SWAC of PCB-126 in AOPCs 9A and 9B is below the associated PRG. For the purpose of defining the depth of screening level exceedances for this chemical in the initial Project Area, a screening value of three times the PRG for PCB-126 is used. These subsurface sediment screening levels are summarized in Table 10. All subsurface sediment data within the

Area of Interest were screened against these levels and the maximum depth of exceedances is plotted for each core location. These maximum screening level exceedance depths, in tandem with the maximum vertical extent of substantial product, will be used in the EE/CA and design process to assist with removal volume determination.

3.1.1.4 Water Screening Levels

Water screening levels from a variety of sources were used to screen TZW, groundwater, and surface water. Table 2 presents the levels used to screen these water data. The following sections further describe the screening levels used for each of these water media. Sections 3.3.1.2 and 3.3.1.3 describe the operational definitions for the depth intervals of TZW and groundwater, respectively, in this AIR.

3.1.1.4.1 TZW

TZW chemistry data were compared to screening levels taken from the Draft BHHRA and the Draft BERA of the *Draft Portland Harbor RI/FS Remedial Investigation Report*, EPA RSLs, National Priority Drinking Water Standards, NRWQC, and the *DEQ Table 33A Water Quality Criteria Summary*. The values used for water data screening are presented in Table 2 and are summarized in the following sections by source.

Draft BHHRA

Criteria and screening concentrations from the following tables of the Draft BHHRA of the *Draft Portland Harbor RI/FS Remedial Investigation Report* were used for data screening:

- Table 6-1 Screening Evaluation of Surface AWQC – 17.5 g/day dose and 175 g/day dose[3]
- Table 6-2 Screening Concentrations for TZW, Tapwater RSL and MCL

Draft BERA

Toxicity reverence values (TRVs) from "Table 6-26: Water TRVs for TZW COPCs" of the Draft BERA of the *Draft Portland Harbor RI/FS Remedial Investigation Report* were used for data screening.

3 "G/day" is an abbreviation for "grams/day", the unit for organism ingestion rate. For example, 17.5 g/day dose refers to a daily consumption of 17.5 grams of organism.

EPA RSL Table Master April 2009

The EPA RSL for Tapwater was used for data screening.

National Priority Drinking Water Standards

MCLs from the National Drinking Water Standards were used for data screening.

NRWQC

The following NRWQC were used for data screening:

- NRWQC for Priority Toxic Pollutants – Freshwater Chronic Concentration
- NRWQC for Priority Toxic Pollutants – Freshwater Maximum Concentration
- NRWQC for Priority Toxic Pollutants – Human Health for Consumption of Water and Organism
- NRWQC for Priority Toxic Pollutants – Human Health for Consumption of Organism Only. These values were used for COCs with no AWQC level listed in Table 6-1 of the Draft BHHRA of the *Draft Portland Harbor RI/FS Remedial Investigation Report.*

DEQ Table 33A Water Quality Criteria Summary

Water quality criteria for Freshwater Maximum Concentration were used for COCs with no Freshwater Maximum Concentration screening level listed in the NRWQC.

3.1.1.4.2 Groundwater

Groundwater chemistry data were compared to the *EPA RSL Table Master April 2009* for tapwater and to the National Priority Drinking Water Standards MCLs. Groundwater data were compared to additional screening levels pursuant to the upland FS process. These additional upland screening levels are described in Section 3.2.2. Exceedances of these additional upland levels are not applicable to in water pathways and should not be used to make determinations about the in-water project areas.

3.1.1.4.3 Surface Water

Surface water chemistry data were compared to values taken from the Draft BHHRA and Draft BERA of the *Draft Portland Harbor RI/FS Remedial Investigation Report*, EPA RSLs, National Priority Drinking Water Standards, NRWQC, and the DEQ Table 33A Water Quality Criteria Summary. The criteria used for data screening are listed by source in the following sections.

Draft BHHRA

Criteria from the following Draft BHHRA tables were used for data screening:

- "Table 2-14: Screening Concentrations for Surface Water, Direct Contact with Divers"
- "Table 2-17: Screening Concentrations for Surface Water, Domestic Water Source, Tapwater RSL and MCL"
- "Table 6-1: Screening Evaluation of Surface Water Against Ambient Water Quality Criteria (AWQC) – 17.5 g/day dose and 175 g/day dose"

Draft BERA

Criteria from "Table 6-22: Water TRVs for Surface Water COPCs" from the Draft BERA of the *Draft Portland Harbor RI/FS Remedial Investigation Report* were used for data screening.

EPA RSLs Table Master April 2009

The EPA RSLs for tapwater were used for data screening.

National Priority Drinking Water Standards

Maximum Contaminant Levels (MCLs) from the National Drinking Water Standards were used for data screening.

NRWQC

The following NRWQC were used for data screening:

- NRWQC for Priority Toxic Pollutants – Freshwater Chronic Concentration
- NRWQC for Priority Toxic Pollutants – Freshwater Maximum Concentration
- NRWQC for Priority Toxic Pollutants – Human Health for Consumption of Water and Organism
- NRWQC for Priority Toxic Pollutants – Human Health for Consumption of Organism Only. These values were used for COCs with no AWQC level listed in "Table 6-1 Screening Evaluation of Surface AWQC – 17.5 g/day dose and 175 g/day dose" the *Draft BHHRA of the Draft Portland Harbor RI/FS Remedial Investigation Report*.[4]

4 "G/day" is an abbreviation for "grams/day", the unit for organism ingestion rate. For example, 17.5 g/day dose refers to a daily consumption of 17.5 grams of organism.

DEQ Table 33A Water Quality Criteria Summary

Criteria for Freshwater Maximum Concentration were used for COCs with no Freshwater Maximum Concentration screening level listed in the NRWQC.

3.1.2 Portland Harbor Site Benthic Toxicity

The results for benthic toxicity tests were compared to screening levels derived from Table 2-3 of the *Benthic Toxicity Reanalysis Technical Memorandum* (Windward 2009a). The *Benthic Toxicity Reanalysis Technical Memorandum* describes several procedures used to calculate these benthic toxicity thresholds, entitled: "EPA 2009 method," "Calcasieu BERA method," and "Draft BERA method." Table 2-3 of the *Benthic Toxicity Reanalysis Technical Memorandum* lists the thresholds calculated using each method. The following approach was used to select the *Benthic Toxicity Reanalysis Technical Memorandum* thresholds used for benthic toxicity data screening:

- Values for the REV and low thresholds are the "REV" and "low threshold" value obtained using the EPA 2009 method
- Value for the high threshold is the "high threshold" value obtained using the Draft BERA method

Table 3 of this AIR presents the levels used for screening the benthic toxicity test results. Section 3.3 presents the toxicity assessment based on the sediment toxicity tests.

3.1.2.1 In-water Screening for the Portland Harbor Site Background Levels Line of Evidence

Surface water and sediment background concentrations for select COCs are presented in the *Draft Portland Harbor RI/FS Remedial Investigation Report* (Integral et al. 2009). Tables 1 and 2 include background values for the project COCs identified in Section 3.3 of the SOW used to screen surface water and sediment data. These background values were taken from:

- Upriver surface sediment upper prediction limit (UPL) concentrations, dry weight concentrations, primary outliers removed (Table 7.3-5b of the *Draft Portland Harbor RI/FS Remedial Investigation Report*)
- Upriver surface sediment UPL concentrations, OC-Equivalent, primary outliers removed (Table 7.3-6b of the *Draft Portland Harbor RI/FS Remedial Investigation Report*)
- Upriver surface water UPL concentrations, total concentration basis, outliers removed (Table 7.4-4a of the *Draft Portland Harbor RI/FS Remedial Investigation Report*)

The existing sediment and water data set was screened against the above background levels. Sediment data was also screened against hill top background concentrations. Hill top background concentrations were calculated on a Portland Harbor Site-wide basis using the GIS tool provided to EPA by LWG on October 22, 2009. A replacement value equal to the background number was used in the hill topping routine. These background values were taken from:

- Upriver surface sediment UPL concentrations, dry weight concentrations, primary outliers removed (Table 7.3-5b of the *Draft Portland Harbor RI/FS Remedial Investigation Report*)
- Upriver surface sediment UPL concentrations, OC-Equivalent, primary outliers removed (Table 7.3-6b of the *Draft Portland Harbor RI/FS Remedial Investigation Report*)

3.1.3 In-water Key Lines of Evidence Screening Process

As described in Section 2, the second step in the initial Project Area identification process is using key lines of evidence from the Portland Harbor Site process and site specific information (i.e., evidence of substantial product) to define the initial Project Area. The methods for this step in the process are described in the following subsections, with site-specific information discussed first.

3.1.3.1 Substantial Presence of Product Line of Evidence

As described in the SOW, substantial presence of product in sediments is a key line of evidence related to potential mobility of chemicals in the future. Sediment core observations were examined for substantial product using the definition presented in Section 3.6.2.1 of the SOW and reiterated below. Section 3.3.1.1 describes the location of sediment cores included in this screening.

Visual observations in sediment cores are the primary parameter used for this line of evidence. The term "substantial" product is intended to target product that is related to potential future mobility and indicate a preference for physical removal as defined by RAO 1 in the SOW. The definition of substantial product does not include every incidence of product observation at the Project Area. As defined in the SOW, the working definition of "substantial presence of product" is those sediments that meet the following criteria based on core observations:

- **"Criterion 1:** Bands of product, layers of product, 'saturated' sediments, 'stained' sediments, and/or seams of product that are greater than 2 inches thick.
- **"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."

As described in the SOW, 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"

An additional Criterion 3 will consider whether the 5 feet of overlying relatively clean material includes any sediment that would be expected to be removed as part of U.S. Army Corps of Engineers (USACE) maintenance dredging in the navigation channel. If so, the 5-foot depth requirement should be judged from the depth to which maintenance dredging would occur.

Also for this line of evidence, general knowledge about product extents was considered in the initial Project Area identification. For example, during construction of the tar removal Early Action, observations of exposed tar were identified during very low Willamette River water surface elevations directly downstream from the Early Action removal area beneath the oil pipeline and adjacent to the middle pipeline support. This area of remaining exposed tar is bounded on the downstream channel ward and upstream side by core locations (i.e., RAA-15, RAA-16, and GS-06, respectively) showing no substantial product indicating this tar is of

limited extent. In addition, some tar remains in place at the upper end of the tar removal dredge cut, where an organoclay mat was placed as part of the post removal capping.

The SOW indicates that the perimeter of the in-water area with substantial product will be defined by cores that do not contain substantial product. As described more in Section 6, there are a number of places lacking sufficient data to accurately constrain the perimeter of substantial product per this SOW method, and more data should be collected in these areas. For this reason, the perimeter of substantial product for the purpose of this AIR is not defined following the SOW described method, given that this would provide a very inaccurate depiction of the likely substantial product extents in light of the current data uncertainty. However, once the additional substantial product data are collected, future refined depictions of the substantial product perimeter will follow the SOW methods including in the EE/CA and design. For the purposes of this AIR, areas lacking sufficient data to bound the perimeter of substantial product are identified as data gaps (in Section 5.1.1) and additional data is proposed in these areas (in Section 6.1).

Note that all sediment cores proposed as part of the data gaps sampling investigation (described in Section 6.1) will include visual observations during core logging to further delineate areas with substantial product.

3.1.3.2 Portland Harbor Key Lines of Evidence

As required by the SOW, the Project Area screening process will be evaluated and refined as specific levels are identified in the Portland Harbor Site process for delineating AOPCs in the Project Area with no substantial product. AOPCs have been identified for the Portland Harbor Site by EPA on a preliminary basis at this time and AOPC 9A and 9B encompass the majority of the Area of Interest. It is understood by EPA and LWG that these AOPCs will be refined as the FS proceeds to completion. Consequently, a full list of methods for identifying the Project Area is not clearly defined at this time. Currently, preliminary AOPC delineation in the Portland Harbor Site is being conducted using the March 24, 2010, Focused PRG List (Appendix B). EPA's April 21, 2010, letter directed LWG to use this List in the FS process.

Consistent with EPA's direction, the screening analysis conducted for this AIR as described above is filtered to identify risk areas using the March 24, 2010, Focused PRG List (Appendix B). These filtered risk areas are combined with the map identifying substantial product areas—the site specific key line of evidence. Finally, these combined areas are evaluated for contamination

that may not be related to historic Gasco and Siltronic property discharges. Such an evaluation is generally consistent with the upstream and downstream extents of the potential remediation area depicted in Figure 1 of the SOW.

EPA and LWG agree that the benthic risk areas will be mapped using an approach that considers multiple lines of evidence, including bioassay results, benthic SQGs in the March 24, 2010 Focused PRG list (Appendix B), and other lines of evidence. Currently, LWG and EPA do not agree on the methodology to be used in this approach. The benthic risk areas shown in this AIR only consider the benthic SQGs in the March 24, 2010, Focused PRG list (Appendix B) and therefore does not account for the remaining benthic risk lines of evidence. It is understood that the risk areas mapped solely based on these PRGs will be reevaluated following agreement on the methodology to be used to identify benthic risk areas.
Any such revisions will be incorporated into the project EE/CA.

The procedures identified in this section for the initial Project Area identification serve as a starting point for later Project Area refinements to be completed in the EE/CA and during design. As additional information from the Portland Harbor Site RI/FS becomes available, more detailed Project Area definition will be conducted and the area, and any subareas within it, will be refined as necessary.

3.2 Riverbank Soil Initial Project Area Identification Process

As noted in Section 2, the evaluation of riverbank soils for potential inclusion in the initial Project Area uses both available soils screening levels as well as the presence of substantial product. (Unlike the sediments evaluation, there are no key lines of evidence yet developed for the upland FS process to further refine this area identification process.)

As detailed more in Section 3.2.1, substantial presence of product is defined in Section 3.6.2.1 of the SOW and applies to the Project area, which includes elevations riverward of the top of bank. However, as discussed below, soils cores above and near the top of the bank were evaluated relative to this definition for context purposes only, but not to define any top of bank soils as substantial product, given this definition is not applicable here.

As described in the *Gasco RI Report* (HAI 2007a), the nature and extent of MGP waste material existing on the Gasco and Siltronic properties near the top-of-riverbank areas are highly heterogeneous due to the nature of the upland filling activities and historical direct discharge

pathways. Therefore, observations of substantial product and exceedances of screening levels are likely to be highly spatially variable, decreasing the ability to accurately evaluate continuity of substantial product and/or chemical concentration near the riverbank. Given this conceptual site model, there is a relative low density of information on the riverbank soils. Therefore, the process for identifying the riverbank soil initial Project Area was highly simplified. For this stage of the project, it was assumed that the entire shoreline along the Area of Interest (Figure 1-2) is included in the initial Project Area. Clearly, further data collected in the riverbank soils will help refine the need for actual remediation and/or source controls within this overall generally defined area. For this reason, it should not be assumed at this time that all soils within this area will be subject to remediation and/or source controls. Rather, this represents the area of study at this time given the limited data set for this area.

3.2.1 Substantial Presence of Product

Section 3.6.2.10 of the SOW states that the following criterion associated with substantial product located within the riverbank shall be used to determine the need for, areas of, and design of, riverbank remedy and source controls:

"1. If substantial product is identified in riverbank cores and is contiguous with sediment substantial product (as indicated by sediment cores), the volume of riverbank soils that shall be removed if feasible will extend landward into the riverbank until contiguous product has been removed or a vertical line drawn from the top of the bank (as defined in Section 2.2) is reached. Some product may not be removed because the vertical line at the top of bank is reached, the product extends too deep to be integrated into the sediments dredge prism, or for other feasibility reasons. In these cases, the remaining product shall be capped using an engineered system that reduces potential contaminant flux and product seepage to acceptable levels consistent with the design approach typically used for a sediment cap."

To support evaluation of the above riverbank substantial product criteria, boring logs collected along the top of the riverbank were evaluated for the substantial presence of product using the definition in Section 3.6.2.1 of the SOW. Because the riverbank slope soils may need to be regraded to achieve stable slopes that can be integrated into the sediments dredge prism (this may include riverbank areas that do not contain contiguous substantial product or otherwise require source control measures in order to maintain stable riverbank slopes) modifying factors 1 and 2 (see Section 3.1.2.1) for the substantial product definition were not applied in this

evaluation. Rather, observations of substantial product were identified regardless of elevation throughout the full length of the boring.

The elevations of substantial product in the riverbank were then compared against the nearshore riverbank toe of slope elevations of substantial product to determine if the elevations provided evidence for continuity between the uplands and Willamette River. Except in the location of the tar body Early Action (Figure 4), the GS-01 through GS-12 borings generally provided the most comprehensive data set for the presence/absence of substantial product along the toe of the riverbank. Additional toe of riverbank locations were collected in the vicinity of the former tar body during the Early Action design characterization.

Also, the near-top of riverbank soil core information was compared to the substantial product definition. This was only done for supporting context and not to actually define substantial product in these cores, because this definition does not apply to soils at the top of the bank. This evaluation was conducted to:

- Determine the potential for substantial presence of product at lower elevations on the riverbank and potential continuity with substantial product noted within toe of slope sediments
- Help guide data gap sampling along the riverbank based on currently documented areas where product exists at the top of the shoreline riverbank area.

This top of bank product screening is intended to neither include these soils in the SOW-defined Project Area nor define them as substantial product given the inapplicability of this definition here.

Areas lacking sufficient data to adequately evaluate continuity of substantial product between the riverbank and Willamette River were identified as data gaps (Section 6.1.2) and additional data gathering is proposed in these areas (Section 7.2).

3.2.2 Riverbank Soil and Groundwater Chemical Screening Levels

Riverbank soils and groundwater were screened against additional criteria pursuant to Section 3.4.1.3 of the SOW, which requires that the need for riverbank soil remediation be determined by:

- The need for soils remediation consistent with the upland risk assessment and upland FS
- The need to control sources of contaminants from the riverbank to the river. As the upland risk assessment is still under DEQ review and the FS therefore is not yet complete, generic screening criteria were used in lieu of site specific criteria.

As noted in Section 3.1.1.4, groundwater data were screened against criteria relevant to the in-water screening process. This same groundwater data set was also screened against criteria that are relevant to the above objectives. Riverbank soil and groundwater chemistry data were compared to screening levels from:

- *DEQ Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites, Risk Based Concentrations* ((DEQ RBDM RBCs; DEQ 2009)
- "Table 3-1: Screening Level Values for Soil/Stormwater Sediment, Stormwater, Groundwater, and Surface Water" from the *Joint Source Control Strategy*(JSCS; DEQ and EPA 2005)
- *EPA RSLs Table Master April 2009*

Tables 2 and 4 list the screening level values used for groundwater and riverbank soil, respectively. The screening level values taken from each source are listed in the following subsections.

3.2.2.1 DEQ RBDM RBCs

The following DEQ RBDM RBCs were used for data screening:

- Soil – Occupational Worker – Ingestion, Dermal Contact and Inhalation
- Soil – Construction Worker – Ingestion, Dermal Contact and Inhalation
- Soil – Excavation Worker – Ingestion, Dermal Contact and Inhalation
- Soil – Volatilization to Outdoor Air – Occupational
- Soil – Leaching to Groundwater – Occupational
- Groundwater – Ingestion and Inhalation from Tap Water
- Groundwater – Volatilization to outdoor air
- Groundwater – Excavation

3.2.2.2 JSCS Table 3-1

The following screening levels from JSCS Table 3-1 were used for soil data screening:

- Upland Soil and Sediment – Toxicity
- Upland Soil and Sediment – Bioaccumulation

3.2.2.3 EPA RSL Table Master April 2009

The EPA RSLs for Industrial Soil were used for soil data screening.

3.3 Horizontal and Vertical Extents of Data Evaluations

This section provides further detail on the methods used to determine the horizontal and vertical extent over which sampling data were included in the data set used for the media screening and initial Project Area identification process described in Sections 3.1 and 3.2. The project data were generally taken from samples collected within the Area of Interest, as identified on Figure 1-2 of the Final Work Plan. However, in certain areas, data nearby, but outside of the Area of Interest were included in the data set in order to fill in gaps in coverage for a particular media. This was the case for the groundwater and riverbank soil data sets, as described below in the subsections for each of these media.

This section also presents the methodology used to group data into vertical sampling horizons. The data contained within data set were collected over a wide range of elevations and depth intervals in order to meet a variety of objectives. Soil and TZW data were treated as single intervals in this screening, and each sampling horizon includes data collected over the same general depth. It was necessary, however, to group sediment, groundwater, and surface water data collected at different depths into more general sampling horizons.

The following sections describe the horizontal and vertical extents of the data included in the sediment, surface water, groundwater, TZW, and riverbank soil data sets, and methods used to group the data into sampling horizons (when media was grouped).

3.3.1.1 Sediment Data

For purposes of this screening, sediment is considered to be the riverbed material collected in areas of the LWR where the mudline elevation is less than or equal to 13.3 feet North American Vertical Datum of 1988 (NAVD88). The sediment data set includes samples collected from

within the Area of Interest shown on Figure 1-2. Grab samples, sediment cores (all depths), and sediment trap data were included. Samples collected in the tar body removal area at depth intervals where sediment was removed as part of the Early Action removal were excluded from the sediment data set.

Sediment data was separated into eight sample horizons (identified as Categories A through H). All elevations were referenced as depth below mudline. The categories were defined as follows:

- *Category A:* This sampling horizon includes data collected at depth intervals meeting the Portland Harbor site definition of surface sediment that was identified as the 0 to 40-centimenter depth interval when querying data (defined as 0 to 30 centimeters during sample collection).
- *Category B:* This sampling horizon includes data collected within the 0 to 4-foot depth interval, excluding data that meets the Category A description.
- *Category C-F:* The category C, D, E, and F sampling horizons include data collected within the 4-8 foot, 8-12 foot, 12-16, and 16-20 depth intervals, respectively.
- *Category G:* This sampling horizon includes data collected from depths greater than 20 feet.
- *Category H:* This sampling horizon includes samples considered representative of depth intervals that exceed 8 feet in length. These samples, which were labeled "long composites", were excluded from the above categories, regardless of the elevation where the sample was collected.

Samples collected at depth intervals that span more than one category and do not meet the Category H definition were grouped according to the following rules:

- The sample is associated with the horizon containing more than 50 percent of the sample.
- If a sample is equally split between two horizons, it is associated with the deeper horizon.

In addition, sediment trap data was handled separately, and is not grouped into the above-described sample horizons.

3.3.1.2 TZW Data

The TZW data set includes samples collected from within the Area of Interest shown on Figure 1-2. The LWG sampled the upper 30 centimeters of the sediment as an operational definition of this mixed layer, but in many cases it likely does not extend that deep. For purposes of this data screening, samples collected in the 0 to 38 centimeter interval of the sediment were used in the screening but are not necessarily considered representative of the mixing zone and the interval of exposure to people or aquatic organisms. In addition, groundwater samples collected from deeper intervals were included in the TZW data screening to facilitate better spatial coverage in areas lacking shallower TZW data. These data are proposed for the data screening only and not considered representative in anyway of the actual interval of exposure to people or aquatic organisms. Of the 166 samples used in the screening, 108 met the operational definition of 0 to 38 centimeters, 44 were collected between 38 and 60 centimeters below mudline, and an additional 14 were collected at elevations up to 215 centimeters below mudline. As noted above, the TZW was treated as a single sampling horizon, regardless of sample depth. This is an acceptable method for a preliminary screening, but further project evaluations will likely differentiate deeper TZW samples as not having any actual direct exposures to people or aquatic organisms.

3.3.1.3 Groundwater Data

The groundwater data set includes samples collected from within the Area of Interest shown on Figure 1-2. In addition, groundwater data from samples collected in locations near the top of the riverbank were included to provide context to the riverbank and in-river data evaluations. Groundwater data were grouped into two sampling horizons: alluvial and fill ground water (collected at elevations above -100 feet NAVD 88 and below shallow elevations that were considered TZW) and deep groundwater (collected at elevations deeper than -100 feet NAVD88).

For the purposes of this screening, the groundwater results collected from in-water and riverbank locations were screened as a single data set. All groundwater data were screened against the in-water screening levels for groundwater listed in Section 3.1.1.4 as well as the additional groundwater screening levels listed in Section 3.2.2.

3.3.1.4 Riverbank Soil Data

The riverbank soil data set consists of sample results considered indicative of riverbank conditions within the Area of Interest (Figure 1-2). The riverbank is defined in the SOW as the area extending above elevation 13.3 feet NAVD88 to the generally flat area on top of the riverbank and not extending beyond. Because few samples were collected in this area, data from sediment cores collected at the toe of the riverbank at elevations slightly below 13.3 feet NAVD88 (i.e., GS-01 through GS-12 series borings) were included in the riverbank soil screening. These borings were also screened against the sediment screening levels and were therefore screened twice (i.e., soils and sediment screening levels). No locations located above 13.3 feet NAVD88 were screened against the sediment screening levels. In cases where more than one sample was collected from a boring, the highest concentration detected for each COC was presented on the GIS layers (Appendix C), but all existing data was screened and presented in the associated data tables (Appendix D).

Most of the nearshore borings extended deep below the ground surface. For the purposes of the soil data screening, only soils data within the top 20 feet below ground surface was included in the data screening. This horizon is considered representative of the soils that will contribute potential chemicals to the Willamette River through riverbank erosion, stormwater infiltration, and shallow groundwater discharge, and/or potentially be exposed during the cleanup activities due to riverbank layback to support toe of slope dredging.

As discussed above, very few samples were collected in the riverbank areas defined by the SOW. Therefore, some stations locations offset from the top of riverbank were selected to provide general context for the Project Area (e.g., locations GP-33, P-02, P-03, P-04, and P-05 adjacent to the Siltronic top of riverbank). Additionally, stations along the riverbank that were below the soil elevation boundary of 13.3 feet NAVD88 (such as samples SS-2, SS-4, SS-5, SS-6, SS-7, SS-9, and SS-10, as well as GS-01 through GS-12 as noted above) were included in evaluations of upland riverbank soils. The location of the sediment cores and soil borings included in data screening were shown on the riverbank GIS layers (Appendix C).

Soil boring locations located further beyond the top of the riverbank that were not included in the soils chemical screening were evaluated to provide further context regarding the potential for substantial product to exist along the top-of-riverbank areas, where true top of riverbank boring were lacking. These data were not used in the initial Project Area identification,

consistent with Section 3.4.1.3 of the SOW. The locations of the borings evaluated for product were shown on Figure 4.

3.3.1.5 Surface Water Data

Samples in this dataset were either specifically collected to characterize the Gasco Sediments Site or were collected in the LWR from RM 6.0 to 6.7. The samples are grouped into the following three sampling horizons for the purposes of this data screening:

- Surface-depth (i.e., within a few feet of the water surface)
- Mid-depth
- Near-bottom (i.e., within a few feet of the river bottom).

It is important to note that these horizons are only intended to support this screening and may not be representative of actual exposures to either people or aquatic organisms that are the subject of water quality criteria. In the Portland Harbor Site process, for example, it has been agreed that for certain types of exposure assessments surface water should be evaluated using vertically and horizontally integrated samples for comparison to water quality criteria and water PRGs.

All surface water samples collected in the area of interest were included except for samples collected during tar removal construction. These construction data were not considered representative of normal ambient site conditions and were therefore omitted from the data screening. Samples from the tar removal monitoring that were collected during development of the background conditions prior to construction were included in the dataset.

3.3.1.6 Benthic Toxicity Data

Benthic toxicity data was collected from bioassay tests conducted on surface sediment collected from 18 locations (see Figure 3) within the Area of Interest.

3.4 Data Quality and Sources

This section provides further detail on the data sources used, evaluations of data quality, and data handling procedures used during the data screening and initial Project Area identification.

3.4.1 Data Sources

Data used for this screening were obtained from the following sources:

- *Draft Source Control Evaluation Report, RPAC-Portland Site* (AMEC 2008)
- *NW Natural "Gasco" Site Draft Screening Level Nearshore Source Control Evaluation Results Report* (Anchor 2001)
- Public Review Draft Engineering Analysis/Cost Evaluation, Removal Action NW Natural "Gasco" Site" (Anchor 2005a)
- *Annual Data Evaluation Monitoring Report – Year 0 Long-Term Pilot Cap Monitoring* (Anchor 2007c)
- *Groundwater/NAPL Pilot Program Extraction Well and Performance Evaluation Design Report* (Anchor 2007f)
- *Offshore Investigation Report: NW Natural "Gasco" Site* (Anchor 2008b)
- *Annual Data Evaluation Monitoring Report – Year 1 Long-Term Pilot Cap Monitoring* (Anchor 2008d)
- *Portland Harbor RI/FS Round 3A In-River Sediment Trap Sampling Data Report; Draft; AE08-09* (Anchor 2008e)
- *Annual Data Evaluation Monitoring Report – Year 2 Long-Term Pilot Cap Monitoring* (Anchor 2009b)
- *Draft Annual Data Evaluation Monitoring Report – Year 3 Long-Term Pilot Cap Monitoring* (Anchor QEA 2010b)
- *Assessment of the Nature of PAH in Surface Sediments along the Southwestern Shore of Portland Harbor Superfund Site, Portland, Oregon.* (Battelle 2002)
- *Updated Phase I Site Characterization Summary Report, Siltronic Corporation Property, Portland, Oregon* (HAI 2005)
- *Remedial Investigation Report, NW Natural "Gasco" Facility. Portland, Oregon.* (HAI 2007a)
- *Sediment Characterization Study of Local Sponsors' Berths; Columbia and Willamette River Navigation Channel Deepening; Longview and Kalama, Washington and Portland, Oregon.* (Hart Crowser 1999)
- *Round 1 Site Characterization Summary Report* (Integral 2004)
- *Portland Harbor Site RI/FS Round 2A Sediment Site Characterization Summary Report* (Integral 2005b)
- *Portland Harbor Site RI/FS Round 2 Groundwater Pathway Assessment Transition Zone Water Site Characterization Summary Report* (Integral 2006c)

- *Portland Harbor Site RI/FS Round 2A Surface Water Site Characterization Summary Report* (Integral 2006d)
- *Portland Harbor Site RI/FS Round 2B Subsurface Sediment Data* Report (Integral 2006e)
- *Portland Harbor Site RI/FS Round 3A Low-flow and Stormwater-Impacted Surface Water Data Report* (Integral 2007a)
- *Portland Harbor Site RI/FS Round 3A Winter 2007 High-flow Surface Water Data Report* (Integral 2007b)
- *Portland Harbor RI/FS Round 3B Sediment Data Report* (Integral 2008)
- *Portland Harbor RI/FS Sediment Chemical Mobility Testing Data Report* (Integral 2009)
- *Portland Harbor Site RI/FS Round 2 Benthic Tissue and Sediment Data Report* (Integral and Windward 2006)
- *Portland Harbor RI/FS Round 3B Fish and Invertebrate Tissue and Collocated Surface Sediment Field Sampling Report* (Integral and Windward 2008)
- *Remedial Investigation Report, Siltronic Corporation site* (MFA 2007)
- *Dredged Material Management Plan Sediment Characterization Report* (Tetra Tech 2006)
- *Final Limited Sediment Investigation Report, U.S. Government Moorings, Portland, Oregon* (URS 2003)
- *Results of July 1997 Willamette River Sediment Study* (USACE 1997)
- *Portland Harbor Sediment Investigation Report, Multnomah County, Oregon; Report No. 04000-019-036-AACE* (Weston 1998)

3.4.2 Data Quality Review and Categorization

In accordance with the SOW, existing chemistry data used in this screening were reviewed to establish whether the data fall into the Category 1 or Category 2 data categories used in the *Portland Harbor Programmatic Work Plan* (Integral et al. 2004). The categories were defined as:

- **Category 1.** Category 1 data are of known quality and are considered acceptable for use in decision making for the project. There is sufficient information on these data sets to confidently verify that the data, along with associated data qualifiers, accurately represent chemical concentrations present at the time of sampling.
- **Category 2.** Category 2 data are of generally unknown or suspect quality. The quality assurance and quality control (QA/QC) information shows that data quality is poor or suspect, or essential QA/QC data (e.g., surrogate recoveries, matrix spike/matrix spike duplicates) are either incomplete or lacking.

Project decisions will be based on analyses using Category 1 data that have had an EPA-approved level of data validation. Category 1 data were used in the data screening and initial Project Area identification process.

3.4.3 Analytes Screened and Data Handling Protocols

The following sections summarize the analytes carried through the data screening for each media type, the summing rules for calculated totals, and other data handling procedures.

3.4.3.1 Analytes Screened

Only chemicals on the COC list in Section 3.3 of the SOW were included in this data screening. The project COC list is:

- Benzene, toluene, ethylbenzene, xylenes (BTEX)
- Polycyclic aromatic hydrocarbon (PAHs); naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene), extended to include 2-methylnaphthalene
- Dibenzofuran and carbazole
- Cyanide (including total cyanide in sediment and total, available, and free forms in water samples)
- Zinc
- trichloroethene (TCE)
- cis-DCE
- Trans- 1,2 dichloroethylene (trans-DCE)
- 1,1 dichloroethylene (1,1-DCE)
- Vinyl chloride
- PCBs
- Dichlorodiphenyltrichloroethanes (DDTs)
- dichlorodiphenyldichloroethanes (DDDs)
- dichlorodiphenyldichloroethylenes (DDEs)
- Diesel range hydrocarbons
- Residual range hydrocarbons

- Alpha-, beta- and gamma- benzene hexachlorides (BHCs)
- Endrin Ketone

Table 8 presents the individual analytes that were included in the more general categories listed above (e.g., 4,4-DDT, which is one of the DDTs).

Several of the COCs were screened as both an individual analyte and as part of a calculated total. For example, benzo(a)pyrene was both screened against criteria specific to that individual analyte and included in a calculated result for total PAHs, where sufficient data exists to calculate a total PAH value. Calculated totals followed the summing rules applied to the Portland Harbor Risk Assessment and background data set. The *Draft Portland Harbor RI/FS Remedial Investigation Report* (Integral et al. 2009) describes the general summing rules and rules for including individual analytes in calculated totals, which are summarized below.

3.4.3.2 Summation Rules

The general summation rules for calculated totals are:

- Calculated totals are the sum of all detected concentrations with non-detected results for analytes included in the summation at one-half the detection limit.
- If none of the analytes are detected for a given sample, then the highest detection limit is used as the summation value.

Individual analytes were included in totals following the summing rules outlined in the Attachment F2 of the Draft BHHRA of the *Draft Portland Harbor RI/FS Remedial Investigation Report* (Integral et al. 2009) with the following exception. The Draft BHHRA specifies that an individual analyte determined not to be present in the medium (according to the rules in Section 3.1 of the Attachment), was not included in the sum. For the data set in this AIR, all non-detects were included in summations at one-half the associated detection limit, regardless of whether the analyte was determined to be presence in the medium. Individual analytes included in totals were as follows:

- *Total PCBs:* Sum of PCB Aroclors or PCB congeners. Total PCB Aroclors represent the sum of all reported Aroclors. Total PCB congeners represent the sum of all reported (up to 209) individual congeners. For this data screening, total PCB congeners were selected to represent total PCBs when available. If not available, total PCB Aroclors were selected.

- *PCB TEQs:* Toxic equivalency factors (TEFs) were used to calculate PCB TEQs. Concentrations of congeners were multiplied by their TEFs to estimate toxicity of the congeners relative to 2,3,7,8-TCDD. Resulting concentrations were summed. TEFs are published by the World Health Organization (for fish and birds (Van den Berg et al. 1998) and for mammals (Van den Berg et al. 2006).
- *Total DDx:* Total DDx is calculated from the six DDx compounds: 2,4′-dichloro-diphenyl-dichloroethane (; 4,4′-DDD; 2,4′-dichloro-diphenyl-dichloroethene; 4,4′-DDE; 2,4′-dichloro-diphenyl-trichloroethane; and 4,4′-DDT. Total DDD were calculated with 2,4′-DDD and 4,4′-DDD; total DDE were calculated with 2,4′-DDE and 4,4′-DDE; and total DDT were calculated with 2,4′-DDT and 4,4′-DDT.
- *Total LPAHs:* Total low molecular weight PAHs (LPAHs) are the sum of 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene.
- *Total HPAHs:* Total high molecular weight PAHs (HPAHs) are the sum of fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthene, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene.
- *Total PAHs:* Sum of the individual LPAHs and HPAHs.
- *Total cPAHs:* A benzo(a)pyrene (BAP) equivalent (BaPEq) concentration is calculated by multiplying the cPAHs by their respective potency equivalent factors (PEFs), and summing the resulting concentrations. PAHs classified as carcinogenic are benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, and dibenzo(a,h)anthracene. PEFs were assigned according to EPA (1993) and are shown in Appendix A3 of the *Draft Portland Harbor RI/FS Remedial Investigation Report* (Integral et al. 2009).
- *Total Xylene:* Sum of m,p-xylene, o-xylene, and xylene.

A minimum number of individual analytes for a given sample was required to be analyzed in order to complete the totals. These rules are provided in Table 2-9. Totals with less than the expected number of analytes but above the minimum number of analytes are qualified with an "A." For PCB TEQs, all analytes with TEFs were required in order to calculate a total.

3.4.3.3 Other Data Handling Rules

The following addition data handling rules were applied during the data screening process:

- Non-detects are considered to not exceed any screening level

- The N-qualifier signifies the presumptive evidence of an analyte; for metals, the matrix spike sample recovery is not within control limits, and for organics, the identification is tentative; the analyte exhibits low spectral match parameters but is present.
- The A and T qualifier is applied to all data when applicable. Table 2-9 shows when the A qualifier was added. The T-qualifier is applied when any type of calculation is applied. This includes summing totals, a result that is the average of lab repetitions, or field splits.

4 SCREENING AND INITIAL PROJECT AREA IDENTIFICATION RESULTS

This section presents the results of the data screening and initial Project Area identification process described in Sections 2 and 3.

As discussed in Sections 2 and 3, EPA approved submittal of this Final AIR without revision to the existing data screening and accompanying text describing that the data screening. The data screening results presented in this section and in associated tables, figures, and appendices will be revised following receipt of EPA's comments on the Portland Harbor Site Risk Assessment screening levels and the outcome of the ongoing negotiations between DEQ and NW Natural on the Gasco upland property risk assessment. Other EPA comments from its May 4, 2010, letter have been addressed in the following subsections.

4.1 In-water Media Screening Results

The existing sediment, TZW, groundwater, surface water, and benthic toxicity data used in this data screening is presented in data tables and GIS layers. Appendix D presents the screening summary data tables for each media and categorized depth interval. Note that all elevation data is presented relative to the NAVD88. Concentrations above the associated screening levels (sections 3.1.1 and 3.2.2 [only EPA RSLs]) are highlighted (i.e., color-coded) in the tables. The color of the highlight indicates the number of screening levels that were exceeded for the identified concentration, as defined in the table notes. The color coding scheme was maintained across all screened media to facilitate efficient cross-media exceedance count comparisons. Due to the number of screening levels used, separate data screening summary tables are provided for the human health, ecological, and background screening levels. Appendix D also contains a set of tables that present summary statistics for existing data set by media. These tables present summary statistics such as number of samples, number of samples with a particular chemical detected, and percentage of samples that exceed each screening level for each COC.

As verbally agreed to by EPA (during a phone conversation between Sean Sheldrake, Lance Peterson, and Carl Stivers on January 15, 2010), maps showing the screening level exceedances for each COC for each media within the identified depth intervals are provided in GIS layers in Appendix C in lieu of published maps. The GIS layers can be viewed by downloading ArcReader from http://www.esri.com/software/arcgis/arcreader/download.html. Locations with concentrations above the associated screening levels are highlighted (i.e., color coded) on the maps and can be easily viewed and overlaid for various COCs within each media. Identical

to the summary tables in Appendix D, the color of the highlight indicates the number of screening levels that were exceeded for the identified concentration, as defined in the table notes. The color coding scheme was maintained identical to the Appendix D summary tables to maintain consistency across the table and figure highlights.

Currently, a screening approach to delineate depth of contamination using the March 24, 2010, Focused PRG List (Appendix B) has not been approved for use by EPA. Therefore, the vertical extent of contamination was delineated by screening subsurface sediment data against the PRG-based levels described in Section 3.1.1.3 (i.e.., no revisions were made to the screening approach conducted in the Draft AIR). Two of these screening levels (Small Mouth Bass PRG at a 10^{-4} cancer risk and Adult Tribal Fisher Direct Contact at 10^{-6} cancer risk) were developed using the AOPC rules in EPA's June 23, 2009 letter to LWG. Additional screening levels were developed using the PRGs (from the December 10, 2009 Interim Revised PRG Table) for additional COCs that may cause risk at the same risk level and pathway (benzo(a)anthracene, dibenzo(a,h)anthracene, benzo(b)fluoranthene, cPAH, and indeno(1,2,3-cd)pyrene). Section 3.1.1.2.1 contains additional information on the methodology used to calculate these PRG-based screening levels. All subsurface sediment data within the Area of Interest were screened against these levels and the maximum depth of exceedances is plotted for each core location in Figure 7.

Consistent with the substantial product observations, subsurface sediment hill topping screening level exceedances were identified in generally all of the nearshore locations (from 0 to greater than 12 feet below mudline), some locations in the navigation channel (from 0 to 8 feet below mudline), and in and surrounding the Siltronic Area 1 and Area 2 impact areas (from 0 to 12 feet below mudline; Figure 7. The screening level exceedance results are summarized in Table 12. This table provides the top and bottom elevations showing screening level exceedances, the COCs showing exceedances within that elevation range, and the locations where the bottom elevation of the core shows exceedances.

4.2 In-water Bioassay Results – Screening Against Portland Harbor Site Hit Thresholds

Table 11 summarizes the benthic toxicity tests results for the 18 benthic toxicity test locations in the Area of Interest based on the comparisons with the negative control and the reference

thresholds as discussed in Section 3.1.2. Figure 6 presents the benthic toxicity results for the 18 stations in the Study Area.

In the invertebrate sediment toxicity assessment, 12 toxicity test sampling locations of the 18 locations in the risk dataset are identified as Level 3, having reduced survival or growth based one or more toxicity test endpoint and exceeding the high reference thresholds. No adverse effects are identified at five stations, across all endpoints (i.e., Level 0 and Level 1 in Table 3). One station is categorized as Level 2 by exceeding the low reference thresholds for one or more of the four endpoints but not exceeding the high thresholds.

4.3 Riverbank Soil and Groundwater Screening Against Soil Guidance Levels

As with the in-river media data screening, existing riverbank soil and riverbank groundwater results used in this data screening is presented in data tables and GIS layers. Appendix D presents the screening summary data tables. Note that all elevation data is presented relative to NAVD88. Concentrations above the associated screening levels (identified in sections 3.1.1.4 [for groundwater] and 3.2.2 [for groundwater and soil]) are highlighted (i.e., color-coded) in summary tables (Appendix D) and GIS figures (Appendix C) using the same procedures identified above in Section 4.1 for the in-water media. Appendix D also contains a set of tables that present summary statistics for the existing soil and groundwater data set. These tables present summary statistics such as number of samples, number of samples with a particular chemical detected, and percentage of samples that exceed each screening level for each COC.

These screening results indicate that COC concentrations in upland soils and groundwater along or on top of the riverbank are above associated human health and ecological screening values. In other areas, the borings are offset from the top of riverbank some distance so the COC concentrations in the riverbank should be confirmed given the heterogeneity of chemicals distributions along the shoreline area.

4.4 Substantial Product Extents

To facilitate initial Project Area identification, all core logs and top of riverbank boring logs in the Area of Interest (Figure 1-2) were evaluated to identify the lateral and vertical extents of substantial product. The results of this evaluation are described in the following sections.

The core and boring locations showing observations of substantial product are shown on Figure 4. All stations that do not contain substantial product are shown in gray. Sample stations where substantial product was identified are color coded based on the deepest depth interval (below mudline or ground surface) where substantial product was identified. The elevation in feet NAVD88 of the deepest occurrence of substantial product is shown in parenthesis below each station identifier. There was only a single in-water location (LWM-TCLPC11B) where the core did not penetrate beyond observed substantial product (i.e., substantial product was observed in the bottom of the core). Cores collected in the direct vicinity of this station penetrated beyond the depth of substantial product.

4.4.1 In-water Substantial Product Extents

The in-water lateral and vertical extents of substantial product were identified using the screening process described in Section 3.1.2.1. Figure 4 shows that substantial product is mainly constrained west of the navigation channel except in a single location in the downstream area (i.e., GTC-03) and nine locations (i.e., GTC-07, GS-C7, LWM-TCLPC11C, GP-31, GP-32, LW2-C305-2, LW2-C299,LW2-C521, LW2-C305, and GTC-08) in the upstream area offshore of the Gasco and Siltronic property line. West of the navigation channel substantial product was identified from 0 to 4 feet below mudline surface to 12 to 16 ft below mudline surface. The nearshore area offshore the Gasco and Siltronic property line contained the deepest elevations of substantial product.

In some locations additional cores are proposed in the data gaps investigation to either adequately bound the lateral and vertical extents of the substantial product into the navigation channel and/or facilitate refinement of the design dredge prism (Section 7.1).

4.4.2 Riverbank Substantial Product Extents

The upland top of riverbank and riverbank lateral and vertical extents of substantial product and relationship with toe of slope in-water core locations were evaluated using the process described in Section 3.2.1. Substantial product was not identified in any of the riverbank toe of slope locations along the northern portion of the Gasco property (i.e., GS-01 through GS-05 and RAA-15; Figure 4). There are few borings located along the top of riverbank on this portion of the property; locations further upland from the riverbank are screened for substantial product to provide a line of evidence for the potential presence of substantial product in the riverbank along this portion of the Gasco property. Three of the four upland locations along this northern

segment of shoreline show substantial product. However, given the lack of substantial product in the toe of riverbank borings it is unclear whether this information provides any real indication of the potential for substantial product in the riverbank between these top-of-riverbank and toe of riverbank locations.

The southern portion of the Gasco property shows observations of substantial product along the toe of riverbank in the vicinity of the former drainage feature adjacent to the removal action area (RAA-19 and RAA-20; Figure 4). Substantial product has been visually observed during construction at the downriver, shoreward extent of the dredge cut in this area as well directly west of an oil pipeline support. Top of riverbank borings immediately upland of the removal action (B-54 and B-1) have no substantial product present. Just south of the removal action area several borings near the top of riverbank (i.e., B-29, B-5 and B-2) showed substantial product. GS-07 at the toe of riverbank shows substantial product. However, GS-7 is significantly offset to the south from B-29, B-5, and B-2, and thus, do not provide a direct indication on the likelihood of product in the intervening fill.

Further upstream along the Gasco property line, the toe of riverbank locations (i.e., GS-08 and GS-09) show no substantial product. Top of riverbank borings B-31 and B-56 in this same area did show observations of substantial product but a number of other borings in the direct vicinity did not. Again, the sporadic presence of substantial product in this area makes it difficult to extrapolate to conditions of the intervening riverbank fill.

A single riverbank location (i.e., GS-10) along the northern portion of the Siltronic property shows substantial product and two locations further south (i.e., GS-11 and GS-12) showed no observations of substantial product. One of three borings along the top of riverbank in the vicinity of GS-10 showed substantial product but the elevations of substantial product were much different between the two locations. No upland borings were collected in the direct vicinity of GS-11. Two top of riverbank borings in the vicinity of GS-12 show substantial product but the lack of substantial product at GS-12 again makes it difficult to extrapolate to conditions of the intervening riverbank fill.

The Area of Interest extends further south of GS-12 along the Siltronic riverbank but there was no toe of riverbank boring in this area. There is a single boring (i.e., P-5) somewhat shoreward of the top of riverbank in this area that contained substantial product. This limited information

provides little indication of the condition of the riverbank proper given the heterogeneity of substantial product observations presented above.

4.5 Identification of Initial Project Area

The initial Project Area is identified based on the observations of the substantial presence of product, the application of the March 24, 2010, Focused PRG list (Appendix B) identified in Section 3.1.3.2, and the interpretation of these rules to address offsite sources of COCs to sediments in the vicinity of the Area of Interest as discussed in this section. The lateral extents of each of these key lines of evidence is overlaid on Figure 5 (provided as a layered PDF), and the initial Project Area drawn to generally encompass the largest footprint for these lines of evidences except as modified below.

The overlaid lines-of-evidence map has been evaluated for contamination that may not be related to historical Gasco and Siltronic property operations. Such an evaluation is generally consistent with the upstream and downstream extents of the potential remediation area depicted in Figure 1 of the SOW.

Looking in the upstream direction, a relatively large contiguous area of PCB contamination exists extending from well upstream of and down into the immediate vicinity of the Gasco and Siltronic property shorelines. Given that historic PCB discharges are not associated with Gasco and Siltronic operations, the upstream boundary of the initial Project Area is not extended significantly upstream of Figure 1 of the SOW on the basis of exceedance of PCB PRGs. In addition, there are exceedances of the Tribal direct contact and the clam consumption benzo(a)pyrene sediment PRGs upstream of the Area of Interest shown in Figure 5.

In this case, however, there is a break in the concentration gradient at the location indicated on Figure 5 by the proposed upstream boundary of the initial Project Area. This concentration gradient break indicates at least one other PAH source upstream of the SOW Figure 1 area of interest. One potential source for these upstream PAHs may be Outfall 22-C, which serves portions of the Gasco and Siltronic properties. However, the drainage area to this outfall is considerably larger than just Gasco and Siltronic and a potentially complex set of sources may exist here. Further, the concentrations of PAHs in front of this outfall are similar to those seen in front of other City of Portland outfalls in the wider Portland Harbor area. Consequently, consistent with the SOW Figure 1, this more complex upstream source situation should be left to the Portland Harbor Site process.

Similarly, looking downstream, areas exceeding the Tribal fisher direct contact and the clam consumption benzo(a)pyrene PRGs and the PCB background sediment PRGs are located downstream of the U.S. Moorings dock (Figure 5). The initial Project Area should not be extended further downstream due to the PCB background PRG exceedances, given that the Gasco and Siltronic sites are not sources of PCBs and because this background PRG is exceeded over wide areas of the Portland Harbor Site. The initial Project Area should also not be extended further downstream due to the many other shoreline sites with potential PAH sources and other chemical impacts to sediments.

Offshore of the initial Project Area, a large area exceeds the Fish Dietary Assessment - Small Mouth Bass and Fish Dietary Assessment – Sculpin tributyltin (TBT) PRGs. Given that historic TBT discharges are not associated with Gasco and Siltronic operations, the off-shore boundary of the initial Project Area is not extended to encompass areas showing exceedances of the TBT PRG.

LWG and EPA have agreed to identify benthic risk using a multiple lines of evidence approach that emphasizes bioassay results as the primary and most important line of evidence. Exceedances of the March 24, 2010, Focused PRGs (Appendix B) for benthic risk (benthic SQGs) were generally used to identify the initial Project Area for this AIR. NW Natural and Siltronic are currently using this initial Project Area, which generally encompasses larger, broader SQG map areas in the navigation channel; however, the Project Area will be revised accordingly when the additional lines of evidence are selected and existing data in affected areas are evaluated against those lines. Additional data gap sampling may be warranted if it is determined that collection of additional data for selected lines of evidence will assist remedial alternative selection in the EE/CA or design process. Examples of potential future data collection for this purpose are additional bioassays and surface chemistry data in certain areas to verify the presence or absence of benthic risk.

The full extent of the riverbank area encompassed by the upstream and downstream extents of the in-water initial Project Area is retained as the riverbank initial Project Area. As noted in Section 3.2, given the heterogeneous nature of the riverbank area and the relatively sparse data, the existing riverbank data set is not sufficient to exclude any part of this area from consideration. This area should be considered the "area of study" at this time (rather than an area of likely remediation). This data gap is discussed further in Section 6.1.2.

5 ENGINEERING DESIGN EXISTING DATA REVIEW

As described in Section 3.4.2 of the SOW, in addition to defining the initial Project Area, this AIR reviews existing design-related information to determine data gaps necessary to conduct the EE/CA and design for a final remedy in the Project Area. A summary of this existing data review is presented in the following sections.

5.1 TCLP Testing

The toxic characteristic leaching potential (TCLP) is a standardized simple leaching procedure that is promulgated by federal regulation (40 CFR §261.24) and is designed to approximately simulate contaminant mobility in landfill conditions. Section 3.6.3.1 of the SOW describes a detailed procedure whereby removed sediments and soils must be tested both prior to and during construction for TCLP to determine their potential disposal location. To support waste disposal suitability evaluations for sediments adjacent to the Gasco property, TCLP testing has been conducted by the LWG as part of the Portland Harbor Site RI and by NW Natural during the Early Action removal action design characterization in 2005 and subsequently in 2009. These data are reviewed in the following subsections.

5.1.1 LWG TCLP Testing

The LWG has used the EPA screening calculation to assess the locations for TCLP testing within the Portland Harbor Site to support the FS evaluations. The calculation assumes that the entire bulk sediment concentration would leach into the test water during the TCLP test and is performed by dividing the sediment concentration by a factor of 20 to obtain the theoretical maximum leachable concentration in milligrams per liter (mg/L). If the calculated water concentrations are below the TCLP criteria, an exceedance during an actual TCLP test is impossible. The screening calculation was performed using the maximum sediment chemical concentrations identified throughout the Portland Harbor Site to determine where calculated water concentrations has been greater than the TCLP regulatory criteria. The results of the initial screening calculation have been further screened at five times the TCLP criteria level. The five times level was selected as a reasonable conservative measure of sediments that have a realistic potential to leach contaminants at concentrations greater than the TCLP limits in an actual TCLP test.

The calculated water concentrations for sediments adjacent to the Gasco property exceeded the TCLP regulatory criteria by a factor of 5 at several locations. TCLP samples have been collected at three locations (i.e., LWM-TCLPC11A, LWM-TCLPC11B, and LWM-TCLPC11D) showing the highest concentrations to maximize the chances of identifying potential hazardous waste level sediments. The locations are shown on Figure 8.

At each station a single core was collected via vibracoring methods and the full length of the core was composited using equal volumes from each linear foot. Samples from this homogenized volume were submitted for TCLP testing as well as bulk sediment chemical analyses. A single bulk sediment sample from each location was analyzed for metals, semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), pesticides and herbicides. The TCLP results for the three locations are provided in Table 13 and are compared to the Maximum Concentration of Contaminants for the Toxicity Characteristics (per 40 CFR §261.24 Table 1). There were no detections of TCLP chemicals at LWM-TCLPC11A; detections of barium (400 micrograms per liter [μg/L]), methylphenol (53 μg/L), phenol (21 μg/L), and benzene (2,900 μg/L) at LWM-TCLPC11B; and, detections of barium (290 μg/L) and benzene (13 μg/L) at LWM-TCLPC11C. Of the detected concentrations, only the 2,900 μg/L detection of benzene at LWM-TCLPC11B was greater than the Maximum Concentration of Contaminants for the Toxicity Characteristics (500 μg/L).

5.1.2 NW Natural TCLP Testing

NW Natural conducted TCLP testing in 2005 to support waste suitability determinations for the tar body removal action. The removal action design characterization involved the collection of a single core via geoprobe methods from a number of locations within the removal action area. As directed by EPA, two samples of the tar body (RAA-11 and RA-13) and two samples of visually contaminated sediments (RAA-03 and RAA-11) were analyzed by TCLP to profile the material for disposal. The results are presented in Table 14. The area where these samples resided was removed during the Early Action so the results can no longer be directly applied to these locations. However, similar types of material may still exist within the Project Area so the results are presented herein to provide supplemental information for design planning purposes.

The results showed no exceedances of the Maximum Concentration of Contaminants for the Toxicity Characteristics criterion (40 CFR §261.24 Table 1) for the visually contaminated material but the two tar body samples had benzene results greater than this criterion (500 μg/L).

NW Natural performed additional coring at select locations in early 2009 to support determination of areas that may exceed the TCLP Maximum Concentration of Contaminants for the Toxicity Characteristics criterion (40 CFR §261.24 Table 1). Based on a review of the aerial extents and depth of identified contamination including product, 10 cores were collected (Figure 8; GTC-01 through GTC-10 locations). Core penetration at each of these locations targeted the full depth of contamination that would be evaluated for removal during a future remedy.

Core processing included splitting the cores and sampling one half for TCLP analysis and the other half for bulk sediment chemistry analysis. The sampling depths at each location was determined based on previously identified depths of contamination in the vicinity of each core location as well as field observations of stratigraphy and/or signs of visual contamination and substantial product (e.g., sheen, DNAPL, oil, strong chemical odors). Samples were preferentially collected from each core showing the highest potential for chemical mobility (e.g., saturated, heavy sheen, visible oil) to characterize those sediments with the greatest potential for exceeding the Maximum Concentration of Contaminants for the Toxicity Characteristics criterion (40 CFR §261.24 Table 1). Following splitting and determination of the sampling depth, representative un-homogenized samples were sampled for VOCs. The remainder of the bulk sediment chemistry analytes were sampled from the same depth of the core and homogenized to form a composite sample for analysis of the remainder of the proposed analytes described below. The same full length of sediment sampled for bulk chemistry from the remaining core section was composited and submitted for TCLP analyses.

The TCLP analytical results are provided in Table 15 and the bulk sediment results are provided in Appendix D. None of the concentrations exceed the Maximum Concentration of Contaminants for the Toxicity Characteristics criterion (40 CFR §261.24 Table 1). Although planned as a contingency, no bench scale treatability amendment tests have been completed on the TCLP samples, because no criteria were exceeded.

5.2 Dredging Elutriate Testing

To provide information for a detailed removal water quality analysis two samples were collected during the tar body removal action from both the surface tar body (stations RAA-11 and RAA-13) and visibly contaminated zones (stations RAA-03 and RAA-11) within the removal action area and analyzed using the USACE Dredging Elutriate Test (DRET) method (DiGiano et al. 1995). The elutriate water samples obtained from the DRET procedures were

analyzed for SVOCs, VOCs, total petroleum hydrocarbons (TPH), total and amenable cyanide, and total and dissolved arsenic, chromium, copper, nickel, lead and zinc. The DRET method is intended as bench scale simulation of conditions that might be present in the water column very close to the dredge (within a few feet). This information was used to evaluate potential water quality impacts associated with dredging. The area where these samples resided was removed during the Early Action so the results can no longer be directly applied to these locations. However, similar types of material may still exist within the Project Area so the results are presented herein to provide supplemental information for design planning purposes.

The results of the DRET are summarized in Table 16 and compared against appropriate water quality guidelines that are discussed further in Section 3.6.1 of the *Removal Action Project Plan* (Anchor 2005b). Several PAH and BTEX compounds were detected in both the tar body and visually contaminated sediment elutriate waters. It was also noted during elutriate testing of tar samples that a light sheen was visible at the surface of the test vessel after the elutriate procedure was conducted. This sheen was light and did not have a measurable thickness of non-aqueous phase liquid. No such sheen was observed in DRET analyses for visually contaminated sediments. The presence of detected chemicals in the elutriate test water is consistent with the presence of a visible sheen in the tar DRET tests. The estimates of potential water concentrations during dredging conducted using these DRET results predicted lower concentrations than generally observed during actual construction. There are likely many reasons for this, including: the sediment cores used may not have sampled pockets of liquid product present within the tar and/or that the generalized water quality modeling using DRET did not accurately mimic the relatively atypical construction conditions.

5.3 SBLT Testing

The sequential batch leachate test (SBLT) is a tool to help estimate groundwater leachate concentrations and characteristics from confined disposal facilities (CDFs) and is typically recommended for use on freshwater sediments. The SBLT relies less closely on disposal Site specific conditions and can establish a general desorption isotherm that is potentially applicable in a wide range of situations, including a variety of confined disposal options, as well as in-situ capping of sediments. The LWG conducted SBLT on four locations (i.e., LWM-C11-A, LWM-C11-B, LWM-C11-C, and LWM-C11-D) adjacent to the Gasco property and northern portion of the Siltronic property. The SBLT was completed in accordance with the procedure developed by the USACE Waterways Experiment Station, as described in Appendix D of the *Upland Testing Manual* (USACE 2003).

The SBLT results are summarized in Table 15. There are no screening levels available to directly screen the data so no screening was conducted.

5.4 Disposal Treatment Bench Scale Free Liquid and Bearing Capacity Testing

During the Early Action design characterization sampling described in the *NW Natural "Gasco" Site Removal Action Work Plan* (Anchor 2004), bench scale treatment testing was conducted with representative samples of surface tar/sediments to estimate the amount of drying reagent that would need to be mixed into the material to pass paint filter test and a bearing capacity of 1 ton per square foot (tsf), which are two requirements for disposal at a Subtitle C disposal facility. The results of this test are shown in Appendix D. In summary, approximately 5 percent (by weight) Portland cement met the 1 tsf requirement in one day of curing time. Greater than 5 percent cement may be needed to pass the paint filter test in the same one day curing time and/or a greater curing time may be needed. Actual construction observations indicated that 5 percent was too low to remove all free liquid, likely due to inability to completely mix the reagent into a barge load of sediments. Consequently, on average approximately 10 percent of Portland cement was used during actual construction.

6 DATA GAPS IDENTIFICATION

There remain several data gaps related to the identification of the Project Area and design-related information necessary to conduct the EE/CA and conduct the design. The following subsections describe these data gaps.

6.1 Project Area Identification Data Gaps

6.1.1 Sediment Horizontal and Vertical Extents

Two sediment data gaps exist regarding the identification of the horizontal and vertical extents of the Project Area: 1) benthic toxicity and surficial sediment chemistry data to refine the extent of benthic risk and 2) product observations to refine the horizontal and vertical extents of substantial product.

Bioassay test results will be used as a line of evidence to corroborate the assessment of benthic risk in the Project Area; however, bioassay data is not available for surface sediment within the navigation channel and at portions of the upstream and downstream extents of the initial Project Area. Additional sediment toxicity data and surficial sediment chemistry data is needed to assess benthic risk in these areas. Consistent with the Portland Harbor Site process, it is generally agreed that actual bioassay tests should be considered a more accurate indication of site-specific benthic toxicity as compared to sediment quality guidelines derived from site models or "off the shelf" sediment quality guidelines. Consequently, actual bioassay data is preferred to fill this data gap in most cases, and sediment chemistry will be relied on as corroborating information on benthic toxicity or to fill gaps between bioassay stations.

The lateral extents of substantial product have not been sufficiently characterized in some areas to bound the observations of substantial product in the initial Project Area. As shown in Figure 5, the channel ward extents of substantial products is currently unbounded in several locations (e.g., GTC-03, LW2-C276, and GTC-08) and bounded in other areas by core locations that are a relatively large distance apart (e.g., LW2-C270, GTC-07 and GS-C7). The downstream portions of the initial Project Area also contain cores showing substantial product that are unbounded in the upstream (i.e., LW2-C263 and LWM-C11-A). Additional product observations are needed in these areas to refine the horizontal and vertical extent of substantial product.

Further, there is currently no information regarding substantial product in the near shore area between riverbank borings GS-03 and GS-04 (Figure 4). In addition, substantial product was not observed in the toe of riverbank cores GS-08 and GS-09 (Figure 3-1) which are in the vicinity of the former effluent pond discharge and surrounded by a number of adjacent channel ward cores that show substantial product. Additional product observations are needed in these areas to refine the horizontal and vertical extent of substantial product.

6.1.2 Riverbank Soil Areal Extents

As noted in Section 4.5, the entire riverbank area located within the Area of Interest (Figure 2) has been retained as part of the initial Project Area (i.e., the needed area of study) because the existing data set is insufficient to further refine this area. Data gaps remain regarding the identification of the horizontal and vertical extents of substantial product along the riverbank as well as the subsurface soil chemistry in this area.

As reviewed in Section 4.4.2, the information along the top and toe of the riverbank slope are highly varied and often contradictory along the same segment of shoreline with regards to the potential for substantial product to be present in the intervening riverbank slope area. Consequently, there is generally insufficient data along the slope of the riverbank to adequately evaluate the potential presence of product and chemical screening level exceedances in the riverbank. In addition, in some areas there are limited borings that are truly located at the very top of the riverbank slope (i.e., existing borings are offset some distance landward of this slope). In general, additional data are needed along the riverbank throughout the initial Project Area. Specific areas of observed data gaps are discussed in this section.

Given the existing lack of data and noted heterogeneity, additional data is needed along the slope of the riverbank and top of the riverbank on transects adjacent to the toe of riverbank slope GS-01 through GS-12 borings to facilitate direct comparison of in-water and riverbank substantial product elevations and chemical exceedances. The following rationale was used to guide the data gaps identification process for the riverbank area:

1. In areas where the toe of riverbank boring contains substantial product, middle-of-riverbank soil data is needed to determine if the substantial product extends from the sediments into the riverbank. Should this data indicate the presence of substantial product, top of riverbank data is needed to further determine if the substantial product

extends into the uplands through the riverbank. If substantial product is not identified in the middle of the riverbank, top-of-riverbank information is not needed.

2. In areas where the toe of riverbank boring does not contain substantial product, top-of-riverbank soil data is needed to determine if substantial product is potentially extending from the uplands (outside the Project Area per the riverbank definition in the SOW) into the riverbank (potentially part of the Project Area). Should this data indicate the presence of substantial product, middle-of-riverbank data will be needed to determine if the substantial product extends through the riverbank. If substantial product is not identified in the top of the riverbank, middle-of-riverbank information is not needed.

The riverbank data gaps identification process also takes into account areas where existing data along the middle of the riverbank and the top of the riverbank landward of the toe of riverbank slope borings provide sufficient information to fill identified presence of substantial product and chemistry data gaps. The rationale also takes into account historical site uses and potential source areas where substantial product and/or chemical screening level exceedances have a higher probability of occurring. Application of this rationale along the full length of riverbank shoreline in the initial Project Area is detailed in this section.

The northern portion of the shoreline extending from GS-01 through GS-05 contains no substantial product at the toe of the riverbank slope. In addition, there are no existing top-of-riverbank borings along this portion of the riverbank. Top-of-riverbank data is needed landward GS-01 through GS-05. Middle-of-riverbank data will be needed if substantial product is identified in the top of riverbank.

In the riverbank area in the vicinity of the tar body removal action area, design characterization prior to the removal includes the collection of riverbank slope borings at location RAA-19 and RAA-20 where substantial product was observed. Top-of-riverbank data is needed in this area to determine if this substantial product extends to the uplands. Just south of the removal action area, substantial product was identified at GS-07. Substantial product has also been identified in top-of-riverbank boring, so middle-of-riverbank slope data is needed in this area, but top-of-riverbank data is not.

Further upstream along the Gasco property line, the toe of riverbank locations (i.e., GS-08 and GS-09) show no substantial product. Top-of-riverbank borings B-31 and B-56 upslope of GS-08

does show observations of substantial product. Therefore, middle-of-riverbank slope data is needed in this location but top-of-riverbank data is not. A number of borings along the top of the riverbank upslope of GS-09 contained no substantial product. However, given that this area served as an effluent pond discharge point at one time, additional top-of-riverbank data and slope of riverbank data (in the event that product is found in the top of the riverbank) is needed to confirm the lack of substantial product in the riverbank.

A single toe of riverbank location (i.e., GS-10) along the northern portion of the Siltronic property shows substantial product and two locations further south (i.e., GS-11 and GS-12) showed no observations of substantial product. One of three borings along the top of bank in the vicinity of GS-10 also shows substantial product. Therefore, only middle-of-riverbank data is needed in this location. No upland borings were collected in the direct vicinity of GS-11 so additional top-of-riverbank data is needed in this location, and middle-of-riverbank slope data if product is identified at the top of the riverbank. Two top-of-bank borings in the vicinity of GS-12 show substantial product but there was no substantial product in GS-12. Therefore, middle-of-riverbank slope data is needed but additional top-of-riverbank data is not.

Given the lack of toe of riverbank borings south of GS-12 along the Siltronic property and the distance to the upstream extents of the initial Project Area, additional data is needed in this portion of the riverbank along two transects approximately the same lateral separation as between GS-10, GS-11 and GS-12 (roughly 200 feet). Top-of-riverbank data is needed in the area of the first upriver transect. Middle-of-riverbank slope data would also be needed should product be identified. The most upriver transect would be shoreward of the existing top-of-riverbank boring P-5. This boring shows substantial product, so middle-of-riverbank slope data is needed in this area.

Additional data is also needed to characterize the bulk soil chemistry in the riverbank to support an evaluation of the need to control sources of contaminants from the riverbank to the Willamette River from leaching of chemicals due to shallow groundwater movement through the riverbank and/or stormwater infiltration and discharge through riverbank soils (Section 2.2). As noted in Section 3.3.1.4, limited bulk soil chemistry data is available in the riverbank area defined in the SOW. In addition, upland soil borings installed near the riverbank were not analyzed for the full COC list because some chemicals (e.g., PCBs) are not related to historical upland activities. Additional data is needed within the riverbank area across the initial Project

Area to assess this area against the criterion 3 and 4 to be used to determine the need for and areas of riverbank remedy and source controls.

6.2 EE/CA and Design Data Gaps

The following sections identify additional data gaps sampling necessary to support evaluation of remedial alternatives and completion of the EE/CA and design.

6.2.1 Waste Characterization Testing

Waste characterization testing is needed for the EE/CA and design to make an initial determination as to whether (per Section 3.6.3.1 of the SOW) material removed from the Project Area for off-site disposal would need to be transported and disposed of as a RCRA hazardous waste, "Special Waste," or "Cleanup Material." The characteristics of Special Wastes and Cleanup Material, as defined for this project, and the disposal requirements for material meeting these definitions are presented in Section 3.6.3.1 of the SOW.

As described in Section 5.1, both the LWG and NW Natural have conducted waste characterization testing (i.e., TCLP tests) on sediment collected from the initial Project Area. Additional data is needed within the initial Project Area where TCLP samples have not been collected (Figure 8). Additional TCLP data is also warranted in some near shore areas of the initial Project Area as well as within Area 1 and Area 2 (Figure 1-2) to provide additional spatial resolution. Data is also needed to confirm the absence of other properties that would cause the material to be transported and disposed of as a RCRA hazardous waste (e.g., ignitability, corrosivity).

Section 3.6.3.1 of the SOW also presents a testing process intended to determine the designation of dredged material management units (DMMUs) as RCRA hazardous waste, Special Waste, or Cleanup Material. Currently, there is insufficient information to delineate DMMUs within the Project Area. Thus, the current data need is to fill in existing spatial gaps in waste characterization data across the initial Project Area to further delineate the disposal suitability across a range of representative sediment conditions. Note that this new data combined with the 15 TCLP cores already collected in the initial Project Area (described in Section 5.1) is expected to provide a sufficient density to make an initial determination of the designation of DMMU material, once DMMUs are delineated. Per Section 3.6.3.1 of the SOW, it is recognized that additional waste characterization will be needed during construction.

To date, riverbank material has not been submitted for TCLP or other waste characterization testing. Waste characterization information is necessary to make a preliminary determination of the designation of riverbank material.

6.2.2 DRET Testing

DRET data is needed for the EE/CA and design to understand point of impact water quality conditions during removal activities. As described in Section 5.2, DRET tests were conducted on sediment within the tar body removal area. Observations and measurements of water quality during the tar body removal action provide additional information related to potential water quality impacts during further removal activities. Additional DRET data is needed to understand potential impacts to water quality across the range of potential sediment chemical and physical conditions throughout portions of the Project Area that may require dredging. These areas include the navigational channel, Area 1 and Area 2 (shown on Figure 1-2), and in near shore areas.

6.2.3 SBLT Testing

SBLT data is needed for the EE/CA and design to make an initial determination of the suitability of sediment in the Project Area for in-water disposal (e.g., in a confined disposal facility [CDF]). SBLT data may also indicate the potential for short-term water quality impacts related to cap placement. As described in Section 5-3, SBLT data is available for four near shore locations within the initial Project Area. The ranges of chemical concentrations and presence of product within the initial Project Area varies widely. For example, it is very likely that leaching rates and conditions are very different in the Willamette River channel and upstream and downstream ends of the site as compared to conditions in the areas of substantial product where the existing SBLT cores were collected. Further SBLT testing will allow this range of conditions to be further evaluated to determine whether certain types of sediments within the initial Project Area can meet CDF suitability criteria. Areas that require further differentiation include the navigational channel, Area 1 and Area 2 (shown on Figure 1-2), and in some near shore areas.

6.2.4 Sediment and Riverbank Geotechnical Testing

Sediment geotechnical testing is necessary for design of the dredge plan, disposal plan, and cap design.

Riverbank geotechnical testing is necessary for design of temporary dredge cuts into the shoreline as well as the future long-term shoreline grades. This geotechnical information will be used with the additional chemical testing along the top of the riverbank and along the slope of the riverbank to design cut slopes. Portions of the slope may need to be removed before or concurrent with dredging along the shoreline to prevent erosion of riverbank soils at the shoreline dredge cut. Additional soil may need to be removed to ensure long-term slope stability. Geotechnical data will be used to inform the disposal plan for riverbank soils in addition to the design of the future slope configuration. In addition, geotechnical data will be used to design potential capping and armoring components of the future shoreline as well as in situ caps constructed offshore.

6.2.5 Transition Zone Water Quality-Specific Remedial Technologies Studies

Groundwater and TZW data related to MGP chemicals under the river is extensive and provides a comprehensive depiction of the nature and extent of chemical plumes related to MGP chemicals. No data gaps in TZW and groundwater exist for MGP chemicals. The ongoing Segment 2 Capture Zone test will provide additional information on the expected reductions in the rate of groundwater seepage through the sediments provided by the upland groundwater source controls currently under design. This test will provide critical information to determine the types and areas of sediments that can be capped either with or without pre-dredging.

Data gaps may exist related to the nature and extent and potential for recontamination from CVOCs sourced in the uplands, due to the ongoing natural attenuation of TCE and its degradation products. As demonstrated during the upland RI of the Siltronic property (MFA 2007), concentrations of TCE and its degradation products in groundwater have been steadily attenuated over time due to the combination of physical processes(e.g., dispersion) and biochemical degradation (i.e., sequential dechlorination) by bacteria native to the Project Area. The periodic monitoring data collected from the upland groundwater plume for the RI indicated that degradation rates for TCE and its degradation products were consistent with literature values, with rates increasing as the plume is dynamically degraded (MFA 2007).

The results of the 2004 and 2005 in-river investigation of groundwater and TZW confirmed that natural attenuation of TCE and its degradation products is also occurring in the alluvial water bearing zone (AWBZ) under the river. Data from these events were used to define the nature and extent of in-river impacts, and confirmed that degradation products cis-1,2-DCE and vinyl chloride were present in TZW in Area 1. Groundwater discharging through the TZW to the

Willamette River at Area 1 could therefore recontaminate the Project Area or remedial components (e.g., cap material). The attenuation processes identified above, however, are likely to have reduced the cis-1,2-DCE and vinyl chloride concentrations and the extent of Area 1.

Based upon the degradation rates (i.e., bulk half-lives) derived from the upland data, the maximum Area 1 TZW concentration of CVOCs (GP-65; collected May 19, 2005, with cis-1,2-DCE = 14,400 μg/L) could have since been reduced to the method reporting limit (0.2 μg/L) by approximately mid-September 2008. The maximum concentration of TCE or its degradation products in shallow groundwater that may discharge to Area 1 (GP-65, 3 feet below mud line; collected 5/19/05, with cis-1,2-DCE = 19,200 μg/L) could have since been reduced to the method reporting limit (0.2 μg/L by approximately October 2008. The maximum concentration of TCE or its degradation products in deep groundwater, which is not likely to discharge to Area 1 (GP-30, 50 feet below mud line; collected 10/25/2004, with cis-1,2-DCE = 16,600 μg/L), could have since been reduced to the method reporting limit (0.2 μg/L) by approximately early March 2008. These calculations suggest that CVOCs may no longer be present at significant concentrations in Area 1 TZW or deep groundwater, in contrast with the characterization presented in the Work Plan.

It is acknowledged that significant uncertainty remains regarding the extent to which the upland attenuation rates are applicable to in-river groundwater and TZW. TZW samples will be collected where CVOC concentrations were elevated in 2004 and 2005 to verify in-river degradation rates. TZW samples will also be collected to characterize the current nature and extent of Area 1 .

7 SUMMARY OF PROPOSED DATA GAP INVESTIGATIONS

This section presents the investigations proposed to address the Project Area identification, EE/CA, and design data gaps identified in Section 6. This data gaps sampling and analysis program includes sediment quality investigation, riverbank soil quality investigation, waste characterization, physical testing, and TZW investigation in Area 1.

This section is intended to summarize the main elements of these investigations. Additional detail is contained in the Data Gaps QAPP (Appendix A) and the FSP (Attachment A to the QAPP). The Data Gaps QAPP describes the data quality objectives and QA/QC protocols. The FSP details the sampling equipment, methodologies, and analytical methods to be used during program implementation. Tables 1-1, 1-2, 1-3, and 1-14 of the FSP to the list the analytical parameters for each element of the sampling program and the proposed sample locations are shown on Figure 1-2 of the FSP.

Although the intent of the data gaps investigation is to collect all data needed to complete the design, once the preferred alternative(s) is selected via the EE/CA, there may be a need for additional specific data collection to support design work.

7.1 Surface and Subsurface Sediment Quality

As described above in Section 6.1.1, additional surface and subsurface sediment quality data is needed to refine the extent of benthic risk and horizontal and vertical extents of substantial product. The following investigation activities are proposed to address the sediment data gaps.

1. Collection of 20 surface sediment grab samples and analysis for bulk chemistry and benthic toxicity (using two sediment toxicity tests: the 10-day survival and growth test using the midge *Chironomus dilutus* (formerly *C. tentans)* and the 28-day survival and growth test using the amphipod *Hyalella azteca)*.
2. Collection of up to 27 sediment cores for inspection for presence of substantial product. In addition, samples of surficial and subsurface sediments will be collected from 18 of these cores and submitted for laboratory analysis for bulk chemistry.

To further refine the extent of benthic risk, surface sediment grab samples for benthic toxicity testing are proposed at a single location in the nearshore area just upstream of the U.S. Moorings dock, along two transects within the navigation channel, and at three locations on a

transect on the upstream portion of the initial Project Area. A single location is also proposed in Area 1 and Area 2.

Sediment core locations are proposed in areas to attempt to further refine or define the channel ward upstream and downstream extents of substantial product within the initial Project Area. Contingency cores are proposed in a number of secondary locations to attempt to further delineate the lateral extents of substantial product beyond product identified in the proposed sediment cores.

Figure 2 of the FSP shows the locations proposed for these sediment grab samples and sample cores.

7.2 Riverbank Quality

As described in Section 6.1.2, the additional riverbank data is needed to refine the Project Area. The following investigation is proposed to address this data gap:

- Collection of soil borings from 14 locations (top of riverbank, slope of riverbank, or both locations based on field conditions) for inspection for presence of substantial product. An additional eight contingent boring locations are proposed based on substantial product observations in the initial borings.
- Bulk chemistry analysis on samples collected from each boring in the upper 5 feet and lower 5 feet of the target penetration depths.

Top of riverbank boring depths are based on target elevations that exceed the depths of substantial product observed, if any, in both in-water and middle-of-riverbank 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.

Middle-of-riverbank 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 proposed borings are located in the data gap areas identified in Section 6.1.2. Figure 2 of the FSP shows the locations proposed for these soil borings.

7.3 Waste Characterization Testing

Section 6.2.1 identifies the EE/CA and design data gaps associated with an initial determination whether material that may be removed from the Project Area for off-site disposal would be transported and disposed of as a RCRA hazardous waste, Special Waste, or as Cleanup Material (as defined in Section 3.6.3.1 of the SOW). These data gaps are:

- Waste characterization data in areas of the navigation channel and riverbank within the initial Project Area where TCLP samples have not been collected.
- Waste characterization data in the landward portion of the initial Project Area to confirm the absence of properties that would cause the material to be transported and disposed of as a RCRA hazardous waste.
- Waste characterization in Area 1 and Area 2

To address this data gap, samples from six sediment cores and three soil borings will be submitted for TCLP testing and for analysis for the characteristics of ignitability and corrosivity (there is currently no EPA-approved method 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. Note that the results for bulk chemistry testing described under Sections 7.1 and 7.2 will be used to confirm the presence or absence of F002 waste once DEQ-approved RBCs for incidental ingestion, dermal contact and inhalation by landfill workers are available (Section 3.6.3.1 of the SOW). Remaining sample volume following sampling for waste characterization and chemical and physical analysis will be archived for potential future use for treatability testing (Section 7.6).

The locations of the in-water TCLP locations are shown on Figure 2 of the FSP and the riverbank locations will be determined in the field based on visual observations during boring collection.

Due to 14-day holding time limitation for VOC testing in the leachate, a separate sample volume will be collected for VOC analysis and submitted to the laboratory for expedited analysis. The results will be reviewed within this hold time to determine if TCLP criterion

exceedances are identified and whether bench scale treatability tests (Section 7.6) will be run to attempt to reduce the leachate concentrations below the criterion.

7.4 DRET Testing

Section 6.2.2 identifies the EE/CA and design data gaps associated with the point of impact water quality conditions during removal activities. Additional DRET data is needed for material in the Project Area, including in navigational channel, Area 1 and Area 2 (shown on Figure 1-2), and in near shore areas.

To address this data gap, DRET tests will be performed using samples from eight locations showing a range of conditions likely to be encountered during potential future dredging. Three of the proposed locations are within the navigation channel along the northern/central portion of the initial Project Area to provide data in the channel area outside of zones of known contamination (i.e., Area 1 and 2). One location is proposed within Area 1 and one location is proposed within Area 2. Three additional locations are proposed in the nearshore area in the general vicinity of the Gasco and Siltronic property lines in areas showing substantial product. 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. If TCLP testing is conducted at the same core location, the TCLP and DRET tests will be run using material from the same depth intervals.

Figure 2 of the FSP shows the sediment core locations proposed for DRET testing.

7.5 SBLT Testing

Section 6.2.3 identifies the EE/CA and design data gaps associated with SBLT data. This includes SBLT data in navigational channel, Area 1 and Area 2 (shown on Figure 1-2), and in some near shore areas.

To address this data gap, approximately five SBLT tests will be performed using sediment and soil from a variety of locations from the initial Project Area showing a representative range of chemical and physical characteristics 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).

At this time it is assumed that information on the Port of Portland Terminal 4 placement criteria are the best available estimate of placement criteria that may exist in the future for CDFs in general. If these criteria are refined or revised, additional testing may be needed for the design. Sediment treatment will be conducted in consultation with EPA, and may include the addition of amendments, such as organoclay or related adsorptive material.

7.6 Disposal Suitability Bench Scale Treatment Testing

Bench scale treatment testing to evaluate the potential to reduce chemical leaching may be conducted on a subset of the samples submitted for TCLP tests described in Section 6.2.1 if the leachate concentrations are above the maximum concentrations identified in 40 CFR §261.24 Table 1. As discussed in Section 7.3, due to 14-day holding time limitation for TCLP VOC testing, 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 bench scale treatability tests (Section 7.6) will be run to attempt to reduce the leachate concentrations below the criterion.

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 (Section 5.4), 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. The TCLP testing will be conducted separately on the resulting non-volatile and volatile sediment-admixture sample using the same procedures as the original samples to facilitate direct comparison of results between the non-amended and amended materials. The TCLP VOC tests will be conducted within the 14-day holding time limitation.

Similar testing may be conducted on a subset of SBLT samples if the material fails qualitative or quantitative placement criteria expected for Portland Harbor CDFs. (At this time it is assumed that information on T4 placement criteria are the best available estimate of placement criteria that may exist in the future for CDFs in general. If these criteria are refined or revised, additional testing may be needed for the design.)

Additional testing to determine the ability to remove free liquid and/or meet bearing strength requirements of potential disposal facilities may be performed on a portion of the amended material submitted for TCLP and/or SBLT testing.

7.7 Geotechnical Testing

Section 6.2.4 identifies the EE/CA and design data gaps associated the in-water and riverbank geotechnical data set. The following activities will be conducted to address this data gap:

- All in-water and riverbank explorations will be logged by a geologist or engineer noting the change in stratigraphy, physical conditions, and environmental observations. The information from the different exploration locations will be used to develop subsurface profiles across the initial Project Area.
- Select sediment geotechnical testing will be performed on each of the bulk sediment samples submitted for analysis.
- Geotechnical testing of the riverbank soils will be performed on split spoon samples taken on five-foot intervals and Shelby tube samples. Index and strength geotechnical testing will be performed on soil samples collected along the riverbank at elevations that may be exposed as the riverbank is reconfigured for contaminant removal and bank stability.

The collected physical, geotechnical and chemical data coupled with the visual observations from the explorations will be used to complete slope stability analyses for proposed dredge cuts. Finally, collected geotechnical data will be used to complete cap designs.

Figure 2 of the FSP (Attachment 1 to the QAPP) shows the sediment core locations proposed for geotechnical testing.

7.8 TZW-Specific Remedial Technologies Studies

The uncertainty regarding the current nature and extent of CVOCs in the offshore groundwater plume and the TZW at Area 1 suggests that additional investigation of in-water groundwater and TZW is warranted. The primary objective of the investigation is to confirm the present nature and extent of the groundwater plume entering the river at Area 1 for the purpose of informing the remedial alternatives analysis. The secondary objective of the investigation is to provide data necessary to estimate in-river attenuation rates for TCE and its degradation products. These objectives are intended to provide data necessary to support the analysis of MNR in combination with upland source control as a likely practicable alternative for groundwater and TZW impacted by TCE and its degradation products. This is based upon the fact that degradation of TCE and its degradation products by native bacteria has already been confirmed by existing data.

Meeting the secondary objective will require re-sampling at a subset of the 2004 and 2005 sampling locations. The subset will include TZW and/or groundwater locations where TCE and its degradation products were previously detected at concentrations above 1,000 μg/L.[5] The data will be compared to the 2004/2005 data to estimate the rate of attenuation that has occurred in the interim. 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 CVOC distribution in groundwater and TZW.

TZW and groundwater samples will be collected and analyzed from 13 locations using methods and equipment consistent with previously-approved techniques, which are further described in the FSP (Attachment 1 to the QAPP).

5 As noted previously, using the estimated half-life from the upland data set suggests that concentrations could have since been reduced to the MRL by 2008. Conservatively doubling the half-life to 150 days suggests that concentrations greater than 1,000 may still be present in 2010. The cut-off of 1,000 ug/L is conservative for identifying sample points appropriate for meeting for the second objective.

8 REFERENCES

AMEC. 2008. Draft Source Control Evaluation Report RPAC-Portland Site, prepared by AMEC Earth & Environment, Inc., submitted to Oregon Department of Environmental Quality, February 13, 2008.

Anchor Environmental, LLC (Anchor). 2001. NW Natural "Gasco" Site Draft Screening Level Nearshore Source Control Evaluation Results Report. Prepared for submittal to Oregon Department of Environmental Quality. Prepared on behalf of NW Natural. July 2001.

Anchor. 2004. NW Natural "Gasco" Site Removal Action Work Plan. Prepared on behalf of NW Natural. Seattle, Washington. August 2004.

Anchor. 2005a. "Public Review Draft Engineering Analysis/Cost Evaluation, Removal Action NW Natural "Gasco" Site." Prepared for submittal to the Environmental Protection Agency, Region 10. Seattle, Washington.

Anchor. 2005b. Removal Action Project Plan. Prepared for Submittal to U.S. Environmental Protection Agency Region 10. Prepared on behalf of NW Natural. July 2005.

Anchor. 2006a. Final Removal Action Completion Report – Removal Action NW Natural "Gasco" Site. Prepared on behalf of NW Natural. April 2006.

Anchor. 2006b. Gasco Source Control Data Gaps Evaluation NW Natural "Gasco" Site. Prepared on behalf of for NW Natural. November 2006.

Anchor. 2006c. Portland Harbor RI/FS. Round 3A Sediment Trap Deployment Field Report. Prepared for the Lower Willamette Group, Portland, Oregon. Anchor Environmental, LLC, Seattle, Washington. December 2006.

Anchor. 2007a. Portland Harbor RI/FS. Round 3A Sediment Trap Sampling Quarter 1 Field Report. Prepared for the Lower Willamette Group, Portland, Oregon. Anchor Environmental, LLC, Seattle, Washington. April 16, 2007.

Anchor. 2007b. Portland Harbor RI/FS. Round 3A Sediment Trap Sampling Quarter 2 Field Report. Prepared for the Lower Willamette Group, Portland, Oregon. Anchor Environmental, LLC, Seattle, Washington. July 2007.

Anchor. 2007c. Annual Data Evaluation Monitoring Report – Year 0 Long-Term Pilot Cap Monitoring. Prepared on behalf of NW Natural. Seattle, Washington. September 2007.

Anchor. 2007d. Gasco/Siltronic Groundwater and NAPL Source Control Focused Feasibility Study. Prepared for NW Natural. November 2007.

Anchor. 2007e. Phase 1 Report and Phase 2 Field Sampling Approach. Prepared on behalf of NW Natural. May 2007.

Anchor. 2007f. Groundwater/NAPL Pilot Program Extraction Well and Performance Evaluation Design Report. Prepared on behalf of NW Natural. May 2007.

Anchor. 2008a. Portland Harbor RI/FS. Round 3A Sediment Trap Sampling Quarter 4 Field Report. Prepared for the Lower Willamette Group, Portland, Oregon. Anchor Environmental, LLC, Seattle, Washington. January 2008.

Anchor. 2008b. Offshore Investigation Report. NW Natural "Gasco" Site. Prepared for NW Natural. Prepared by Anchor Environmental LLC. February.

Anchor. 2008c. "Proposed Revised Long-Term Pilot Cap Monitoring Approach – NW Natural Gasco Site." Memorandum. Prepared on behalf of NW Natural. March 26, 2008.

Anchor. 2008d Annual Data Evaluation Monitoring Report – Year 1 Long-Term Pilot Cap Monitoring. Prepared on behalf of NW Natural. Seattle, Washington. May 2008.

Anchor. 2008e. Portland Harbor RI/FS. Round 3A In-River Sediment Trap Sampling Data Report. Draft. AE08-09. Prepared for the Lower Willamette Group, Portland, Oregon. Anchor Environmental, LLLC, Seattle, Washington, and Integral Consulting Inc., Mercer Island, Washington. June 2008.

Anchor. 2009. Offshore Investigation Report Prepared for NW Natural. Prepared by Anchor Environmental L.L.C, Seattle, Washington. February 2008

Anchor and Integral Consulting, Inc. (Integral). 2008. Round 3A In-River Sediment Trap Sampling Data Report. Anchor Environmental, LLC. and Integral Consulting, Inc. July 18, 2008.

Anchor QEA, LLC (Anchor QEA). 2009a. Source Control Evaluation Report. "Segment 3" Siltronic Property Related to NW Natural "Gasco" Site. Prepared for NW Natural. Prepared by Anchor QEA, LLC. February.

Anchor QEA. 2009b. Annual Data Evaluation Monitoring Report – Year 2 Long-Term Pilot Cap Monitoring. Prepared for NW Natural. Prepared by Anchor QEA, LLC. July 2009.

Anchor QEA. 2010a. Final Work Plan: Gasco Sediments Cleanup Action. Prepared for NW Natural, under Docket No. CERCLA 10-2009-0255. Portland, Oregon. January 2010.

Anchor QEA. 2010b. Draft Annual Data Evaluation Monitoring Report Year 3 Long-Term Pilot Cap Monitoring. Removal Action NW Natural "Gasco" Site. Prepared on behalf of NW Natural. 2010.

Battelle. 2002. Assessment of the Nature of PAH in Surface Sediments along the Southwestern Shore of Portland Harbor Superfund Site, Portland, Oregon. Prepared for the Light Products Study Group. Battelle, Duxbury, MA.

Hahn and Associates, Inc. (HAI). 2005. Updated Phase I Site Characterization Summary Report, Siltronic Corporation Property, Portland, Oregon. July 22, 2005.

HAI. 2006. Remedial Investigation Proposal, Historical Manufactured Gas Plant Activities, Siltronic Corporation Property, 7200 NW Front Avenue, Portland, Oregon. November 17, 2006.

HAI. 2007a. Remedial Investigation Report, NW Natural "Gasco" Facility. Portland, Oregon. April 30, 2007.

HAI. 2007b. RI Workplan – Historical Manufactured Gas Plant Activities, Siltronic Corporation Property, 7200 NW Front Avenue, Portland Oregon. July 13, 2007.

Hart Crowser. 1999. Sediment Characterization Study of Local Sponsors' Berths; Columbia and Willamette River Navigation Channel Deepening; Longview and Kalama, Washington and Portland, Oregon. Prepared for the Port of Portland, Portland, Oregon. Hart Crowser, Inc., Portland, Oregon.

Integral. 2004. Round 1 Site Characterization Summary Report. Integral Consulting, Inc. October 12.

Integtral. 2005a. Portland Harbor Site RI/FS Groundwater Pathway Assessment Sampling and Analysis Plan. Draft. IC05-0013. Prepared for the Lower Willamette Group, Portland, Oregon. Integral Consulting Inc., Mercer Island, Washington.

Integral. 2005b. Round 2A Sediment Site Characterization Summary Report. Integral Consulting, Inc. July 15.

Integral. 2006a. Portland Harbor Site RI/FS Round 2 Groundwater Assessment Sampling and Analysis Plan Addendum 1 to the Transition Zone Water Field Sampling Plan. Prepared for the Lower Willamette Group, Portland, Oregon. Integral Consulting Inc., Mercer Island, Washington.

Integral. 2006b. Portland Harbor Site RI/FS Round 2 Groundwater Pathway Assessment Transition Zone Water Sampling Field Sampling Report. Draft. IC06-0002. Prepared for the Lower Willamette Group, Portland, Oregon. Integral Consulting Inc., Mercer Island, Washington.

Integral. 2006c. Portland Harbor Site RI/FS Round 2 Groundwater Pathway Assessment Transition Zone Water Site Characterization Summary Report. Draft. IC06-0020. Prepared for the Lower Willamette Group, Portland, Oregon. Integral Consulting Inc., Mercer Island, Washington.

Integral. 2006d. Round 2A Surface Water Site Characterization Summary Report. Integral Consulting, Inc. April 24.

Integral. 2006e. Round 2B Subsurface Sediment Data Report. Integral Consulting, Inc. May 22.

Integral. 2007a. Round 3A Low-flow and Stormwater-Impacted Surface Water Data Report. Integral Consulting, Inc. May 21.

Integral. 2007b. Round 3A Winter 2007 High-flow Surface Water Data Report. Integral Consulting, Inc. October 15.

Integral. 2009. Sediment Chemical Mobility Testing Data Report. Integral Consulting, Inc. August 11.

Integral and Windward Environmental, LLC (Windward). 2006. Round 2 Benthic Tissue and Sediment Data Report. Integral Consulting, Inc. and Windward Environmental, LLC. September 1.

Integral and Windward. 2008. Round 3B Fish and Invertebrate Tissue and Collocated Surface Sediment Field Sampling Report. Integral Consulting, Inc. and Windward Environmental, LLC. February 15.

Integral Consulting, Inc., Windward Environmental, LLC, Kennedy/Jenks Consultants, Anchor Environmental, LLC, and Groundwater Solutions, Inc. 2004. Portland Harbor Programmatic Work Plan. Prepared for The Lower Willamette Group. April 2004.

Integral Consulting, Inc., Windward Environmental, LLC, Kennedy/Jenks Consultants, and Anchor Environmental, LLC. 2007. Portland Harbor Site RI/FS Round 2 Comprehensive Site Characterization Summary and Data Gaps Analysis Report. Final. IC07-0004. Prepared for the Lower Willamette Group, Portland, Oregon. Integral Consulting, Inc., Mercer Island, Washington; Windward Environmental, LLC, Seattle, Washington;

Kennedy/Jenks Consultants, Portland, Oregon; Anchor Environmental, LLC, Seattle, Washington.

Integral Consulting, Inc., Windward Environmental, LLC, Kennedy/Jenks Consultants, and Anchor QEA, LLC. 2009. Draft Portland Harbor RI/FS Remedial Investigation Report. Prepared for The Lower Willamette Group. October 27, 2009.

MacDonald, D.D., and P.F. Landrum PF. 2008. An evaluation of the approach for assessing risks to the benthic invertebrate community at the Portland Harbor Superfund site. Preliminary draft. Prepared for US Environmental Protection Agency. September 2008. MacDonald Environmental Sciences, Ltd., Nanaimo, BC, and Landrum and Associates, Ann Arbor, MI.

Maul Foster & Alongi, Inc (MFA). 2005a. Letter re: results of in-river sediment and groundwater investigation, Siltronic Corporation, 7200 NW Front Avenue, Portland, Oregon, ECSI # 183) to M. McClincy, Oregon Department of Environmental Quality, from J. Peale and J. Maul, Maul Foster & Alongi, Inc. February 1.

MFA. 2005b. Supplemental investigation report, Siltronic Corporation site, Portland, Oregon. Maul Foster & Alongi, Inc., Portland, Oregon. September 8.

MFA. 2007. Remedial Investigation Report, Siltronic Corporation site. Portland Oregon. April 2007.

Oregon Department of Environmental Quality (DEQ). 2004. Oregon DEQ Table 33A Water Quality Criteria Summary. Environmental Quality Commission. 2007.

DEQ. 2009. DEQ Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites, Risk Based Concentrations. Last accessed November 2009 at www.deq.state.or.us/lq/rbdm.htm

DEQ and U.S. Environmental Protection Agency. 2005. Joint Source Control Strategy. Last accessed November 2009 at www.deq.state.or.us/lq/cu/nwr/PortlandHarbor/jointsource.htm

Tetra Tech. 2006. Dredged Material Management Plan Sediment Characterization Report. Prepared for US Army Corps of Engineers, Portland District. Tetra Tech EC, Inc., Portland, Oregon.

URS. 2003. Final Limited Sediment Investigation Report, U.S. Government Moorings, Portland, Oregon. Prepared for US Army Corps of Engineers, Seattle District, Seattle, Washington. URS, Seattle, Washington.

U.S. Army Corps of Engineers (USACE). 1997. Results of July 1997 Willamette River Sediment Study. US Army Corps of Engineers, Portland District, Portland, Oregon

USACE. 2003. Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities — Testing Manual. Engineer Research and Development Center. Environmental Laboratory. ERDC/EL TR-03-1. Vicksburg, Mississippi.

U.S. Environmental Protection Agency (EPA). 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. Interim Final. Office of Emergency and Remedial Response. Washington, DC 20460. EPA/540/G-89/004. October 1988.

EPA. 1993. Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons. EPA/600/R-93/089. U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Washington, DC. July, 1993.

EPA. 2001. Administrative Order on Consent for the Remedial Investigation/Feasibility Study for Portland Harbor Superfund Site. U.S. Environmental Protection Agency, Portland, Oregon. 92 pp.

EPA. 2002. Office of Solid Waste and Emergency Response Memorandum. Subject: Transmittal of Policy Statement: Role of Background in the CERCLA Cleanup Program OSWER 9285.6-07P. From: Michael B. Cook, Director s/ Michael B. Cook, Office of Emergency and Remedial Response. To: Superfund National Policy Managers Regions 1 – 10. Signed May 1, 2002.

EPA. 2003. EPA 816-F-03-016, National Priority Drinking Water Standards. EPA. 2005. Contaminated Sediment Remediation Guidance for Hazardous Waste Sites. EPA-540-R-05-012, Office of Solid Waste and Emergency Response, OSWER 9355.0-85. Washington, D.C. December 2005.

EPA. 2009a. EPA Regional Screening Level (EPA RSL) Table Master April 2009. Website URL: http://www.epa.gov/reg3hscd/risk/human/rb-concentration_table/Generic_Tables/ (accessed November 2009).

EPA. 2009b. National Recommended Water Quality Criteria. Office of Water and Office of Science and Technology. Last accessed at http://www.epa.gov/waterscience/criteria/wqctable/nrwqc-2009.pdf

Van den Berg, M., L. Birnbaum, A.T.C. Bosveld, B. Brunström, P. Cook, M. Feeley, and others. 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ. Health Perspect. 106(12):775-792.

Van den Berg, M., L.S. Birnbaum, M. Denison, M. De Vito, W. Farland, M. Freeley, and others. 2006. The 2005 World Health Organization reevaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds. Tox. Sci. 2(93):223-241.

Weston. 1998. Portland Harbor Sediment Investigation Report, Multnomah County, Oregon. Report No. 04000-019-036-AACE. Prepared for the U.S. Environmental Protection Agency and Oregon Department of Environmental Quality, Portland, Oregon. Roy F. Weston, Inc., Seattle, Washington

Windward. 2009a. Draft Portland Harbor RI/FS Benthic Toxicity Reanalysis Technical Memorandum. Prepared for The Lower Willamette Group. Prepared by Windward Environmental LLC. WE-09-0004. November 2009.

Windward. 2009b. Portland Harbor Superfund Site Remedial Investigation/Feasibility Study (RI/FS): Appendix H: Baseline Ecological Risk Assessment. Prepared for The Lower Willamette Group. Prepared by Windward Environmental LLC. June 12, 2009

TABLES

Table 1

Sediment Screening Levels[1]

Chemicals	Human Health					Ecological					Background			
	BHHRA Screening Concentrations		Portland Harbor PRG-based Screening Concentrations[4,11]		EPA RSLs[5]	BERA Screening Concentrations[6]		Portland Harbor PRG-Based Screening Concentrations[12]	Final Benthic SQGs[7]		LWR Background			
	In-Water Sediment[2] (µg/kg)	Industrial Use Beach Sediment[3] (µg/kg)	Hill Top Sediment Concentrations for AOPCs 9A and 9B – Adult Fish Consumption, SMB, Low IR (10^{-4}) (µg/kg)	Hill Top Sediment Concentrations for AOPCs 9A and 9B - In-Water Direct Contact, Tribal Fisher (10^{-6}) (µg/kg)	Industrial Soil (µg/kg)	Dietary Dose TSC - NOAEL (µg/kg dw)	Dietary Dose TSC - LOAEL (µg/kg dw)	Hill Top Sediment Concentrations for AOPCs 9A and 9B - Mink, Multispecies Diet (µg/kg)	Low Threshold SQG (µg/kg)	High Threshold SQG (µg/kg)	Surface Sediment UPL[8] (µg/kg dw)	Surface Sediment UPL[9] (µg/kg OC-Eq)	Hill Top Surface Sediment UPL[10,11] (µg/kg dw)	Hill Top Surface Sediment UPL[10] (µg/kg OC-Eq)
Metals/Inorganics														
Zinc	3.10E+07	3.10E+07			3.10E+08	2.07E+06	5.36E+06			4.69E+05 [a]	1.10E+05		3.39E+05	
Cyanide	2.00E+06				2.00E+07									
Petroleum														
Diesel Range Hydrocarbons	7.00E+07													
Residual Range Hydrocarbons	1.00E+08													
Polycyclic Aromatic Hydrocarbons														
2-Methylnaphthalene	4.10E+05	4.10E+05			4.10E+06									
Acenaphthene	3.30E+06	3.30E+06			3.30E+07									
Acenaphthylene	3.30E+06	3.30E+06												
Anthracene	1.70E+07	1.70E+07			1.70E+08									
Benzo(a)anthracene	2.10E+03	2.10E+03		1.91E+04	2.10E+03						1.57E+01	2.42E+01	2.12E+01	4.28E+01
Benzo(a)pyrene	2.10E+02	2.10E+02		4.84E+02	2.10E+02	2.18E+02	4.63E+02				1.53E+01	2.36E+01	2.12E+01	4.33E+01
Benzo(b)fluoranthene	2.10E+03	2.10E+03			2.10E+03				5.30E+04 [b]	5.30E+04 [b]	2.02E+01	3.11E+01	2.79E+01	5.71E+01
Benzo(g,h,i)perylene	1.70E+06	1.70E+06												
Benzo(k)fluoranthene	2.10E+04	2.10E+04			2.10E+04				5.30E+04 [b]	5.30E+04 [b]			1.64E+01 [r]	2.92E+01 [r]
Chrysene	2.10E+05	2.10E+05			2.10E+05						2.49E+01	3.84E+01	3.93E+01	8.67E+01
Dibenzo(a,h)anthracene	2.10E+02	2.10E+02		1.58E+03	2.10E+02								4.65E+00 [r]	9.83E+00 [r]
Fluoranthene	2.20E+06	2.20E+06			2.20E+07									
Fluorene	2.20E+06	2.20E+06			2.20E+07									
Indeno(1,2,3-cd)pyrene	2.10E+03	2.10E+03		1.39E+04	2.10E+03								1.50E+01 [r]	2.97E+01 [r]
Naphthalene	2.00E+04	2.00E+04			2.00E+04								[n]	[n]
Phenanthrene	1.70E+06	1.70E+06												
Pyrene	1.70E+06	1.70E+06			1.70E+07									
Total LPAHs						1.25E+06			1.60E+03	1.80E+04				
Total HPAHs						1.57E+05	7.84E+05		2.20E+04	6.10E+05				
Total PAHs						2.02E+03	5.95E+03						2.46E+02 [r]	4.80E+02 [r]
Total cPAH				5.22E+02							2.28E+01 [f]	3.51E+01 [f]	3.05E+01	6.13E+01
Pesticides														
alpha-HCH	2.70E+02	2.70E+02			2.70E+02								[n,t]	[n,t]
beta-HCH	9.60E+02	9.60E+02			9.60E+02						1.05E+00	1.62E+00	3.54E+00 [t]	[n,t]
delta-HCH									1.26E+00	2.35E+00				
gamma-HCH (Lindane)	2.10E+03				2.10E+03								1.88E-01 [r,t]	3.40E-01 [r,t]
Technical-grade HCH					9.60E+02									
Total DDD	7.20E+03	7.20E+03			7.20E+03 [c]						1.31E+00	2.02E+00	1.90E+00	4.03E+00
Total DDE	5.10E+03				5.10E+03 [d]	1.00E+03	1.00E+04				1.72E+00	2.65E+00	2.73E+00	4.12E+01
Total DDT	7.00E+03	7.00E+03			7.00E+03 [e]						1.10E+00	1.69E+00	1.86E+00	4.27E+00
Total DDx						7.11E+03	7.11E+04		2.18E+02	2.18E+02	3.59E+00 [k]	5.53E+00 [k]		
Endrin ketone	1.80E+04								8.50E+00	8.50E+00				

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Table 1

Sediment Screening Levels[1]

Chemicals	Human Health					Ecological					Background			
	BHHRA Screening Concentrations		Portland Harbor PRG-based Screening Concentrations[4,11]		EPA RSLs[5]	BERA Screening Concentrations[6]		Portland Harbor PRG-Based Screening Concentrations[12]	Final Benthic SQGs[7]		LWR Background			
	In-Water Sediment[2] (µg/kg)	Industrial Use Beach Sediment[3] (µg/kg)	Hill Top Sediment Concentrations for AOPCs 9A and 9B – Adult Fish Consumption, SMB, Low IR (10^{-4}) (µg/kg)	Hill Top Sediment Concentrations for AOPCs 9A and 9B - In-Water Direct Contact, Tribal Fisher (10^{-6}) (µg/kg)	Industrial Soil (µg/kg)	Dietary Dose TSC - NOAEL (µg/kg dw)	Dietary Dose TSC - LOAEL (µg/kg dw)	Hill Top Sediment Concentrations for AOPCs 9A and 9B - Mink, Multispecies Diet (µg/kg)	Low Threshold SQG (µg/kg)	High Threshold SQG (µg/kg)	Surface Sediment UPL[8] (µg/kg dw)	Surface Sediment UPL[9] (µg/kg OC-Eq)	Hill Top Surface Sediment UPL[10,11] (µg/kg dw)	Hill Top Surface Sediment UPL[10] (µg/kg OC-Eq)
Polychlorinated Biphenyls														
Aroclor 1016					2.10E+04									
Aroclor 1221					6.20E+02									
Aroclor 1232					6.20E+02									
Aroclor 1242					7.40E+02									
Aroclor 1248					7.40E+02									
Aroclor 1254					7.40E+02									
Aroclor 1260					7.40E+02									
PCB 77					1.10E+02						2.52E-02	3.88E-02	3.39E-02	8.29E-02
PCB 81					1.10E+02						9.32E-04	1.44E-03	1.27E-03	2.56E-03
PCB 105					1.10E+02						1.63E-01	2.51E-01	2.60E-01	4.68E-01
PCB 114					2.30E+00									
PCB 118					1.10E+02						2.31E-01	3.56E-01	s	s
PCB 123					1.10E+02									
PCB 126			g		1.10E-01						3.92E-03	6.04E-03	5.93E-03	1.28E-02
PCB 156					2.30E+00						6.85E-02	1.06E-01	1.21E-01	2.22E-01
PCB 157					2.30E+00						4.86E-02	7.49E-02	3.39E-01	1.54E+00
PCB 167					1.10E+02									
PCB 169					1.10E+02								n	n
PCB 189					1.10E+02									
Total PCBs	7.40E-01 h	7.40E+02 i	5.81E+01		7.40E+02 l	1.89E+03	9.44E+03	9.50E+01	2.50E+02 p	5.00E+02 p	1.69E+01 q	2.60E+01 q	2.61E+01	5.81E+01 o
Total PCBs TEQ	1.80E-05	1.80E-05				5.62E-02	5.62E-01				6.06E-04	9.30E-04	1.35E-03	3.44E-03
Semi-Volatile Organic Compounds														
Carbazole	2.20E+06	2.20E+06							1.10E+03	1.10E+03				
Dibenzofuran	2.20E+06	2.20E+06												
Volatile Organic Compounds														
1,1-Dichloroethene					1.10E+06									
Benzene	5.60E+03				5.60E+03									
cis-1,2-Dichloroethene	1.00E+06				1.00E+07									
trans-1,2-Dichloroethene	5.00E+04				5.00E+05									
Ethylbenzene	2.90E+04				2.90E+04									
Toluene	9.30E+06				4.60E+07									
Trichloroethene	1.40E+04				1.40E+04									
Vinyl chloride	1.70E+03				1.70E+03									
m-Xylene					1.90E+07									
p-Xylene					2.00E+07									
m,p-Xylene					1.90E+07 m									
o-Xylene					2.30E+07									
Xylenes	3.00E+05				2.60E+06 j									

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Table 1
Sediment Screening Levels[1]

Notes:

a Criteria based on Calcasieu approach, as presented in Benthic Toxicity Reanalysis Technical Memorandum (Windward 2009a). Final Benthic SQGs are from "Table 4-5 Final Sets of High and Low SQGs."

b Criteria for total benzofluoranthenes used for Benzo(b)fluoranthene and Benzo(k)fluoranthene screening. Individual criteria not available.

c EPA RSL for DDD used for total DDD screening.

d EPA RSL for DDE used for total DDE screening.

e EPA RSL for DDT used for total DDT screening.

f Criteria for cPAH BaPEq used for cPAH screening.

g No hill top number listed because the area-wide average for AOPCs 9A and 9B is below the Portland Harbor PRG for this COC.

h Screening concentration for total PCBs congeners used for total PCBs screening.

i Screening concentration for total PCBs aroclors used for total PCBs screening.

j EPA RSL for xylene, mixture used for xylenes screening.

k Background level for total DDx - LWG case used for total DDx screening.

l EPA RSL for PCBs (high risk) used for total PCBs screening.

m Criteria for m-Xylene used for m,p-Xylene screening.

n No hill top number listed because the surface weighted average concentration is already below the background value for this COC.

o 26.2 µg/kg oc-eq total PCBs is used as the replacement value in the hill topping routine. 26.2 µg/kg oc-eq total PCBs represents the background oc-eq total PBC concentration considering PCB congener and PCB arochlor data for sample stations with no PCB congener data.

p SQG for total PCBs aroclors used for total PCBs screening

q Background for total PCBs congeners used for total PCBs screening

r The following replacement values (µg/kg) were used in the hill topping routine. The total dry weght background value is listed first, followed by the oc-equivelent background value:

Benzo(k) fluoranthene:	10.5	16.1
Dibenzo(a,h)fluroanthene:	3.2	4.92
Indeno(1,2,3-cd)pyrene:	11.4	17.5
Total PAHs:	190	292
gamma-HCH (Lindane):	0.117	0.18

s A hill top value for PCB 118 was not calculated due to insufficient data.

t Mean values (with associated detection value used in the case of non-detect) is used for the background values

1 Refer to the source tables referenced in the following footnotes for additional notes pertaining to the criteria listed in this table.

2 BHHRA Screening Concentrations are from Table 2-12 of Draft BHHRA (Appendix F of the *Draft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009]).

3 BHHRA Screening Concentrations are from Table 2-10 of Draft BHHRA (Appendix F of the *Draft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009]).

4 Portland Harbor PRG-based screening concentrations are hill top sediment concentrations calculated for AOPCs 9A and 9B using the GIS tool provided to EPA by LWG on October 22, 2009. The screening concentration is calculated using the AOPC rules described in the EPA's June 23, 2009, letter to LWG.

5 EPA RSLs are from *EPA RSL Table Master April 2009* (EPA 2009a).

6 BERA Calculated Values are from Tables 7-23, 8-14, 8-16, and 8-39 of Draft BERA (Appendix G of the Draft Portland Harbor RI/FS Remedial Investigation Report [Integral et al. 2009]). The lowest screening level listed in these tables for each COC was selected.

7 Final Benthic SQGs are from "Table 4-5: Final Sets of High and Low SQGs" of *Benthic Toxicity Reanalysis Technical Memorandum* (Windward 2009a). Values for the low threshold are the "low threshold" value obtained using the EPA 2009 procedure, as presented in Table 4-5. Values for the high threshold is the "high threshold" value obtained using the BERA Procedure, except for zinc, where no Draft BERA- or EPA 2009-calculated number is available and the Calcasieu-calculated number is used, as presented in Table 4-5.

8 Surface sediment background UPLs are obtained from "Table 7.3-5b. Upriver Surface Sediment Central Tendency and Upper Threshold Statistics, Dry Weight Concentrations, Primary Outliers Removed" from *Draft Portland Harbor RI/FS Remedial Investigation Report* (Integral et al. 2009). Criteria used are those with outliers excluded.

9 OC-eq surface sediment background UPLs are obtained from "Table 7.3-6b. Upriver Surface Sediment Central Tendency and Upper Threshold Statistics, OC-Equivalent Dry Weight Concentrations, Primary Outliers Removed" from *Draft Portland Harbor RI/FS Remedial Investigation Report* (Integral et al. 2009). Criteria used are those with outliers excluded.

10 Hill top background surface sediment concentrations are calculated using the GIS tool provided to EPA by LWG on October 22, 2009. Hill top concentrations are calculated for the Portland Harbor Site-wide basis using the associated background concentration as a replacement value.

11 Cells highlighted in yellow contain screening levels used for AOPC delineation in the manner described in the EPA's June 23, 2009, letter to LWG. These screening levels are considered primary lines of evidence for the initial Project Area identification.

12 Portland Harbor PRG-based screening concentrations are hill top sediment concentrations calculated for AOPCs 9A and 9B using the GIS tool provided to EPA by LWG on October 22, 2009. The screening concentrations are calculated using the by-river mile hill topping approach. The PRG equates to 31 µg/kg dry weight total PCBs achieved on a SWAC basis by river mile. A replacement value equal to the PRG is used in the hill topping routine.

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Table 2
Water Screening Levels [1]

Chemicals	Human Health											
	BHHRA Screening Concentrations						EPA RSLs[6]	CWA and SDWA Criteria		DEQ RBDM RBC Groundwater[9]		
	Surface Water – Domestic Water Source (MCL)[2] (µg/L)	Surface Water – Domestic Water Source (Tapwater RSL) and Direct Contact (Diver)[3] (µg/L)	Human Health AWQC - 17.5 g/day (Organism only)[4] (µg/L)	Human Health AWQC - 175 g/day (Organism only)[4] (µg/L)	Transition Zone Water Screening Value (Tapwater RSL)[5] (µg/L)	Transition Zone Water Screening Value (MCL)[5] (µg/L)	Tapwater (µg/L)	Water MCLs[7] (µg/L)	Human Health - Water + Organism[8] (µg/L)	Ingestion & Inhalation from Tapwater - Occupational (µg/L)	Volatilization to Outdoor Air - Occupational (µg/L)	GW in Excavation (µg/L)
Metals/Inorganics												
Zinc [13]		1.10E+03 [i]	2.60E+04	2.60E+03	1.10E+03 [i]		1.10E+04		7.40E+03			
Free Cyanide			1.40E+02 [k]		7.30E+01	2.00E+02	7.30E+02	2.00E+02	1.40E+02	2.90E+03		2.50E+06
Polycyclic Aromatic Hydrocarbons												
2-Methylnaphthalene		1.50E+01			1.50E+01		1.50E+02					
Acenaphthene		2.20E+02	9.90E+02	9.90E+01	2.20E+02		2.20E+03		6.70E+02			
Acenaphthylene		2.20E+02			2.20E+02							
Anthracene		1.10E+03	4.00E+04	4.00E+03	1.10E+03		1.10E+04		8.30E+03			
Benzo(a)anthracene		2.90E-02	1.80E-02	1.80E-03	2.90E-02		2.90E-02		3.80E-03	5.60E-01		9.10E+00
Benzo(a)pyrene	2.00E-01	2.90E-03	1.80E-02	1.80E-03	2.90E-03	2.00E-01	2.90E-03	2.00E-01	3.80E-03	5.60E-02		5.30E-01
Benzo(b)fluoranthene		2.90E-02	1.80E-02	1.80E-03	2.90E-02		2.90E-02		3.80E-03	5.60E-01		
Benzo(g,h,i)perylene		1.10E+02			1.10E+02							
Benzo(k)fluoranthene		2.90E-01	1.80E-02	1.80E-03	2.90E-01		2.90E-01		3.80E-03			
Chrysene		2.90E+00	1.80E-02	1.80E-03	2.90E+00		2.90E+00		3.80E-03			
Dibenzo(a,h)anthracene		2.90E-03	1.80E-02	1.80E-03	2.90E-03		2.90E-03		3.80E-03	5.60E-02		2.10E-01
Fluoranthene		1.50E+02	1.40E+02	1.40E+01	1.50E+02		1.50E+03		1.30E+02			
Fluorene		1.50E+02	5.30E+03	5.30E+02	1.50E+02		1.50E+03		1.10E+03			
Indeno(1,2,3-cd)pyrene		2.90E-02	1.80E-02	1.80E-03	2.90E-02		2.90E-02		3.80E-03			
Naphthalene		1.40E-01			1.40E-01		1.40E-01			7.20E-01	1.60E+04	5.00E+02
Phenanthrene		1.10E+02			1.10E+02							
Pyrene		1.10E+02	4.00E+03	4.00E+02	1.10E+02		1.10E+03		8.30E+02			
Pesticides												
alpha-HCH		1.10E-02	4.90E-03	4.90E-04			1.10E-02		2.60E-03	6.50E-02		2.80E+01
beta-HCH		3.70E-02	1.70E-02	1.70E-03			3.70E-02		9.10E-03			
gamma-HCH (Lindane)	2.00E-01	6.10E-02	1.80E+00	1.80E-01			6.10E-02	2.00E-01	9.80E-01	3.70E-01		1.70E+02
Technical-grade HCH							3.70E-02					
2,4'-DDD												
2,4-DDT												
4,4'-DDD			3.10E-04 [k]						3.10E-04	1.70E+00		4.00E+01
4,4'-DDE			2.20E-04 [k]						2.20E-04	1.20E+00		3.20E+01
4,4'-DDT			2.20E-04 [k]						2.20E-04	1.20E+00		1.50E+01
Total DDD		2.80E-01 [j]	3.10E-04	3.10E-05	2.80E-01		2.80E-01 [a]		3.10E-04 [n]	1.70E+00 [d]		4.00E+01 [d]
Total DDE		2.00E-01 [j]	2.20E-04	2.20E-05	2.00E-01		2.00E-01 [b]		2.20E-04 [o]	1.20E+00 [e]		3.20E+01 [e]
Total DDT		2.00E-01 [j]	2.20E-04	2.20E-05	2.00E-01		2.00E-01 [c]		2.20E-04 [p]	1.20E+00 [f]		1.50E+01 [f]
Endrin ketone		1.10E+00										

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Table 2
Water Screening Levels [1]

Chemicals	Human Health											
	BHHRA Screening Concentrations						EPA RSLs[6]	CWA and SDWA Criteria		DEQ RBDM RBC Groundwater[9]		
	Surface Water – Domestic Water Source (MCL)[2] (µg/L)	Surface Water – Domestic Water Source (Tapwater RSL) and Direct Contact (Diver)[3] (µg/L)	Human Health AWQC - 17.5 g/day (Organism only)[4] (µg/L)	Human Health AWQC - 175 g/day (Organism only)[4] (µg/L)	Transition Zone Water Screening Value (Tapwater RSL)[5] (µg/L)	Transition Zone Water Screening Value (MCL)[5] (µg/L)	Tapwater (µg/L)	Water MCLs[7] (µg/L)	Human Health - Water + Organism[8] (µg/L)	Ingestion & Inhalation from Tapwater - Occupational (µg/L)	Volatilization to Outdoor Air - Occupational (µg/L)	GW in Excavation (µg/L)
Polychlorinated Biphenyls												
Aroclor 1016							9.60E-01					
Aroclor 1221							6.80E-03					
Aroclor 1232							6.80E-03					
Aroclor 1242							3.40E-02					
Aroclor 1248							3.40E-02					
Aroclor 1254							3.40E-02					
Aroclor 1260							3.40E-02					
PCB 77							5.20E-03					
PCB 81							5.20E-03					
PCB 105							5.20E-03					
PCB 114							1.00E-04					
PCB 118							5.20E-03					
PCB 123							5.20E-03					
PCB 126							5.20E-06					
PCB 156							1.00E-04					
PCB 157							1.00E-04					
PCB 167							5.20E-03					
PCB 169							5.20E-03					
PCB 189							5.20E-03					
Total PCBs	5.00E-01 [s]	3.40E-02 [s]	6.40E-05 [s]	6.40E-06 [s]			1.70E-01 [g]	5.00E-01	6.40E-05	2.00E-01		3.30E+00
Total PCBs TEQ	3.00E-05	5.20E-07	5.10E-09	5.10E-10								
Semi-Volatile Organic Compounds												
Carbazole												
Dibenzofuran					1.50E+02							
Volatile Organic Compounds												
1,1-Dichloroethene			7.10E+03 [k]		3.40E+01	7.00E+00	3.40E+02	7.00E+00	3.30E+02	1.40E+03		4.30E+04
Benzene			5.10E+01 [k]		4.10E-01	5.00E+00	4.10E-01	5.00E+00	2.20E+00	2.20E+00	1.40E+04	1.70E+03
cis-1,2-Dichloroethene					3.70E+01	7.00E+01	3.70E+02	7.00E+01		1.50E+03		1.20E+05
trans-1,2-Dichloroethene			1.00E+04 [k]		1.10E+01	1.00E+02	1.10E+02	1.00E+02	1.40E+02	4.50E+02	1.80E+06	1.40E+04
Ethylbenzene			2.10E+03 [k]		1.50E+00	7.00E+02	1.50E+00	7.00E+02	5.30E+02	7.80E+00	4.10E+04	4.40E+03
Toluene			1.50E+04 [k]		2.30E+02	1.00E+03	2.30E+03	1.00E+03	1.30E+03	9.20E+03		2.10E+05
Trichloroethene			3.00E+01 [k]		1.70E+00	5.00E+00	1.70E+00	5.00E+00	2.50E+00	2.20E-01	8.70E+02	1.60E+02
Vinyl chloride			2.40E+00 [k]		1.60E-02	2.00E+00	1.60E-02	2.00E+00	2.50E-02	5.20E-01	6.80E+03	1.20E+03
m-Xylene							1.40E+03					
p-Xylene							1.50E+03					
m,p-Xylene							1.40E+03 [q]					
o-Xylene							1.40E+03					
Total Xylenes					2.00E+01	1.00E+04	2.00E+02 [h]	1.00E+04		8.50E+02		2.30E+04

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Table 2
Water Screening Levels [1]

Chemicals	Ecological				Background
	CWA Criteria		BERA Screening Concentrations		LWR Background[12]
	Freshwater CMC[8] (Acute) (µg/L)	Freshwater CCC[8] (Chronic) (µg/L)	Surface Water TRVs[10] (µg/L)	TZW TRVs[11] (µg/L)	Surface Water UPL - Total Basis (µg/L)
Metals/Inorganics					
Zinc [13]	3.65E+01 [l,u]	3.65E+01 [l,u]	3.65E+01 [i]	3.65E+01	
Free Cyanide	2.20E+01	5.20E+00		5.20E+00 [t]	
Polycyclic Aromatic Hydrocarbons					
2-Methylnaphthalene				2.10E+00	
Acenaphthene				2.30E+01	
Acenaphthylene					
Anthracene				7.30E-01	
Benzo(a)anthracene			2.70E-02	2.70E-02	
Benzo(a)pyrene			1.40E-02	1.40E-02	
Benzo(b)fluoranthene				6.774E-01	
Benzo(g,h,i)perylene				4.391E-01	
Benzo(k)fluoranthene				6.415E-01	
Chrysene				2.042E+00	
Dibenzo(a,h)anthracene				2.825E-01	
Fluoranthene				6.16E+00	
Fluorene				3.90E+00	
Indeno(1,2,3-cd)pyrene				2.75E-01	
Naphthalene			1.20E+01	1.20E+01	
Phenanthrene				6.30E+00	
Pyrene				1.011E+01	
Pesticides					
alpha-HCH					
beta-HCH					
gamma-HCH (Lindane)	9.50E-01				
Technical-grade HCH					
2,4'-DDD				1.00E-03	
2,4-DDT				1.00E-03	
4,4'-DDD				1.00E-03	
4,4'-DDE				1.00E-03	
4,4'-DDT	1.10E+00	1.00E-03	1.00E-03	1.00E-03	
Total DDD			1.00E-03 [j]	1.00E-03	9.83E-05
Total DDE			1.00E-03 [j]	1.00E-03	1.92E-04
Total DDT	1.10E+00 [l]	1.00E-03 [l]	1.00E-03 [j]	1.00E-03	3.13E-04
Endrin ketone					

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Table 2
Water Screening Levels [1]

Chemicals	Ecological				Background
	CWA Criteria		BERA Screening Concentrations		LWR Background[12]
	Freshwater CMC[8] (Acute) (µg/L)	Freshwater CCC[8] (Chronic) (µg/L)	Surface Water TRVs[10] (µg/L)	TZW TRVs[11] (µg/L)	Surface Water UPL - Total Basis (µg/L)
Polychlorinated Biphenyls					
Aroclor 1016					
Aroclor 1221					
Aroclor 1232					
Aroclor 1242					
Aroclor 1248					
Aroclor 1254					
Aroclor 1260					
PCB 77					5.63E-07
PCB 81					1.63E-08
PCB 105					3.43E-06
PCB 114					
PCB 118					9.22E-06
PCB 123					
PCB 126					4.66E-08
PCB 156					
PCB 157					
PCB 167					
PCB 169					2.79E-08
PCB 189					
Total PCBs	2.00E+00 [m]	1.40E-02	1.40E-02		3.89E-04 [r]
Total PCBs TEQ					6.28E-09
Semi-Volatile Organic Compounds					
Carbazole					
Dibenzofuran				3.70E+00	
Volatile Organic Compounds					
1,1-Dichloroethene				2.50E+01	
Benzene				1.30E+02	
cis-1,2-Dichloroethene				5.90E+02	
trans-1,2-Dichloroethene					
Ethylbenzene			7.30E+00	7.30E+00	
Toluene				9.80E+00	
Trichloroethene			4.70E+01	4.70E+01	
Vinyl chloride					
m-Xylene					
p-Xylene					
m,p-Xylene				6.67E+01	
o-Xylene				1.30E+01	
Total Xylenes				1.30E+01	

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Table 2
Water Screening Levels[1]

Notes:

a EPA RSL for DDD used for total DDD screening.
b EPA RSL for DDE used for total DDE screening.
c EPA RSL for DDT used for total DDT screening.
d DEQ RBDM RBC for DDD (4-4' DDD) used for total DDD screening.
e DEQ RBDM RBC for DDE (4-4' DDE) used for total DDE screening.
f DEQ RBDM RBC for DDT (4-4' DDT) used for total DDT screening.
g EPA RSL for PCBs (low risk) used for total PCBs screening.
h EPA RSL for xylene, mixture used for xylenes screening.
i Criteria based on a dissolved zinc concentration.
j Water TRV for total DDx used for total DDT, DDE, and DDD screening.
k Criteria for human health consumption of organism only, from US EPA 2009, used for screening.
l Freshwater criteria for 4,4'-DDT used for total DDT screening.
m Freshwater acute criteria for total PCBs from DEQ 2005 used for total PBC screening.
n Human Health for consumption of water + organism criteria for 4,4'-DDD used for total DDD screening.
o Human Health for consumption of water + organism criteria for 4,4'-DDE used for total DDE screening.
p Human Health for consumption of water + organism criteria for 4,4'-DDT used for total DDT screening.
q Criteria for m-Xylene used for m,p-Xylene screening.
r Background for total PCBs congeners used for total PCBs screening
s Screening concentration for total PCBs congeners used for total PCBs screening
t The screening level for cyanide has been modified from 5.2 x 10^{-3} µg/l (as presented in the Draft BERA) to 5.2 µg/l, consistent with *National Recommended Water Quality Criteria* (EPA 2009b), which is the source referenced for this value in the Draft BERA.
u Screening level for zinc is based on a hardness of 36.5 mg/l, consistent with the hardness used in the Draft BERA.
1 Refer to the source tables in the following footnotes for additional notes pertaining to the criteria listed in this table.
2 BHHRA Screening Concentrations for Surface Water - Domestic Water Source based on MCLs are from Table 2-17 of Draft BHHRA (Appendix F of the *Draft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009]).
3 BHHRA Screening Concentrations for Surface Water - Domestic Water Source based on SLs and Direct Contact are from Tables 2-14 and 2-17 of Draft BHHRA (Appendix F of the D*raft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009]). These screening levels are combined because the levels are generally identical. In cases where two levels are present or a level is missing, the most conservative level available is used for screening.
4 National AWQC for the 17.5 g/day and 175 g/day ingestion rates are as screened in Table 6-1 of Draft BHHRA (Appendix F of the *Draft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009]). The criteria for human health consumption of organism only from EPA National 2009 National Recommended Water Quality Criteria was used for COCs without criteria in Table 6-1 (indicated by k).
5 BHHRA Screening Concentrations for Transition Zone Water - Domestic Water Source based on Tapwater RSLs and MCLs are from Table 6-2 of Draft BHHRA (Appendix F of the *Draft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009]).
6 EPA RSLs are from *EPA RSL Level Table Master April 2009* (EPA 2009a).
7 MCLS are from EPA 816-F-03-016, *National Priority Drinking Water Standards* (EPA 2003).
8 Criteria obtained from EPA N*RWQC for Priority Toxic Pollutants 2009* , except for total PCBs acute, which is from *DEQ Table 33A Water Quality Criteria Summary* (DEQ 2004).
9 RBDM RBCs for Individual Chemicals are from *DEQ Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites* (DEQ 2009).
10 Surface water TRVs are from Table 6-22 of Draft BERA (Appendix G of the *Draft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009]).
11 TZW TRVs are from Table 6-26 of Draft BERA (Appendix G of the *Draft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009]).
12 Criteria obtained from "Table 7.4-4a: Upriver Surface Water Upper Threshold Calculations, Total Concentration Basis, Outliers Removed" of *Draft Portland Harbor RI/FS Remedial Investigation Report* (Integral et al. 2009). Criteria used are those with outliers excluded.
13 Unless specified otherwise (indicated by note i), criteria will be applied on the total concentration basis.

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Table 3
Benthic Toxicity Screening Criteria

	EPA 2009 Toxicity Thresholds REV (L1) Threshold (percent)	EPA 2009 Toxicity Thresholds Low (L2) Threshold (percent)	Draft BERA Toxicity Thresholds High (L3) Threshold (percent)
Chironomus dilutus survival	93.9	84.5	71.9
Chironomus dilutu s biomass	91	81.9	68.7
Hyalella azteca survival	88.1	79.3	66.7
Hyalella azteca biomass	73.6	66.2	47.1

Notes:

Criteria obtained from "Table 2-3 Toxicity Thresholds Based on the Calcasieu, Draft BERA, and EPA 2009 Procedures" from *Benthic Toxicity Reanalysis Technical Memorandum* (Windward 2009a). For L1 and L2, selected criteria based on the EPA 2009 method; for L3, selected criteria based on Draft BERA method.

L1 Level 1

L2 Level 2

L3 Level 3

REV Reference Envelope Value

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Table 4

Upland Soil Screening Levels[1]

Chemicals	Human Health						Ecological	
	EPA RSLs[2]	DEQ RBDM RBC Soil[3]					JSCS SLV - Upland Soil and Sediment[4]	
	Industrial Soil (µg/kg)	Occupational Worker - Ingestion, Dermal Contact, and Inhalation (µg/kg)	Construction Worker - Ingestion, Dermal Contact, and Inhalation (µg/kg)	Excavation Worker - Ingestion, Dermal Contact, and Inhalation (µg/kg)	Volatilization to Outdoor Air - Occupational (µg/kg)	Leaching to Groundwater - Occupational (µg/kg)	Toxicity (µg/kg)	Bioaccumulation (µg/kg)
Metals/Inorganics								
Zinc	3.10E+08						4.59E+05	3.00E+03
Cyanide	2.00E+07	2.00E+07	6.20E+06					
Polycyclic Aromatic Hydrocarbons								
2-Methylnaphthalene	4.10E+06						2.00E+02	
Acenaphthene	3.30E+07	6.10E+07	1.90E+07				3.00E+02	
Acenaphthylene							2.00E+02	
Anthracene	1.70E+08		9.30E+07				8.45E+02	
Benzo(a)anthracene	2.10E+03	2.70E+03	2.10E+04	5.90E+05			1.05E+03	
Benzo(a)pyrene	2.10E+02	2.70E+02	2.10E+03	5.90E+04			1.45E+03	
Benzo(b)fluoranthene	2.10E+03	2.70E+03	2.10E+04	5.90E+05				
Benzo(g,h,i)perylene							3.00E+02	
Benzo(k)fluoranthene	2.10E+04	2.70E+04	2.10E+05	5.90E+06			1.30E+04	
Chrysene	2.10E+05	2.70E+05	2.10E+06	5.90E+07			1.29E+03	
Dibenzo(a,h)anthracene	2.10E+02	2.70E+02	2.10E+03	5.90E+04			1.30E+03	
Fluoranthene	2.20E+07	2.90E+07	8.90E+06				2.23E+03	
Fluorene	2.20E+07	4.10E+07	1.20E+07				5.36E+02	
Indeno(1,2,3-cd)pyrene	2.10E+03	2.70E+03	2.10E+04	5.90E+05			1.00E+02	
Naphthalene	2.00E+04	2.30E+04	5.80E+05	1.60E+07	2.70E+04	4.40E+02	5.61E+02	
Phenanthrene							1.17E+03	
Pyrene	1.70E+07	2.10E+07	6.70E+06				1.52E+03	
Pesticides								
alpha-HCH	2.70E+02	3.40E+02	2.60E+03	7.40E+04		3.50E+01		
beta-HCH	9.60E+02							
gamma-HCH (Lindane)	2.10E+03	2.00E+03	1.50E+04	4.20E+05		1.20E+02	4.99E+00	
Technical-grade HCH	9.60E+02							
4,4'-DDD		1.10E+04	8.30E+04	2.30E+06			2.80E+01	3.00E-01
4,4'-DDE		7.70E+03	5.80E+04	1.60E+06		1.60E+06	3.13E+01	3.00E-01
4,4'-DDT		7.70E+03	5.80E+04	1.60E+06			6.29E+01	3.00E-01
Total DDD	7.20E+03 [a]	1.10E+04 [d]	8.30E+04 [d]	2.30E+06 [d]			2.80E+01 [i]	3.00E-01 [i]
Total DDE	5.10E+03 [b]	7.70E+03 [e]	5.80E+04 [e]	1.60E+06 [e]		1.60E+06 [e]	3.13E+01 [j]	3.00E-01 [j]
Total DDT	7.00E+03 [c]	7.70E+03 [f]	5.80E+04 [f]	1.60E+06 [f]			6.29E+01 [k]	3.00E-01

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Table 4

Upland Soil Screening Levels[1]

Chemicals	Human Health						Ecological	
	EPA RSLs[2]	DEQ RBDM RBC Soil[3]					JSCS SLV - Upland Soil and Sediment[4]	
	Industrial Soil (µg/kg)	Occupational Worker - Ingestion, Dermal Contact, and Inhalation (µg/kg)	Construction Worker - Ingestion, Dermal Contact, and Inhalation (µg/kg)	Excavation Worker - Ingestion, Dermal Contact, and Inhalation (µg/kg)	Volatilization to Outdoor Air - Occupational (µg/kg)	Leaching to Groundwater - Occupational (µg/kg)	Toxicity (µg/kg)	Bioaccumulation (µg/kg)
Polychlorinated Biphenyls								
Aroclor 1016	2.10E+04						5.30E+02	4.20E+02
Aroclor 1221	6.20E+02							
Aroclor 1232	6.20E+02							
Aroclor 1242	7.40E+02							2.00E+00
Aroclor 1248	7.40E+02						1.50E+03	4.00E+00
Aroclor 1254	7.40E+02						3.00E+02	1.00E+01
Aroclor 1260	7.40E+02						2.00E+02	
PCB 77	1.10E+02							
PCB 81	1.10E+02							
PCB 105	1.10E+02							
PCB 114	2.30E+00							
PCB 118	1.10E+02							
PCB 123	1.10E+02							
PCB 126	1.10E-01							
PCB 156	2.30E+00							
PCB 157	2.30E+00							
PCB 167	1.10E+02							
PCB 169	1.10E+02							
PCB 189	1.10E+02							
Total PCBs	7.40E+02 [g]	9.80E+02	7.60E+03	2.10E+05			6.76E+02	
Semivolatile Organic Compounds								
Carbazole							1.60E+03	
Volatile Organic Compounds								
1,1-Dichloroethene	1.10E+06	2.70E+07	1.20E+07			4.50E+04		
Benzene	5.60E+03	3.40E+04	3.40E+05	9.50E+06	5.00E+04	5.30E+01		
cis-1,2-Dichloroethene	1.00E+07	1.00E+07	3.10E+06	8.60E+07		2.40E+04		
trans-1,2-Dichloroethene	5.00E+05	9.20E+06	4.50E+06			1.00E+04		
Ethylbenzene	2.90E+04	1.40E+05	1.60E+06	4.40E+07	1.60E+05	9.00E+02		
Toluene	4.60E+07	7.70E+07	2.40E+07					
Trichloroethene	1.40E+04	3.90E+03	4.30E+04	1.20E+06	4.30E+03	1.20E+01	2.10E+03	
Vinyl chloride	1.70E+03	3.90E+03	3.00E+04	8.30E+05	8.90E+04	1.00E+01		
m-Xylene	1.90E+07							
p-Xylene	2.00E+07							
o-Xylene	2.30E+07							
Xylenes	2.60E+06 [h]	2.50E+07	1.90E+07			1.00E+05		

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Table 4
Upland Soil Screening Levels[1]

Notes:

a EPA RSL for DDD used for total DDD screening.
b EPA RSL for DDE used for total DDE screening.
c EPA RSL for DDT used for total DDT screening.
d DEQ RBDM RBC for DDD (4-4' DDD) used for total DDD screening.
e DEQ RBDM RBC for DDE (4-4' DDE) used for total DDE screening.
f DEQ RBDM RBC for DDT (4-4' DDT) used for total DDT screening.
g EPA RSL for PCBs (high risk) used for total PCBs screening.
h EPA RSL for xylene, mixture used for xylenes screening.
i JSCS Screening Level Value for DDD (4-4' DDD) used for total DDD screening.
j JSCS Screening Level Value for DDE (4-4' DDE) used for total DDE screening.
k JSCS Screening Level Value for DDT (4-4' DDT) used for total DDT screening.

1 Refer to the source tables in the following footnotes for additional notes pertaining to the criteria listed in this table.
2 EPA RSLs are from *EPA RSL Master April 2009* (EPA 2009a).
3 RBDM RBCs for Individual Chemicals are from *DEQ Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites* (DEQ 2009).
4 JSCS Screening Level Values are from "Table 3-1 Screening Level Values for Soil/Stormwater Sediment, Stormwater, Groundwater, and Surface Water" of the *Portland Harbor Joint Source Control Strategy* (DEQ and EPA 2005).

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Table 5
Summary of COCs without Screening Levels

Chemicals	Media		
	Sediment	Soil	Water
Petroleum			
Diesel Range Hydrocarbons		•	•
Residual Range Hydrocarbons		•	•
Polycyclic Aromatic Hydrocarbons			
Total LPAHs		•	•
Total HPAHs		•	•
Total PAHs		•	•
cPAH		•	•
Pesticides			
delta-HCH		•	•
2,4'-DDD	•	•	
2,4'-DDT	•	•	
4,4'-DDD	•		
4,4'-DDE	•		
4,4'-DDT	•		
Total DDx		•	•
Endrin ketone		•	
Polychlorinated Biphenyls			
Total PCB TEQ		•	
Semi-Volatile Organic Compounds			
Carbazole			•
Dibenzofuran		•	

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Table 6
Summary of Screening Levels for Preliminary Area Identification

Criteria	Sediment			Water			Benthic Toxicity	Upland Soils	
	Surface Sediment	Subsurface Sediment	Sediment Trap Data	Surface Water	TZW	Groundwater		Surface Soil	Subsurface Soil
SOW-Described Screening[1]									
Substantial Product Observation Screening	X	X						X	X
BHHRA Screening Concentrations[2]									
In-Water Sediment	X	X	X						
Industrial Use Beach Sediment	X	X							
Surface Water – Domestic Water Source (MCL)				X					
Surface Water – Domestic Water Source (Tapwater RSL) and Direct Contact (Diver)				X					
Human Health AWQC – 17.5 g/day (Organism Only)				X	X				
Human Health AWQC – 175 g/day (Organism Only)				X	X				
TZW Screening Value (Tapwater RSL)					X				
TZW Screening Value (MCL)					X				
BERA Screening Concentrations[3]									
Surface Water TRVs				X					
TZW TRVs					X				
Dietary Dose TSC – NOAEL	X	X	X						
Dietary Dose TSC – LOAEL	X	X	X						
Portland Harbor PRG-Based Screening Levels[4]									
Hill top Sediment Concentrations for AOPCs 9A and 9B – Adult Fish Consumption, SMB, Low IR (10^{-4}) in µg/kg	X	X	X						
Hill top Sediment Concentrations for AOPCs 9A and 9B – In-Water Direct Contact, Tribal Fisher (10^{-6}) in µg/kg	X	X	X						
Hill top Sediment Concentrations for AOPCs 9A and 9B – Mink Multispecies Diet	X	X	X						

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Table 6
Summary of Screening Levels for Preliminary Area Identification

Criteria	Sediment			Water			Benthic Toxicity	Upland Soils	
	Surface Sediment	Subsurface Sediment	Sediment Trap Data	Surface Water	TZW	Groundwater		Surface Soil	Subsurface Soil
Final Benthic SQGs[5]									
Low Threshold SQG	X	X	X						
High Threshold SQG	X	X	X						
Benthic Toxicity Thresholds[6]									
REV (L1) Threshold							X		
Low (L2) Threshold							X		
High (L3) Threshold							X		
EPA RSLs[7]									
Industrial Soil	X	X	X					X	X
Tap water				X	X	X			
CWA and SDWA Criteria[8]									
MCLs				X	X	X			
NRWQC – CCC				X	X				
NRWQC – CMC				X	X				
NRWQC – Human Health – Consumption of Water + Organism				X	X				
DEQ Criteria[9]									
DEQ RBDM RBC – Soil -Occupational Worker – Ingestion, Dermal Contact and Inhalation								X	X
DEQ RBDM RBC – Soil -Construction Worker – Ingestion, Dermal Contact and Inhalation								X	X
DEQ RBDM RBC – Soil -Excavation Worker – Ingestion, Dermal Contact and Inhalation								X	X
DEQ RBDM RBC – Soil -Volatilization to Outdoor Air – Occupational								X	X
DEQ RBDM RBC – Soil –Leaching to Groundwater – Occupational								X	X

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Table 6
Summary of Screening Levels for Preliminary Area Identification

Criteria	Sediment			Water			Benthic Toxicity	Upland Soils	
	Surface Sediment	Subsurface Sediment	Sediment Trap Data	Surface Water	TZW	Groundwater		Surface Soil	Subsurface Soil
DEQ RBDM RBC – Groundwater, Ingestion and Inhalation from Tap Water						X			
DEQ RBDM RBC – Groundwater, volatilization to outdoor air						X			
DEQ RBDM RBC – Groundwater, Excavation						X			
JSCS Screening Level Values[10]									
Upland Soil and Sediment – Toxicity								X	X
Upland Soil and Sediment – Bioaccumulation								X	X
LWR Background[11]									
Surface Sediment UPL	X	X	X						
Surface Sediment UPL OC equivalent	X	X	X						
Hill top Surface Sediment UPL	X	X	X						
Hill top Surface Sediment UPL OC equivalent	X	X	X						
Surface Water UPL (total basis)				X	X				

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Table 6
Summary of Screening Levels for Preliminary Area Identification

Notes:

1 Substantial Product Observation Screening follows the definition of "substantial" presented in Section 3.6.2.1 of the SOW.

2 BHHRA Toxicity Screening Values are from Tables 2-10, 2-12, 2-14, 2-17,6-1 and 6-2 of Draft BHHRA (Appendix F of the *Draft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009]).

3 BERA Screening Values are from Tables 6-22 6-26, 7-23, 8-14, 8-16, and 8-39 of Draft BERA (Appendix G of the *Draft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009]).

4 Portland Harbor PRG-based screening concentrations are are hill top sediment concentrations calculated for AOPCs 9A and 9B using the GIS tool provided to USEPA by LWG on October 22, 2009. The hill top sediment concentrations are calculated based on the AOPC rules described in the EPA's June 23, 2009 letter to LWG, except for the hill top values for mink-multispecies diet. The mink-multispecies diet screening concentrations are calculated using the by-river mile hill topping approach. The PRG equates to 31 µg/kg dw total PCBs achieved on a SWAC basis by river mile. A replacement value equal to the PRG is used in the hill topping routine.

5 Final Benthic SQGs are from "Table 4-5 Final Sets of High and Low SQGs" of *Benthic Toxicity Reanalysis Technical Memorandum* (Windward 2009a). Values for the low threshold are the "low threshold" value obtained using the EPA 2009 procedure, as presented in Table 4-5. Values for the high threshold is the "high threshold" value obtained using the BERA Procedure, except for zinc, where no Draft BERA- or EPA 2009-calculated number is available and the Calcasieu-calculated number is used, as presented in Table 4-5.

6 Benthic Toxicity Thresholds are from "Table 2-3 Toxicity Thresholds Based on the Calcasieu, Draft BERA, and EPA 2009 Procedures" of *Benthic Toxicity Reanalysis Technical Memorandum* (Windward 2009a). Values for the REV (L1) and low (L2) thresholds are the "low threshold" value obtained using the EPA 2009 method, as presented in Table 2-3. Values for the high threshold is the "high threshold" value obtained using the BERA Procedure, as presented in Table 2-3.

7 EPA RSLs are from *EPA RSL Table Master April 2009* (EPA 2009a).

8 MCLs are from EPA 816-F-03-016, *National Priority Drinking Water Standards* (EPA 2003). NRWQ are from *National Recommended Water Quality Criteria* (EPA 2009b).

9 RBDM RBCs for Individual Chemicals are from *DEQ Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites* (DEQ 2009).

10 JSCS Screening Level Values are from" Table 3-1 Screening Level Values for Soil/Stormwater Sediment, Stormwater, Groundwater, and Surface Water" of the *Portland Harbor Joint Source Control Strategy* (DEQ and EPA 2005). Table 3-1 screening concentrations are from multiple sources; see table footnotes for complete list.

11 LWR background levels are from Tables 7.3-5b, 7.3-6b, 7.4-4a, and 7.4-4b of *Draft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009]. Criteria used are those with outliers excluded. Hill top background surface sediment concentrations are calculated on a Portland Harbor Site-wide basis using the GIS tool provided to EPA by LWG on October 22, 2009.

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Table 7
Summary of AIR Screening by SOW Requirement

SOW Screening Requirement	AIR Screening
Significant Volume of Product Line of Evidence: The lateral and vertical extent of significant volumes of NAPL and tar product in sediment.	The process for identifying the substantial presence of product described in SOW Section 3.6.2.1
Portland Harbor Unacceptable Risk Exposure Line of Evidence #1: Existing ecological sediment quality guidelines that are or will be used in the Portland Harbor BLRA that represent a range of levels including, but not limited to, low or no effects levels as well as levels at which some effects are expected.	Draft BERA Calculated NOAEL TSCs Draft BERA Calculated LOAEL TSCs *Benthic Toxicity Reanalysis Technical Memorandum* Low Threshold SQGs [1] *Benthic Toxicity Reanalysis Technical Memorandum* High Threshold SQGs [2] *Benthic Toxicity Reanalysis Technical Memorandum* Benthic Toxicity – REV [3] *Benthic Toxicity Reanalysis Technical Memorandum* Benthic Toxicity – Low Threshold [4] *Benthic Toxicity Reanalysis Technical Memorandum* Benthic Toxicity – High Threshold [5]
Portland Harbor Unacceptable Risk Exposure Line of Evidence #2: Estimated sediment Preliminary Remediation Goals (PRGs) from the Portland Harbor RI/FS process for persistent bioaccumlative toxins (PBTs) that are protective of humans and wildlife that consume aquatic biota from the Willamette River	Hill top Portland Harbor PRG-based screening concentrations for AOPC 9a and 9b for Mink, Multi-Species Diet Hill top Portland Harbor PRG-based screening concentration for AOPC 9a and 9b for Adult Fish Consumption – SMB, Low IR 10^{-4} Risk
Portland Harbor Unacceptable Risk Exposure Line of Evidence #3: Estimated sediment PRGs from the Portland Harbor RI/FS process that are protective of humans from direct contact with and incidental ingestion of COCs in sediments.	Hill top Portland Harbor PRG-based screening concentrations for AOPC 9a and 9b for In-Water Direct Contact Tribal Fisher 10^{-6} Risk Draft BHHRA Screening Concentrations for Industrial Use Beach Sediment Draft BHHRA Screening Concentrations for In-Water Sediments EPA RSLs for industrial soil, from *EPA RSL Table Master April 2009* (EPA 2009a)

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Table 7
Summary of AIR Screening by SOW Requirement

SOW Screening Requirement	AIR Screening
Portland Harbor Unacceptable Risk Exposure Line of Evidence #4: Estimated water PRGs and screening levels from the Portland Harbor RI/FS that are protective of ecological receptors and human health from direct contact with and ingestion of water media. These include but are not limited to those values currently under consideration for Portland Harbor screening values including: human health and ecological ambient Water Quality Criteria (WQC), residential tapwater SLVs from EPA's Regional Screening Level Tables, and Drinking Water Maximum Contaminant Levels.	Draft BHHRA Screening Concentrations for Surface Water, Domestic Water Source Draft BHHRA Screening Concentrations for Surface Water, Direct Contact with Divers Draft BHHRA Screening Evaluation of Surface Water Against AWQC – 17.5 g/day dose Draft BHHRA Screening Evaluation of Surface Water Against AWQC – 175 g/day dose Draft BHHRA TZW Screening Values (tapwater RSL and MCL) Draft BERA Water TRVs for Surface Water COPCs Draft BERA Water TRVs for TZW COPCs EPA RSLs for tapwater, from *EPA RSL Table Master April 2009* (EPA 2009a) MCLs *National Recommended Water Quality Criteria* (NRWQC; EPA 2009b) for Priority Toxic Pollutants – Freshwater Chronic Concentration NRWQC for Priority Toxic Pollutants – Freshwater Maximum Concentration NRWQC for Priority Toxic Pollutants – Human Health for Consumption of Water and Organism NRWQC for Priority Toxic Pollutants – Human Health for Consumption of Organism Only [6] *DEQ Table 33A Water Quality Criteria Summary* (DEQ 2004) Criteria for Freshwater Maximum Concentration [7]

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Table 7
Summary of AIR Screening by SOW Requirement

SOW Screening Requirement	AIR Screening
Portland Harbor Unacceptable Risk Exposure Line of Evidence #5: Conservative water screening levels or, if available, estimated PRGs or management goals from the Portland Harbor RI/FS that are protective of receptors related to groundwater plumes.	Draft BERA Water TRVs for TZW COPCs Draft BHHRA TZW Screening Values (tapwater RSL and MCL) Draft BHHRA Screening Evaluation of Surface Water Against AWQC – 17.5 g/day dose Draft BHHRA Screening Evaluation of Surface Water Against AWQC – 175 g/day dose MCLs NRWQC for Priority Toxic Pollutants – Freshwater Chronic Concentration NRWQC for Priority Toxic Pollutants – Freshwater Maximum Concentration NRWQC for Priority Toxic Pollutants – Human Health for Consumption of Water and Organism
Portland Harbor Background Line of Evidence: Currently available lines of evidence for Portland Harbor baseline and/or background conditions	Upriver surface sediment UPL concentrations, dry weight concentrations, primary outliers removed Upriver surface sediment UPL concentrations, OC-Equivalent, primary outliers removed Upriver surface water UPL concentrations, total concentration basis, outliers removed Hill top Portland Harbor background – surface sediment UPL concentrations, dry weight concentrations, primary outliers removed Hill top Portland Harbor background – surface sediment UPL concentrations, OC-Equivalent, primary outliers removed

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Table 7
Summary of AIR Screening by SOW Requirement

SOW Screening Requirement	AIR Screening
<u>The need for Riverbank Work:</u> The need for riverbank work shall be determined by: The need for soils remediation consistent with the upland risk assessment and upland FS The need to control sources of contaminants from the riverbank to the river including processes of soil erosion, leaching of chemicals due to shallow groundwater movement through the bank, and/or stormwater infiltration and discharge through riverbank soils.	DEQ RBDM RBC – Soil – Occupational Worker – Ingestion, Dermal Contact and Inhalation [8] DEQ RBDM RBC – Soil – Construction Worker – Ingestion, Dermal Contact and Inhalation DEQ RBDM RBC – Soil – Excavation Worker – Ingestion, Dermal Contact and Inhalation DEQ RBDM RBC – Soil – Volatilization to Outdoor Air – Occupational DEQ RBDM RBC – Soil – Leaching to Groundwater – Occupational DEQ RBDM RBC – Groundwater, Ingestion & Inhalation from Tap Water DEQ RBDM RBC – Groundwater, Volatilization to Outdoor Air DEQ RBDM RBC – Groundwater, Excavation JSCS Screening Level for Upland Soil and Sediment – Toxicity [9] JSCS Screening Level for Upland Soil and Sediment – Bioaccumulation EPA RSLs for industrial soil, from *EPA RSL Table Master April 2009* (EPA 2009a) The process for determining the need for, areas of, and design of riverbank remedy and source controls described in SOW Section 3.6.2.10

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Table 7
Summary of AIR Screening by SOW Requirement

Notes:

Draft BERA refers to Appendix G of the *Draft Portland Harbor RI/FS Remedial Investigation Report* (Integral et al. 2009).

Draft BHHRA refers to Appendix f of the *Draft Portland Harbor RI/FS Remedial Investigation Report* (Integral et al. 2009).

1 Values for the low threshold are the "low threshold" value obtained using the EPA 2009 procedure, as presented in Table 4-5 of the *Benthic Toxicity Reanalysis Technical Memorandum (*Windward 2009a).

2 Values for the high threshold are the "high threshold" value obtained using the BERA Procedure, except for zinc, where no Draft BERA- or EPA 2009-calculated number is available and the Calcasieu-calculated number is used, as presented in Table 4-5 of the *Benthic Toxicity Reanalysis Technical Memorandum*.

3 Values for the REV and low thresholds are the "REV" value obtained using the EPA 2009 method, as presented in Table 2-3 of the *Benthic Toxicity Reanalysis Technical Memorandum*. Values for the REV and low thresholds are the "REV" and "low threshold" value obtained using the EPA 2009 method, as presented in Table 2-3 of the *Benthic Toxicity Reanalysis Technical Memorandum*. Values for the high threshold is the "high threshold" value obtained using the BERA Procedure, as presented in Table 2-3 *Benthic Toxicity Reanalysis Technical Memorandum*.

4 Values for the REV and low thresholds are the "low threshold" value obtained using the EPA 2009 method, as presented in Table 2-3 *Benthic Toxicity Reanalysis Technical Memorandum*.

5 Values for the high threshold is the "high threshold" value obtained using the BERA Procedure, as presented in Table 2-3 of the *Benthic Toxicity Reanalysis Technical Memorandum.*

6 Criteria from this source used for COCs with no AWQC screening level listed in Table 6-1 of the Draft BHHRA (Appendix F of the *Draft Portland Harbor RI/FS Remedial Investigation Report* [Integral et al. 2009]).

7 Criteria from this source used for COCs with no Freshwater Maximum Concentration screening level listed in *National Recommended Water Quality Criteria* (EPA 2009b).

8 "DEQ RBDM RBCs" refers to *DEQ Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites, Risk Based Concentrations (*DEQ 2009).

9 "JSCS" refers to *Joint Source Control Strategy (*DEQ and EPA 2005).

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Table 8
Data Screening Analytes Listed by COC

COC	Data Screening Analytes
Zinc	Total Zinc Dissolved Zinc (water)
Cyanide	Total Cyanide Available Cyanide (water) Free Cyanide (water)
Diesel Range Hydrocarbons	Total Diesel Range Hydrocarbons
Residual Range Hydrocarbons	Total Residual Range Hydrocarbons
PAHs (Expanded list)	2-Methylnaphthalene Acenaphthene Acenaphthylene Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Benzo(k)fluoranthene Chrysene Dibenzo(a,h)anthracene Fluoranthene Fluorene Indeno(1,2,3-cd)pyrene Naphthalene Phenanthrene Pyrene Carbazole Dibenzofuran Total LPAHs Total HPAHs Total PAHs Total cPAH
BHCs	Alpha-HCH Beta-HCH Delta-HCH Gamma-HCH (Lindane) Technical-grade HCH
DDDs	2,4'-DDD 4,4'-DDD Total DDD
DDEs	2,4'-DDE 4,4'-DDE Total DDE

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Table 8
Data Screening Analytes Listed by COC

COC	Data Screening Analytes
DDTs	2,4'-DDT 4,4'-DDT Total DDT
--	Total DDx*
Endrin ketone	Endrin ketone
Polychlorinated Biphenyls	Available Individual PCB Aroclors Available Individual PCB Congeners Total PCBs aroclors Total PCBs congeners Total PCB TEQ
BTEX	Benzene Toluene Ethylbenzene m-Xylene p-Xylene m,p-Xylene o-Xylene Total Xylenes
1,1-Dichloroethene	1,1-Dichloroethene
Cis-1,2-Dichloroethene	Cis-1,2-Dichloroethene
Trans-1,2-Dichloroethene	Trans-1,2-Dichloroethene
Trichloroethene	Trichloroethene
Vinyl Chloride	Vinyl Chloride

Notes:
* Total DDx is the sum of isomers 2,4'-DDD, 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, and 4,4'-DDT.

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Table 9
Number of Analytes Required for Each Calculated Total

Chemical Name[1]	Expected Analytes	A' qualify (Limited)	Do Not Sum
Total PCBs Aroclors	7 or 9	<7	<2
Total PCB Congeners	209	<150	<100
Total DDx	6	<6	--
Sum DDD	2	<2	--
Sum DDE	2	<2	--
Sum DDT	2	<2	--
Total HPAHs	10	<10	<5
Total LPAHs	7	<7	<3
Total PAHs	17	<17	<10
Total Xylene	2	<2	--

Notes:
Table based on Table 2.1-5 of the *Draft Portland Harbor RI/FS Remedial Investigation Report* (Integral et. al 2009)

DDx sum of 2,4'- and 4,4'-DDD, DDE, and DDT
HPAH high molecular weight PAH
LPAH low molecular weight PAH
PAH polycyclic aromatic hydrocarbon
PCB polychlorinated biphenyl

1 Sums and totals of chemicals are calculated.

Table 10
Summary of Subsurface Sediment Screening Hill Topping Values and 3XPRGs

AOPC	Adult Fish Consumption, SMB, Low IR (10^{-4}) in ug/kg[1]			In-Water Direct Contact, Tribal Fisher (10^{-6}) in ug/kg					
	LWG RA Total PCB Aroclors (Calculated U = 1/2)	LWG RA Total PCB Congener (Calculated U = 1/2)	PCB-126	Benzo(a)pyrene	Benzo(a)anthracene	Dibenzo(a,h)anthracene	Benzo(b)fluoranthene	LWG RA Total cPAH TEF (7 minimum) (Calculated U = 1/2)	Indeno(1,2,3-c,d)pyrene
9a/9b	58.1	58100	0.03753 [2]	484	19060	1582	19310	522	13900

Notes:

1 PRGs were developed for 4,4'-DDD, 4,4'-DDE, 4,4'-DDT but were not included in the screening because no risk exists above the 10-4 risk level

2 A PRG-based screening level was not developed for PCB-126 because the SWAC of PCB-126 in AOPCs 9A and 9B is below the associated PRG. For the purpose of defining the depth exceedences for this chemical within the initial Project Area, a screening value of three times the PRG was used.

U Non-detected concentration

TEF Toxicity equivalence factor

Table 11
Study Area Toxicity Data Compared to the Negative Control and Reference Thresholds

Category	Number of Sampling Locations				
	Chironomus		*Hyalella*		Pooled
	Mortality	Growth[a]	Mortality	Growth[a]	Draft BERA Result
Level 0: Not significantly different ($p > 0.05$) from negative control	5	4	9	10	4
Level 1: Significantly different($p \leq 0.05$) from control and less than or equal to low reference threshold	1	1	1	2	1
Level 2: Significantly different ($p \leq 0.05$) from control and greater than low reference threshold and less than or equal to high reference threshold	4	1	1	0	1
Level 3: Significantly different ($p \leq 0.05$) from control and greater high reference threshold	8	12	7	6	12

Notes:

a The growth endpoint was defined as the total mass of survivors in a sample.

Table 12
Summary of Subsurface Sediment Screening Level Exceedences

Location	Core Mudline Elevation (ft NAVD88)	Top Contamination Depth (ft)	Bottom Contamination Depth (ft)	Top Contamination Elevation (ft NAVD88)	Bottom Contamination Elevation (ft NAVD88)	Analyte Exceedances in Core	Max Core Depth (ft)
Cores Located Within 9A, 9B in Area of Interest							
GP-25	1.3	4.0	31.0	-2.7	-29.7	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	41.0
GP-26	-8.1	6.0	23.0	-14.1	-31.1	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	118.0
GP-27	-32.3	8.0	81.3	-40.3	-113.6	-cPAH-B(a)p-D(a,h)a	100.0
GP-28	2.2	3.0	30.0	-0.8	-27.8	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	35.0
GP-29	-37.7	10.0	12.0	-47.7	-49.7	-cPAH-B(a)p	77.0
GP-30	-31.6	6.0	13.0	-37.6	-44.6	-cPAH-B(a)p	23.0
GP-31	-37.6	5.0	12.0	-42.6	-49.6	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	37.0
GP-32	-37.3	4.0	6.0	-41.3	-43.3	-cPAH-B(a)p-B(a)a-D(a,h)a-B(b)Fluor	21.0
GS-03	6.6	4.0	6.0	2.6	0.6	-cPAH-B(a)p	122.0
GS-05	9.2	3.0	4.0	6.2	5.2	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	4.0
GS-06	9.0	4.0	6.0	5.0	3.0	-cPAH-B(a)p	6.0
GS-07	5.5	4.0	6.0	1.5	-0.5	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	6.0
GS-10	4.2	4.0	11.0	0.2	-6.8	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	98.0
GS-11	8.2	4.0	6.0	4.2	2.2	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	173.0
LW2-C179	-6.0	1.0	11.4	-7.0	-17.4	-PCB_Aro-cPAH-B(a)p	11.4
LW2-C182	-8.0	1.0	11.1	-9.0	-19.1	-PCB_Aro-cPAH-B(a)p	11.1
LW2-C184	-8.0	1.0	9.0	-9.0	-17.0	-PCB_Aro-PCB_Cong-cPAH-B(a)p-PCB-126	17.1
LW2-C185	-13.0	1.0	8.1	-14.0	-21.1	-cPAH-B(a)p	10.8
LW2-C187	-22.0	1.0	6.5	-23.0	-28.5	-PCB_Aro-PCB_Cong-cPAH-B(a)p-PCB-126	10.1
LW2-C220	-45.0	1.0	7.2	-46.0	-52.2	-cPAH-B(a)p	7.2
LW2-C221	-45.0	1.0	6.8	-46.0	-51.8	-cPAH-B(a)p	6.8
LW2-C227	-1.0	3.7	6.3	-4.7	-7.3	-PCB_Aro-cPAH-B(a)p	6.3
LW2-C228	-17.0	1.0	5.1	-18.0	-22.1	-cPAH-B(a)p	5.1
LW2-C231	-19.0	1.0	5.3	-20.0	-24.3	-cPAH-B(a)p	5.3
LW2-C240	-9.0	1.0	10.2	-10.0	-19.2	-PCB_Aro-cPAH-B(a)p	10.2
LW2-C245	-10.0	1.0	6.6	-11.0	-16.6	-PCB_Aro-cPAH-B(a)p	15.0
LW2-C252	-44.0	1.0	9.7	-45.0	-53.7	-cPAH-B(a)p	9.7
LW2-C258	-39.0	1.0	10.0	-40.0	-49.0	-cPAH-B(a)p-Indeno_pyr-D(a,h)a	10.0
LW2-C263	2.0	1.0	12.3	1.0	-10.3	-PCB_Aro-cPAH-B(a)p-PCB-126-B(a)a-Indeno_pyr-D(a,h)a	12.3
LW2-C264	-32.0	1.0	7.2	-33.0	-39.2	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	9.5
LW2-C269	-2.0	1.0	17.7	-3.0	-19.7	-PCB_Aro-cPAH-B(a)p	17.7
LW2-C270	-33.0	1.0	8.9	-34.0	-41.9	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	8.9
LW2-C273	3.0	1.0	11.6	2.0	-8.6	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	11.6
LW2-C276	-35.0	1.0	8.8	-36.0	-43.8	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	10.5
LW2-C278	-28.0	1.0	9.4	-29.0	-37.4	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	11.5
LW2-C283	-7.0	1.0	8.5	-8.0	-15.5	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	14.1
LW2-C284	-35.0	1.0	9.6	-36.0	-44.6	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	11.6
LW2-C288	-4.0	1.0	12.8	-5.0	-16.8	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	12.8
LW2-C289	-34.0	1.0	6.8	-35.0	-40.8	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a	11.0
LW2-C294	-1.0	1.0	12.3	-2.0	-13.3	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	12.3
LW2-C299	-35.0	1.0	7.5	-36.0	-42.5	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	7.5
LW2-C301	-5.0	1.0	16.9	-6.0	-21.9	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	16.9
LW2-C302	-6.0	1.0	11.4	-7.0	-17.4	-PCB_Aro-PCB_Cong-cPAH-B(a)p-PCB-126-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	11.4

Table 12
Summary of Subsurface Sediment Screening Level Exceedences

Location	Core Mudline Elevation (ft NAVD88)	Top Contamination Depth (ft)	Bottom Contamination Depth (ft)	Top Contamination Elevation (ft NAVD88)	Bottom Contamination Elevation (ft NAVD88)	Analyte Exceedances in Core	Max Core Depth (ft)
LW2-C305	-35.0	1.0	10.8	-36.0	-45.8	-PCB_Aro-cPAH-B(a)p	10.8
LW2-C305-2	-35.0	1.0	7.9	-36.0	-42.9	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a	9.4
LW2-C311	-18.0	1.0	17.5	-19.0	-35.5	-cPAH-B(a)p	17.5
LW2-C312	-38.0	1.0	5.0	-39.0	-43.0	-PCB_Cong-cPAH-B(a)p-PCB-126	8.0
LW2-C521	-35.0	1.0	10.3	-36.0	-45.3	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	10.3
LW2-C525	-31.0	1.0	14.0	-32.0	-45.0	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	14.0
LW2-C527	-4.0	1.0	15.8	-5.0	-19.8	-PCB_Aro-cPAH-B(a)p	15.8
LW2-C528	-8.0	1.0	12.7	-9.0	-20.7	-PCB_Aro-cPAH-B(a)p	16.1
LW2-C529	-3.0	1.0	17.7	-4.0	-20.7	-PCB_Aro-cPAH-B(a)p	17.7
LW2-C530	-4.0	1.0	17.8	-5.0	-21.8	-PCB_Aro-cPAH-B(a)p	17.8
LW2-C531	-7.0	1.0	12.2	-8.0	-19.2	-PCB_Aro-cPAH-B(a)p	16.9
LW3-C640	-30.0	1.0	3.1	-31.0	-33.1	-cPAH	4.3
LW3-C648	-41.0	1.0	5.0	-42.0	-46.0	-cPAH-B(a)p	11.1
LW3-C662	-6.0	1.0	10.7	-7.0	-16.7	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	10.7
LWM-C11	-20.0	0.0	12.7	-20.0	-32.7	-PCB_Cong-cPAH-B(a)p-PCB-126-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	12.7
PCM-02	-19.8	0.0	1.6	-19.8	-21.4	-cPAH-B(a)p	1.6
PCM-03	-10.0	0.0	2.6	-10.0	-12.6	-cPAH-B(a)p	2.6
PCM-04	-0.7	0.0	1.5	-0.7	-2.2	-cPAH-B(a)p	1.5
PCM-05	-27.8	0.0	1.4	-27.8	-29.2	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a	1.4
PCM-06	-19.2	0.0	2.1	-19.2	-21.3	-cPAH-B(a)p	2.1
PCM-07	0.2	0.1	0.5	0.1	-0.3	-cPAH-B(a)p	0.5
PCM-08	-18.0	0.0	1.8	-18.0	-19.8	-cPAH-B(a)p	1.8
PCM-09	-21.9	0.2	1.7	-22.1	-23.6	-cPAH-B(a)p	1.7
PCM-10	-6.5	0.0	0.7	-6.5	-7.2	-cPAH-B(a)p	0.7
PCM-18	0.3	0.0	0.6	0.3	-0.3	-cPAH-B(a)p	0.6
PCM-21	1.4	1.0	1.0	0.4	0.4	-cPAH-B(a)p	1.0
WLCDRD05VC046	-27.0	0.0	10.3	-27.0	-37.3	-cPAH-B(a)p	10.3
WLCDRD05VC050	-35.0	0.0	4.6	-35.0	-39.6	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a	4.6
WLCDRD05VC052	-37.0	0.0	2.9	-37.0	-39.9	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a	2.9
WLCDRD05VC054	-34.0	0.0	6.6	-34.0	-40.6	-PCB_Aro-cPAH-B(a)p	6.6
WLCDRD05VC056	-33.0	0.0	8.7	-33.0	-41.7	-PCB_Aro-cPAH-B(a)p	8.7
WLCGSD01AN0101	10.0	0.3	1.3	9.7	8.7	-cPAH-B(a)p-D(a,h)a	1.3
WLCGSD01AN0102	-6.0	0.3	1.3	-6.3	-7.3	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	1.3
WLCGSD01AN0103	-19.0	0.3	1.3	-19.3	-20.3	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	1.3
WLCGSD01AN0201	10.0	0.3	1.3	9.7	8.7	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a	1.3
WLCGSD01AN0202	-5.0	0.3	1.3	-5.3	-6.3	-cPAH-B(a)p-B(a)a-D(a,h)a	1.3
WLCGSD01AN0203	-9.0	0.3	1.3	-9.3	-10.3	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	1.3
WLCGSD01AN0204	-26.0	0.3	1.3	-26.3	-27.3	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a	1.3
WLCGSG04RAA02	5.0	10.0	19.0	-5.0	-14.0	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	19.0
WLCGSG04RAA04	9.0	5.0	6.0	4.0	3.0	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	6.0
WLCGSG04RAA05	7.0	10.0	20.0	-3.0	-13.0	-cPAH-B(a)p	20.0
WLCGSG04RAA06	-6.0	4.0	20.0	-10.0	-26.0	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	20.0
WLCGSG04RAA09	7.0	5.0	16.0	2.0	-9.0	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	16.0
WLCGSG04RAA10	4.0	10.0	20.0	-6.0	-16.0	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	20.0

Table 12
Summary of Subsurface Sediment Screening Level Exceedences

Location	Core Mudline Elevation (ft NAVD88)	Top Contamination Depth (ft)	Bottom Contamination Depth (ft)	Top Contamination Elevation (ft NAVD88)	Bottom Contamination Elevation (ft NAVD88)	Analyte Exceedances in Core	Max Core Depth (ft)
WLCGSG04RAA11	7.0	13.0	20.0	-6.0	-13.0	-cPAH-B(a)p	20.0
WLCGSG04RAA12	1.0	18.0	20.0	-17.0	-19.0	-cPAH-B(a)p	20.0
WLCGSG04RAA13	-10.0	11.0	15.0	-21.0	-25.0	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	15.0
WLCGSG04RAA14	-23.0	10.0	14.0	-33.0	-37.0	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	20.0
WLCGSG04RAA17	7.0	0.0	20.0	7.0	-13.0	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	20.0
WLCGSG07GSB2	-21.0	0.0	15.0	-21.0	-36.0	-cPAH-B(a)p-D(a,h)a	15.0
WLCGSG07GSB5	-24.0	0.0	7.0	-24.0	-31.0	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	15.0
WLCGSG07GSB7	-27.0	0.0	15.0	-27.0	-42.0	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	15.0
WLCGSG07GSC2	-39.0	0.0	7.0	-39.0	-46.0	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	7.0
WLCGSG07GSC7	-38.0	0.0	7.0	-38.0	-45.0	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	15.0
WLCGSG07GSD5	-45.0	1.5	2.0	-46.5	-47.0	-cPAH-B(a)p	2.0
WLCGSJ06GS05	9.2	3.0	11.0	6.2	-1.8	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	173.0
WLCGSJ06GS06	9.0	4.0	23.0	5.0	-14.0	-cPAH-B(a)p	98.0
WLCGSJ06GS07	6.0	4.0	27.0	2.0	-21.0	-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	173.0
WLCGSJ06GS09	7.0	4.0	27.0	3.0	-20.0	-cPAH-B(a)p	177.0
WLCMFH00SD04	-33.0	1.0	1.8	-34.0	-34.8	-cPAH-B(a)p	1.8
WLCMFH00SD05	-7.0	1.0	1.8	-8.0	-8.8	-PCB_Aro-cPAH-B(a)p-B(a)a-Indeno_pyr-D(a,h)a-B(b)Fluor	1.8
WLCMRI02CS001	-27.0	0.0	3.0	-27.0	-30.0	-cPAH-B(a)p	3.0
WLCMRI02CS002	-12.0	0.0	3.0	-12.0	-15.0	-cPAH-B(a)p	3.0
WLCMRI02CS003	-5.0	0.0	3.0	-5.0	-8.0	-cPAH-B(a)p	3.0
WR-WSI98SD048	-17.0	0.0	3.0	-17.0	-20.0	-PCB_Aro-cPAH-B(a)p	3.0
WR-WSI98SD055C	-19.0	0.0	3.0	-19.0	-22.0	-PCB_Aro-cPAH-B(a)p	3.0
WR-WSI98SD057	0.0	0.0	3.0	0.0	-3.0	-cPAH-B(a)p	3.0
Cores Located Outside 9A, 9B in Area of Interest							
LW2-C314	-36.0	1.0	11.0	-37.0	-47.0	-PCB Aro-cPAH-B(a)p	11.0
LW2-C316	1.0	1.0	11.1	0.0	-10.1	-PCB Aro-cPAH-B(a)p-PeCDF-B(a)a-Indeno pyr-D(a,h)a	11.1
LW2-C300-2	-41.0	1.0	9.1	-42.0	-50.1	-PCB Aro-cPAH-B(a)p	9.1
LW2-C523	-39.0	1.0	3.9	-40.0	-42.9	-PCB Aro-cPAH-B(a)p	12.1
LW3-C664	-41.0	1.0	3.8	-42.0	-44.8	-PCB Cong	6.6
WLCDRD05VC058	-33.0	0.0	6.5	-33.0	-39.5	-cPAH-B(a)p	6.5
WR-WSI98SD072	-4.0	0.0	3.0	-4.0	-7.0	-PCB Aro-cPAH-B(a)p	3.0

Notes:

Indicates bottom of core contains screening level exceedances

Table 13
LWG FS Design Characterization TCLP Analytical Results

Location ID:		LWM-TCLP11A	LWM-TCLP11B	LWM-TCLP11C
Sample ID:		LWM-TCLPC11A	LWM-TCLPC11B	LWM-TCLPC11C
Sample Date:		8/27/2008	8/27/2008	8/28/2008
Depth:	TCLP criteria	0 to 322 centimeters	0 to 363 centimeters	0 to 325 centimeters
Metals (µg/l)				
Arsenic	5000	200 UT	200 U	200 U
Barium	100000	**380 T**	**400**	**290**
Cadmium	1000	10 UT	10 U	10 U
Chromium	5000	20 UT	20 U	20 U
Lead	5000	100 UT	100 U	100 U
Mercury	200	0.1 UT	0.1 U	0.1 U
Selenium	1000	200 UT	200 U	200 U
Silver	5000	20 UJT	20 UJ	20 UJ
Volatile Organics (µg/l)				
1,1-Dichloroethene	700	10 U	10 U	10 U
1,2-Dichloroethane	500	10 U	10 U	10 U
1,4-Dichlorobenzene	7500	10 U	10 U	10 U
2-Butanone (MEK)	200000	50 U	50 U	50 U
Benzene	500	10 U	**2900**	**13**
Carbon tetrachloride (Tetrachloromethane)	500	10 U	10 U	10 U
Chlorobenzene	100000	10 U	10 U	10 U
Chloroform	6000	10 U	10 U	10 U
Tetrachloroethene (PCE)	700	10 U	10 U	10 U
Trichloroethene (TCE)	500	10 U	10 U	10 U
Vinyl chloride	200	10 U	10 U	10 U
Semivolatile Organics (µg/l)				
2,4,5-Trichlorophenol	400000	50 U	50 U	50 U
2,4,6-Trichlorophenol	2000	50 U	50 U	50 U
2,4-Dinitrotoluene	130	50 U	50 U	50 U
2-Methylphenol (o-Cresol)	200000	10 U	10 U	10 U
4-Methylphenol (p-Cresol)	200000	10 U	**53**	10 U
Hexachlorobenzene	130	10 U	10 U	10 U
Hexachlorobutadiene	500	10 U	10 U	10 U
Hexachloroethane	3000	10 U	10 U	10 U
Nitrobenzene	2000	10 U	10 U	10 U
Pentachlorophenol	100000	50 U	50 U	50 U
Phenol		10 U	**21**	10 U
Pyridine	5000	50 U	50 U	50 U
Pesticides (µg/l)				
alpha-Chlordane (cis-Chlordane)	--	0.5 U	0.5 U	0.5 U
beta-Chlordane (trans-Chlordane)	--	0.5 U	0.5 U	0.5 U
Endrin	20	1 U	1 U	1 U
gamma-BHC (Lindane)	400	0.5 U	0.5 U	0.5 U
Heptachlor	8	0.5 U	0.5 U	0.5 U
Heptachlor epoxide	--	0.5 U	0.5 U	0.5 U
Methoxychlor	10000	5 U	5 U	5 U
Toxaphene	500	50 U	50 U	50 U
LWG RA Total Chlordane (Calculated U = 1/2)	30	0.5 AUT	0.5 AUT	0.5 AUT
Herbicides (µg/l)				
2,4-D (2,4-Dichlorophenoxyacetic acid)	10000	5 U	5 U	5 U
2,4,5-TP (Silvex)	1000	1.2 U	1.2 U	1.2 U

Notes:

Detected concentration is greater than one screening level

Bold	Detected result
U	Compound analyzed, but not detected above detection limit
UJ	Compound analyzed, but not detected above estimated detection limit
A	The total individual analytes summed are limited and are considered below the ideal individual analyte results.
T	Result is the value of a total or calculation
--	Results not reported or not applicable
RA	Portland Harbor Site risk assessment
N	Normal field sample
FD	Field duplicate

Totals are calculated as the sum of all detected results and 1/2 the undetected result. If all are undetected results, the highest reporting limit value is reported as the sum.

Table 14
Early Action Design Characterization TCLP Analytical Results

Location ID		RAA-03	RAA-11	RAA-11	RAA-13
Sample Date		7/21/2004	7/22/2004	7/22/2004	7/20/2004
Depth Interval		5 to 13 feet	2 to 4 feet	4 to 13 feet	9 to 11 feet
Sediment Zone	TCLP Criteria	Visually Contaminated[a]	Tar Body[b]	Visually Contaminated[a]	Tar Body[b]
Metals (mg/L)					
Arsenic	5	**0.03 J**	0.1 U	0.1 U	0.1 U
Barium	100	**1.5**	**0.6 J**	**0.6 J**	**0.5 J**
Cadmium	1	0.01 U	0.01 U	0.01 U	0.01 U
Chromium	5	0.01 U	**0.004 J**	**0.003 J**	**0.003 J**
Lead	5	0.05 U	0.05 U	0.05 U	0.05 U
Selenium	1	0.1 U	0.1 U	0.1 U	0.1 U
Silver	5	0.02 U	0.02 U	0.02 U	0.02 U
Mercury	0.2	0.001 U	0.001 U	0.001 U	0.001 U
Pesticides (mg/L)					
Chlordane	0.03	0.0050 U	0.0050 U	0.0050 U	0.0050 U
Endrin	0.02	0.00050 U	0.00050 U	0.00050 U	0.00050 U
gamma-BHC (Lindane)	0.4	0.00050 U	0.00050 U	0.00050 U	0.00050 U
Heptachlor	0.008	0.00050 U	0.00050 U	0.00050 U	0.00050 U
Heptachlor Epoxide	--	0.00050 U	0.00050 U	0.00050 U	0.00050 U
Methoxychlor	10	0.0010 U	0.0010 U	0.0010 U	0.0010 U
Toxaphene	0.5	0.010 U	0.010 U	0.010 U	0.010 U
2,4-D	10	0.10 U	0.10 U	0.10 U	0.10 U
Silvex	1	0.02 U	0.02 U	0.02 U	0.02 U
Semivolatile Organic Compounds (mg/L)					
2,4,5-Trichlorophenol	400	0.10 U	0.10 U	0.10 U	0.10 U
2,4,6-Trichlorophenol	2	0.10 U	0.10 U	0.10 U	0.10 U
2,4-Dinitrotoluene	0.13	0.10 UJ	0.10 UJ	0.10 UJ	0.10 UJ
2-Methylphenol	200	0.10 U	**0.022 J**	0.10 U	0.10 U
4-Methylphenol	200	0.10 U	**0.083 J**	0.10 U	0.10 U
Hexachlorobenzene	0.13	0.10 U	0.10 U	0.10 U	0.10 U
Hexachlorobutadiene	0.5	0.10 U	0.10 U	0.10 U	0.10 U
Hexachloroethane	3	0.10 U	0.10 U	0.10 U	0.10 U
Nitrobenzene	2	0.10 U	0.10 U	0.10 U	0.10 U
Pentachlorophenol	100	0.25 U	0.25 U	0.25 U	0.25 U
Pyridine	5	0.50 U	0.50 U	0.50 U	0.50 U
Volatile Organic Compounds (mg/L)					
1,1-Dichloroethene	0.7	0.20 U	0.20 U	0.20 U	0.20 U
1,2-Dichloroethane	0.5	0.20 U	0.20 U	0.20 U	0.20 U
1,4-Dichlorobenzene	7.5	0.20 U	0.20 U	0.20 U	0.20 U
2-Butanone (MEK)	200	8.0 U	8.0 U	8.0 U	8.0 U
Benzene	0.5	0.20 U	**30**	**0.45**	**3.3**
Carbon tetrachloride	0.5	0.20 U	0.20 U	0.20 U	0.20 U
Chlorobenzene	100	0.20 U	0.20 U	0.20 U	0.20 U
Chloroform	6	0.20 U	0.20 U	0.20 U	0.20 U
Tetrachloroethene	0.7	0.20 U	0.20 U	0.20 U	0.20 U
Trichloroethene	0.5	0.20 U	0.20 U	0.20 U	0.20 U
Vinyl chloride	0.2	0.080 U	0.080 U	0.080 U	0.080 U

Table 14
Early Action Design Characterization TCLP Analytical Results

Notes:

mg/L	milligrams per liter
a	The sample zone contained visual signs of contamination
b	The sample zone contained tar
J	The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL
U	The compound was analyzed for, but was not detected at or above the MRL/MDL
	The result is greater than the criteria value

Table 15
Supporting Design Characterization TCLP Analytical Results

Location ID:		GTC-03	GTC-03	GTC-04	GTC-04	GTC-05	GTC-05	GTC-06	GTC-06	GTC-07
Sample ID[a]:		GTC-03SC-T-090113	GTC-03SC-T-090113RE	GTC-04SC-T-090114	GTC-04SC-T-090114RE	GTC-05SC-T-090114	GTC-05SC-T-090114RE	GTC-06SC-T-090114	GTC-06SC-T-090114RE	GTC-07SC-T-090113
Sample Date:	TCLP Criteria	1/13/2009	1/13/2009	1/13/2009	1/14/2009	1/13/2009	1/14/2009	1/13/2009	1/14/2009	1/13/2009
Metals (µg/L)										
Arsenic	5000	200 U	--	200 U	--	200 U	--	200 U	--	200 U
Barium	100000	**370**	--	**410**	--	**380**	--	**450**	--	**640**
Cadmium	1000	10 U	--	10 U	--	10 U	--	10 U	--	10 U
Chromium	5000	20 U	--	20 U	--	20 U	--	20 U	--	20 U
Lead	5000	100 U	--	100 U	--	100 U	--	100 U	--	100 U
Mercury	200	0.1 U	--	0.1 U	--	0.1 U	--	0.1 U	--	0.1 U
Selenium	1000	200 U	--	200 U	--	200 U	--	200 U	--	200 U
Silver	5000	20 U	--	20 U	--	20 U	--	20 U	--	20 U
Volatile Organics (VOCs) (µg/L)										
1,1-Dichloroethene	700	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethane	500	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Butanone (MEK)	200000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Benzene	500	10 U	10 U	**25**	10 U	10 U	10 U	**29**	**160**	10 U
Carbon tetrachloride	500	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Chlorobenzene	100000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Chloroform	6000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	700	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Trichloroethene	500	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl chloride	200	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Semivolatile Organics (µg/L)										
1,4-Dichlorobenzene	7500	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Methylphenol (o-Cresol)	200000	10 U	--	10 U	--	10 U	--	10 U	--	10 U
2,4-Dinitrotoluene	130	50 U	--	50 U	--	50 U	--	50 U	--	50 U
2,4,5-Trichlorophenol	400000	50 U	--	50 U	--	50 U	--	50 U	--	50 U
2,4,6-Trichlorophenol	2000	50 U	--	50 U	--	50 U	--	50 U	--	50 U
4-Methylphenol (p-Cresol)	200000	10 U	--	10 U	--	10 U	--	10 U	--	10 U
Hexachlorobenzene	130	10 U	--	10 U	--	10 U	--	10 U	--	10 U
Hexachlorobutadiene	500	10 U	--	10 U	--	10 U	--	10 U	--	10 U
Hexachloroethane	3000	10 U	--	10 U	--	10 U	--	10 U	--	10 U
Nitrobenzene	2000	10 U	--	10 U	--	10 U	--	10 U	--	10 U
Pentachlorophenol	100000	50 U	--	50 U	--	50 U	--	50 U	--	50 U
Phenol		10 U	--	10 U	--	10 U	--	10 U	--	10 U
Pyridine	5000	50 U	--	50 U	--	50 U	--	50 U	--	50 U

Table 15
Supporting Design Characterization TCLP Analytical Results

Location ID:		GTC-03	GTC-03	GTC-04	GTC-04	GTC-05	GTC-05	GTC-06	GTC-06	GTC-07
Sample ID[a]:		GTC-03SC-T-090113	GTC-03SC-T-090113RE	GTC-04SC-T-090114	GTC-04SC-T-090114RE	GTC-05SC-T-090114	GTC-05SC-T-090114RE	GTC-06SC-T-090114	GTC-06SC-T-090114RE	GTC-07SC-T-090113
Sample Date:	TCLP Criteria	1/13/2009	1/13/2009	1/13/2009	1/14/2009	1/13/2009	1/14/2009	1/13/2009	1/14/2009	1/13/2009
PCB Aroclors (µg/L)										
Aroclor 1016		10 U	--	10 U	--	10 U	--	10 U	--	10 U
Aroclor 1221		10 U	--	10 U	--	10 U	--	10 U	--	10 U
Aroclor 1232		10 U	--	10 U	--	10 U	--	10 U	--	10 U
Aroclor 1242		10 U	--	10 U	--	10 U	--	10 U	--	10 U
Aroclor 1248		10 U	--	10 U	--	10 U	--	10 U	--	10 U
Aroclor 1254		10 U	--	10 U	--	10 U	--	10 U	--	10 U
Aroclor 1260		10 U	--	10 U	--	10 U	--	10 U	--	10 U
Pesticides (µg/L)										
alpha-Chlordane (cis-Chlordane)		0.5 U	--	0.5 U	--	0.5 U	--	0.5 U	--	0.5 U
Endrin	20	1 U	--	1 U	--	1 U	--	1 U	--	1 U
gamma-BHC (Lindane)	400	0.5 U	--	0.5 U	--	0.5 U	--	0.5 U	--	0.5 U
gamma-Chlordane		0.5 U	--	0.5 U	--	0.5 U	--	0.5 U	--	0.5 U
Heptachlor	8	0.5 U	--	0.5 U	--	0.5 U	--	0.5 U	--	0.5 U
Heptachlor epoxide		0.5 U	--	0.5 U	--	0.5 U	--	0.5 U	--	0.5 U
Methoxychlor	10000	5 U	--	5 U	--	5 U	--	5 U	--	5 U
Toxaphene	500	50 U	--	50 U	--	50 U	--	50 U	--	50 U
LWG RA Total Chlordane (Calculated U = 1/2)	30	0.5 AUT		0.5 AUT		0.5 AUT		0.5 AUT		0.5 AUT
Herbicides (µg/L)										
2,4,5-TP (Silvex)	1000	1.2 U	--	1.2 U	--	1.2 U	--	1.2 U	--	1.2 U
2,4-D (2,4-Dichlorophenoxyacetic acid)	10000	5 U	--	5 U	--	5 U	--	5 U	--	5 U
Total Petroleum Hydrocarbons (mg/l)										
Diesel Range Hydrocarbons		**0.75**	--	**1.6**	--	**0.92**	--	**3.9**	--	**4.3**
Gasoline Range Hydrocarbons		0.25 U	--	**2.3**	--	**1.5**	--	**4.6**	--	**2**
Motor Oil		0.5 U	--	0.5 U	--	0.5 U	--	0.5 U	--	0.5 U

Table 15
Supporting Design Characterization TCLP Analytical Results

Location ID:		GTC-07	GTC-07	GTC-08	GTC-08	GTC-09	GTC-09	GTC-10	GTC-10
Sample ID[a]:		GTC-07SC-T-090113RE	GTC-57SC-T-090113	GTC-08SC-T-090113	GTC-08SC-T-090113RE	GTC-09SC-T-090114	GTC-09SC-T-090114RE	GTC-10SC-T-090113	GTC-10SC-T-090114RE
Sample Date:	TCLP Criteria	1/13/2009	1/13/2009	1/13/2009	1/13/2009	1/13/2009	1/14/2009	1/13/2009	1/14/2009
Metals (µg/L)									
Arsenic	5000	--	--	200 U	--	200 U	--	200 U	--
Barium	100000	--	--	**440**	--	**530**	--	**630**	--
Cadmium	1000	--	--	10 U	--	10 U	--	10 U	--
Chromium	5000	--	--	20 U	--	20 U	--	20 U	--
Lead	5000	--	--	100 U	--	100 U	--	100 U	--
Mercury	200	--	--	0.1 U	--	0.1 U	--	0.1 U	--
Selenium	1000	--	--	200 U	--	200 U	--	200 U	--
Silver	5000	--	--	20 U	--	20 U	--	20 U	--
Volatile Organics (VOCs) (µg/L)									
1,1-Dichloroethene	700	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethane	500	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Butanone (MEK)	200000	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Benzene	500	10 U	10 U	10 U	10 U	**70**	**24**	10 U	**21**
Carbon tetrachloride	500	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Chlorobenzene	100000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Chloroform	6000	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Tetrachloroethene	700	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Trichloroethene	500	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl chloride	200	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Semivolatile Organics (µg/L)									
1,4-Dichlorobenzene	7500	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Methylphenol (o-Cresol)	200000	--	--	10 U	--	10 U	--	10 U	--
2,4-Dinitrotoluene	130	--	--	50 U	--	50 U	--	50 U	--
2,4,5-Trichlorophenol	400000	--	--	50 U	--	50 U	--	50 U	--
2,4,6-Trichlorophenol	2000	--	--	50 U	--	50 U	--	50 U	--
4-Methylphenol (p-Cresol)	200000	--	--	10 U	--	10 U	--	10 U	--
Hexachlorobenzene	130	--	--	10 U	--	10 U	--	10 U	--
Hexachlorobutadiene	500	--	--	10 U	--	10 U	--	10 U	--
Hexachloroethane	3000	--	--	10 U	--	10 U	--	10 U	--
Nitrobenzene	2000	--	--	10 U	--	10 U	--	10 U	--
Pentachlorophenol	100000	--	--	50 U	--	50 U	--	50 U	--
Phenol		--	--	10 U	--	10 U	--	10 U	--
Pyridine	5000	--	--	50 U	--	50 U	--	50 U	--

Table 15
Supporting Design Characterization TCLP Analytical Results

Location ID:		GTC-07	GTC-07	GTC-08	GTC-08	GTC-09	GTC-09	GTC-10	GTC-10
Sample ID[a]:		GTC-07SC-T-090113RE	GTC-57SC-T-090113	GTC-08SC-T-090113	GTC-08SC-T-090113RE	GTC-09SC-T-090114	GTC-09SC-T-090114RE	GTC-10SC-T-090113	GTC-10SC-T-090114RE
Sample Date:	TCLP Criteria	1/13/2009	1/13/2009	1/13/2009	1/13/2009	1/13/2009	1/14/2009	1/13/2009	1/14/2009
PCB Aroclors (µg/L)									
Aroclor 1016		--	--	10 U	--	10 U	--	10 U	--
Aroclor 1221		--	--	10 U	--	10 U	--	10 U	--
Aroclor 1232		--	--	10 U	--	10 U	--	10 U	--
Aroclor 1242		--	--	10 U	--	10 U	--	10 U	--
Aroclor 1248		--	--	10 U	--	10 U	--	10 U	--
Aroclor 1254		--	--	10 U	--	10 U	--	10 U	--
Aroclor 1260		--	--	10 U	--	10 U	--	10 U	--
Pesticides (µg/L)									
alpha-Chlordane (cis-Chlordane)		--	--	0.5 U	--	0.5 U	--	0.5 U	--
Endrin	20	--	--	1 U	--	1 U	--	1 U	--
gamma-BHC (Lindane)	400	--	--	0.5 U	--	0.5 U	--	0.5 U	--
gamma-Chlordane		--	--	0.5 U	--	0.5 U	--	0.5 U	--
Heptachlor	8	--	--	0.5 U	--	0.5 U	--	0.5 U	--
Heptachlor epoxide		--	--	0.5 U	--	0.5 U	--	0.5 U	--
Methoxychlor	10000	--	--	5 U	--	5 U	--	5 U	--
Toxaphene	500	--	--	50 U	--	50 U	--	50 U	--
LWG RA Total Chlordane (Calculated U = 1/2)	30			0.5 AUT		0.5 AUT		0.5 AUT	
Herbicides (µg/L)									
2,4,5-TP (Silvex)	1000	--	--	1.2 U	--	1.2 U	--	1.2 U	--
2,4-D (2,4-Dichlorophenoxyacetic acid)	10000	--	--	5 U	--	5 U	--	5 U	--
Total Petroleum Hydrocarbons (mg/l)									
Diesel Range Hydrocarbons		--	--	**2.7**	--	**3.3**	--	**3.2**	--
Gasoline Range Hydrocarbons		--	**4.1**	**0.96**	--	**7.2**	--	**5.4**	--
Motor Oil		--	--	0.5 U	--	0.5 U	--	0.5 U	--

Table 15
Supporting Design Characterization TCLP Analytical Results

Notes:

	Detected concentration is greater than one screening level
a	The laboratory was asked to reanalyze the TCLP VOCs from an archived homogenized jar to minimize potential variations from VOC collection constraints (taking small plugs of heavily contaminated and clean sample over several feet of core without homogenizing was challenging). The reanalysis samples are identified by "RE" appended to the sample ID (i.e., GTC-04SC-T-090114RE).
µg/L	micrograms per liter
Bold	Detected result
U	Compound analyzed, but not detected above detection limit
UJ	Compound analyzed, but not detected above estimated detection limit
A	The total individual analytes summed are limited and are considered below the ideal individual analyte results.
T	Result is the value of a total or calculation
--	Results not reported or not applicable
RA	Portland Harbor Site risk assessment
N	Normal field sample
FD	Field duplicate

Totals are calculated as the sum of all detected results and 1/2 the undetected result. If all are undetected results, the highest reporting limit value is reported as the sum.

Table 16
Early Action Design Characterization DRET Analytical Results

Location ID	Relevant Acute Water Quality Criteria	RAA-03	RAA-11	RAA-11	RAA-13
Sample Date		7/21/2004	7/22/2004	7/22/2004	7/20/2004
Depth Interval		5 to 13 feet	2 to 4 feet	4 to 13 feet	9 to 11 feet
Sediment Zone		Visually Contaminated	Tar Body	Visually Contaminated	Tar Body
Sheen Visible in Elutriate Test Vessel?		No	Yes	No	Yes
Measurable Non-Aqueous Phase Layer?		No	No	No	No
Conventionals (mg/L)					
Cyanide	0.022	0.01 U	**0.01**	0.01 U	**0.01**
Metals (µg/L)					
Arsenic (dissolved)	340	**2.3**	**0.7**	**0.5**	**0.8**
Arsenic (total)	340	**3.5**	**0.8**	**0.8**	**1**
Chromium (dissolved)	16	**0.31 J**	**0.4**	**0.32 J**	**0.35 J**
Chromium (total)	16	**5.39**	**1.08**	**1.09**	**1.53**
Copper (dissolved)	13	**13.1**	**1.66**	**2.27**	**1.06**
Copper (total)	13	**16.5**	**2.07**	**2.29**	**3.77**
Lead (dissolved)	65	**0.12**	**0.06**	**0.12**	**0.09**
Lead (total)	65	**7.46**	**0.92**	**3.11**	**2.32**
Nickel (dissolved)	470	**0.7**	**1.2**	**1.4**	**1.2**
Nickel (total)	470	**4.4**	**1.9**	**2.1**	**2.1**
Zinc (dissolved)	120	**2.7**	**1.2**	**1.5**	**2.7**
Zinc (total)	120	**16.5**	**3.7**	**4.1**	**7.3**
Total Petroleum Hydrocarbons (µg/L)					
TPH - Diesel Range	--	**430 Z**	**17000 Z**	**240 J**	**13000 Z**
TPH - Residual Range	--	**280 J**	**400 J**	**99 J**	**790 Z**
Semi-Volatile Organic Compounds (µg/L)					
1,2,4-Trichlorobenzene	--	0.20 U	3.9 U	0.20 U	20 U
1,2-Dichlorobenzene	260	0.20 U	3.9 U	0.20 U	3.9 U
1,3-Dichlorobenzene	630	0.20 U	3.9 U	0.20 U	3.9 U
1,4-Dichlorobenzene	180	0.20 U	3.9 U	0.20 U	3.9 U
2,4,5-Trichlorophenol	--	0.48 U	9.6 U	0.48 U	9.6 U
2,4,6-Trichlorophenol	--	0.48 U	9.6 U	0.48 U	9.6 U
2,4-Dichlorophenol	2,020	0.48 U	9.6 U	0.48 U	48 U
2,4-Dimethylphenol	2,120	2.0 U	**14 J**	2.0 U	200 U
2,4-Dinitrophenol		3.9 U	77 U	3.9 U	77 U
2,4-Dinitrotoluene	330	0.20 U	3.9 U	0.20 U	3.9 U
2,6-Dinitrotoluene	--	0.20 U	3.9 U	0.20 U	3.9 U
2-Chloronaphthalene	--	0.20 U	3.9 U	0.20 U	3.9 U
2-Chlorophenol	4,380	0.48 U	9.6 U	0.48 U	9.6 U
2-Methylnaphthalene	--	**0.030 J**	**470**	**0.050 J**	**710**
2-Methylphenol	230	0.48 U	**3.3 J**	0.48 U	**1.6 J**
2-Nitroaniline	--	0.20 U	3.9 U	0.20 U	3.9 U
2-Nitrophenol	--	0.48 U	9.6 U	0.48 U	48 U
3,3'-Dichlorobenzidine	--	2.0 U	39 U	2.0 U	39 U
3-Nitroaniline	--	0.96 U	20 U	0.96 U	20 U

Table 16
Early Action Design Characterization DRET Analytical Results

Location ID	Relevant Acute Water Quality Criteria	RAA-03	RAA-11	RAA-11	RAA-13
Sample Date		7/21/2004	7/22/2004	7/22/2004	7/20/2004
Depth Interval		5 to 13 feet	2 to 4 feet	4 to 13 feet	9 to 11 feet
Sediment Zone		Visually Contaminated	Tar Body	Visually Contaminated	Tar Body
4,6-Dinitro-2-methylphenol	--	2.0 U	39 U	2.0 U	39 U
4-Bromophenylphenylether	--	0.20 U	3.9 U	0.20 U	3.9 U
4-Chloro-3-methylphenol	30	**0.057 J**	9.6 U	**0.076 J**	48 U
4-Chloroaniline	--	0.20 U	3.9 U	0.20 U	20 U
4-Chlorophenyl-phenylether	--	0.20 U	3.9 U	0.20 U	3.9 U
4-Methylphenol	--	0.48 U	**15**	0.48 U	**12**
4-Nitroaniline	--	0.96 U	20 U	0.96 U	20 U
4-Nitrophenol	230	2.0 U	39 U	2.0 U	39 U
Acenaphthene	1,700	**64**	**150**	**6.7**	**440**
Acenaphthylene	--	**1.7**	**390**	**0.48**	**140**
Anthracene	13	**0.12 J**	**41**	**1.2**	**58**
Benzo(a)anthracene	0.49	**0.78**	**4.8**	**0.76**	**19**
Benzo(a)pyrene	0.24	**0.55**	**4.6**	**1**	**24**
Benzo(b)fluoranthene	--	**0.61**	**4.5**	**1**	**22**
Benzo(g,h,i)perylene	--	**0.39**	**3.8 J**	**1**	**20**
Benzo(k)fluoranthene	--	**0.21**	**1.4 J**	**0.39**	**6.9**
Benzoic acid	740	**1.9 J**	96 U	**2.1 J**	480 U
Benzyl alcohol	150	4.8 U	96 U	4.8 U	96 U
bis(2-Chloroethoxy)methane	--	0.20 U	3.9 U	0.20 U	20 U
bis(2-Chloroethyl)ether	--	0.20 U	3.9 U	0.20 U	3.9 U
bis(2-chloroisopropyl)ether	--	0.20 U	3.9 U	0.20 U	3.9 U
bis(2-Ethylhexyl)phthalate	27	2.0 U	39 U	2.0 U	39 U
Butylbenzylphthalate	--	**0.028 J**	3.9 U	**0.027 J**	3.9 U
Chrysene	--	**0.81**	**7.4**	**2.1**	**24**
Dibenzo(a,h)anthracene	--	**0.037 J**	3.9 U	**0.086 J**	**1.8 J**
Dibenzofuran	66	**0.044 J**	**23**	**0.072 J**	**28**
Diethylphthalate	1800	**0.27**	3.9 U	**0.52**	3.9 U
Dimethylphthalate	--	0.20 U	3.9 U	0.20 U	3.9 U
Di-n-butylphthalate	190	**0.091 J**	3.9 U	**0.15 J**	3.9 U
Di-n-octylphthalate	--	0.39 U	7.7 U	0.39 U	7.7 U
Fluoranthene	3,980	**19**	**56**	**6.3**	**110**
Fluorene	70	**0.078 J**	**130**	**0.32**	**150**
Hexachlorobenzene	--	0.20 U	3.9 U	0.20 U	3.9 U
Hexachlorobutadiene	90	0.20 U	3.9 U	0.20 U	20 U
Hexachlorocyclopentadiene	7	0.96 U	20 U	0.96 U	20 U
Hexachloroethane	210	0.20 U	3.9 U	0.20 U	3.9 U
Indeno(1,2,3-cd)pyrene	--	**0.36**	**3.2 J**	**0.83**	**17**
Isophorone	117,000	0.20 U	3.9 U	0.20 U	20 U
Naphthalene	190	**0.078 J**	**6900**	**0.27**	**11000**
Nitrobenzene	27,000	0.20 U	3.9 U	0.20 U	3.9 U

Table 16
Early Action Design Characterization DRET Analytical Results

Location ID	Relevant Acute Water Quality Criteria	RAA-03	RAA-11	RAA-11	RAA-13
Sample Date		7/21/2004	7/22/2004	7/22/2004	7/20/2004
Depth Interval		5 to 13 feet	2 to 4 feet	4 to 13 feet	9 to 11 feet
Sediment Zone		Visually Contaminated	Tar Body	Visually Contaminated	Tar Body
N-Nitroso-di-n-propylamine	5,850	0.20 U	3.9 U	0.20 U	3.9 U
n-Nitrosodiphenylamine	3,800	0.20 U	3.9 U	0.20 U	3.9 U
Pentachlorophenol	19	**0.072 J**	20 U	**0.071 J**	**2.0 J**
Phenanthrene	--	**0.49**	**280**	**1**	**300**
Phenol	10,200	**0.10 J**	**8.9 J**	**0.17 J**	**2.5 J**
Pyrene	--	**20**	**58**	**6**	**110**
Volatile Organic Compounds (µg/L)					
1,1,1-Trichloroethane	200	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	2,100	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichloroethane	5,200	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichlorotrifluoroethan	--	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	830	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethene	450	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichlorobenzene	--	2.0 U	2.0 U	2.0 U	2.0 U
1,2,4-Trichlorobenzene	700	2.0 U	2.0 U	2.0 U	2.0 U
1,2-Dibromo-3-chloropropan	--	2.0 U	2.0 U	2.0 U	2.0 U
1,2-Dichlorobenzene	260	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	8,800	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloropropane	23,000	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichlorobenzene	630	0.50 U	0.50 U	0.50 U	0.50 U
1,4-Dichlorobenzene	180	0.50 U	0.50 U	0.50 U	0.50 U
2-Butanone (MEK)	240,000	20 U	20 U	20 U	20 U
2-Hexanone	1,800	20 U	20 U	20 U	20 U
4-Methyl-2-pentanone (MIBK	2,200	20 U	20 U	20 U	20 U
Acetone	--	**24**	**53**	**25**	**8.4 J**
Benzene	2,300	0.50 U	**810**	**0.26 J**	**220**
Bromochloromethane	--	0.50 U	0.50 U	0.50 U	0.50 U
Bromodichloromethane	--	0.50 U	0.50 U	0.50 U	0.50 U
Bromoform	--	0.50 U	0.50 U	0.50 U	0.50 U
Bromomethane	--	0.50 U	0.50 U	0.50 U	0.50 U
Carbon disulfide	17	0.50 U	**0.53**	0.50 U	0.50 U
Carbon tetrachloride	180	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	1,100	0.50 U	0.50 U	0.50 U	**0.35 J**
Chloroethane	--	0.50 U	0.50 U	0.50 U	0.50 U
Chloroform	490	0.50 U	0.50 U	0.50 U	0.50 U
Chloromethane	--	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,2-Dichloroethene	--	0.50 U	0.50 U	0.50 U	0.50 U
cis-1,3-Dichloropropene	6,060	0.50 U	0.50 U	0.50 U	0.50 U
Cyclohexane	--	1.0 U	1.0 U	1.0 U	1.0 U
Dibromochloromethane	--	0.50 U	0.50 U	0.50 U	0.50 U

Table 16
Early Action Design Characterization DRET Analytical Results

Location ID	Relevant Acute Water Quality Criteria	RAA-03	RAA-11	RAA-11	RAA-13
Sample Date		7/21/2004	7/22/2004	7/22/2004	7/20/2004
Depth Interval		5 to 13 feet	2 to 4 feet	4 to 13 feet	9 to 11 feet
Sediment Zone		Visually Contaminated	Tar Body	Visually Contaminated	Tar Body
Dichlorodifluoromethane	--	0.50 U	0.50 U	0.50 U	0.50 U
Dichloromethane	26,000	**0.66 J**	**0.67 J**	**0.53 J**	**0.90 J**
Ethylbenzene	130	0.50 U	**62**	0.50 U	**290**
Isopropylbenzene	--	2.0 U	**23**	**2.0 U**	**14**
m,p-Xylenes	--	0.50 U	**210**	0.50 U	**210**
Methyl acetate	--	1.0 U	1.0 U	1.0 U	1.0 U
Methyl cyclohexene	--	1.0 U	1.0 U	1.0 U	1.0 U
Methyltert-butylether	--	0.50 U	0.50 U	0.50 U	0.50 U
o-Xylene	--	0.50 U	**100**	0.50 U	**120**
Styrene	--	0.50 U	**38**	0.50 U	0.50 U
Tetrachloroethene	830	0.50 U	0.50 U	0.50 U	0.50 U
Toluene	120	0.50 U	**320**	0.50 U	**160**
trans-1,2-Dichloroethene	1,100	0.50 U	0.50 U	0.50 U	0.50 U
trans-1,3-Dichloropropene	0.99	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethene	440	0.50 U	**0.15 J**	0.50 U	**0.17 J**
Trichlorofluoromethane	--	0.50 U	0.50 U	0.50 U	0.50 U
Vinyl chloride	--	0.50 U	0.50 U	0.50 U	0.50 U

Notes:

Indicates value that exceeds acute criteria.

µg/L micrograms per liter
m/L milligrams per liter
Bold Detected value
J The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
U The compound was analyzed for, but was not detected at or above the MRL/MDL.
Z The chromatographic fingerprint does not resemble a petroleum product.

Water quality criteria from *National Ambient Water Quality Criteria* , Oregon proposed and existing regulations, and ORNL 1996.

-- Not available

Table 17
LWG FS Design Characterization SBLT Analytical Results

Sample ID[a]:	LWM-C11-A	LWM-C11-B	LWM-C11-C	LWM-C11-D
Sample Description:	First Leachate	Second Leachate	Third Leachate	Fourth Leachate
Conventional Parameters (mg/L)				
Ammonia	**16.6**	**8.46**	**6.14**	**3.46**
Cyanide	**0.154 T**	**0.605**	**0.336**	**0.365 T**
Cyanide, free	0.01 UT	0.01 U	0.01 U	0.01 U
Cyanide, amenable	0.005 U	**0.025**	0.005 U	0.005 U
Sulfide	0.05 UJ	0.062 UT	0.05 U	0.1 U
Conventional Parameters (pct)				
Dissolved organic carbon	**0.00251**	**0.00132**	**0.00182**	**0.000951**
Total dissolved solids	**0.0375 J**	**0.0882**	**0.105**	**0.0723**
Total organic carbon	**0.00305 T**	**0.00231**	**0.00188**	**0.00152**
Total suspended solids	**0.00085**	**0.00091**	**0.00299**	**0.0106**
Metals (µg/L)				
Aluminum	**75 T**	**380**	**750**	**650**
Antimony	0.2 UT	0.2 U	0.2 U	0.2 U
Arsenic	**1.2 T**	**1.8**	**2**	**1.8**
Cadmium	0.2 UT	0.2 U	0.2 U	0.2 U
Chromium	0.5 UT	0.5 U	**2.2**	**1.5**
Copper	**2.5 T**	**2.9**	**6.9**	**4.6**
Lead	1 UT	1 U	**3**	**2**
Mercury	0.1 UT	0.1 U	0.1 U	0.1 U
Nickel	**2.5 T**	**1.9**	**4.2**	**3.1**
Silver	0.2 UT	0.2 U	0.2 U	0.2 U
Zinc	**53.5 T**	**32**	**30**	**23**
Volatile Organics (µg/L)				
2,3,4,6 and 2,3,5,6-Tetrachlorophenol coelution	**2.8**	**1.4**	**1.5**	**1.1 J**
Hexachlorobutadiene	0.005 UJ	0.005 UJ	0.05 UJ	0.005 UJ
Aromatic Hydrocarbons (µg/L)				
2-Methylnaphthalene	**590**	**430**	**580 J**	**1700**
Acenaphthene	**290**	**330**	**380 J**	**1200**
Acenaphthylene	**150**	**130**	**150 J**	**470**
Anthracene	**28**	**96**	**130 J**	**450**
Benzo(a)anthracene	**6.4**	**51**	**57 J**	**240**
Benzo(a)pyrene	**7.4**	**56**	**66 J**	**320**
Benzo(b)fluoranthene	**3.7**	**32**	**41 J**	**190**
Benzo(g,h,i)perylene	**6.1**	**35**	**52 J**	**170**
Benzo(k)fluoranthene	**4.7**	**37**	**35 J**	**140**
Chrysene	**7.6**	**63**	**69 J**	**340**
Dibenzo(a,h)anthracene	1 U	**5**	**7.6 J**	**34**
Fluoranthene	**39**	**180**	**280 J**	**970**
Fluorene	**94**	**140**	**170 J**	**580**
Indeno(1,2,3-c,d)pyrene	**4.3**	**25**	**37 J**	**130**
Naphthalene	**8700**	**2700**	**6600 J**	**12000**
Phenanthrene	**220**	**680**	**780 J**	**2400**
Pyrene	**37**	**220**	**280 J**	**1100**
LWG RA Total 7 of 17 LPAH (Calculated U = 1/2)	**10072 T**	**4506 T**	**8790 JT**	**18800 T**
LWG RA Total 10 of 17 HPAH (Calculated U = 1/2)	**116.7 T**	**704 T**	**924.6 JT**	**3634 T**
LWG RA Total 17 PAH (Calculated U = 1/2)	**10188.7 T**	**5210 T**	**9714.6 JT**	**22434 T**
LWG RA Total cPAH TEF (7 minimum) (Calculated U = 1/2)	**9.436 T**	**71.63 T**	**84.45 JT**	**396.8 T**
Semivolatile Organics (µg/L)				
1,2,4-Trichlorobenzene	1 U	3 U	1 UJ	3 U
1,2-Dichlorobenzene	1 U	3 U	1 UJ	3 U
1,3-Dichlorobenzene	1 U	3 U	1 UJ	3 U
1,4-Dichlorobenzene	1 U	3 U	1 UJ	3 U
2,2'-Oxybis (1-chloropropane)	1 U	3 U	1 UJ	3 U
2,3,4,5-Tetrachlorophenol	**0.46**	0.25 U	**0.4**	0.25 UJ
2,4,5-Trichlorophenol	0.25 U	0.25 U	0.25 U	0.25 UJ
2,4,6-Trichlorophenol	0.25 U	0.25 U	0.25 U	0.44 UJ
2,4-Dichlorophenol	5 U	15 U	5 UJ	15 U
2,4-Dimethylphenol	**59**	**19**	**15 J**	**14**
2,4-Dinitrophenol	10 U	30 U	10 UJ	30 U
2,4-Dinitrotoluene	5 U	15 U	5 UJ	15 U
2,6-Dinitrotoluene	5 U	15 U	5 UJ	15 U
2-Chloronaphthalene	1 U	3 U	1 UJ	3 U
2-Chlorophenol	1 U	3 U	1 UJ	3 U
2-Methylphenol (o-Cresol)	**14**	**3.6**	**1.8 J**	3 U
2-Nitroaniline	5 U	15 U	5 UJ	15 U
2-Nitrophenol	5 U	15 U	5 UJ	15 U

Table 17
LWG FS Design Characterization SBLT Analytical Results

Sample ID[a]:	LWM-C11-A	LWM-C11-B	LWM-C11-C	LWM-C11-D
Sample Description:	First Leachate	Second Leachate	Third Leachate	Fourth Leachate
3,3'-Dichlorobenzidine	5 U	15 U	5 UJ	15 U
3-Nitroaniline	5 U	15 U	5 UJ	15 U
4-Bromophenyl-phenyl ether	1 U	3 U	1 UJ	3 U
4-Chloro-3-methylphenol	5 U	15 U	5 UJ	15 U
4-Chloroaniline	5 U	15 U	5 UJ	15 U
4-Chlorophenyl phenyl ether	1 U	3 U	1 UJ	3 U
4-Methylphenol (p-Cresol)	**72**	**15**	**6.4 J**	**3.8**
4-Nitroaniline	5 U	15 U	5 UJ	15 U
4-Nitrophenol	5 U	15 U	5 UJ	15 U
Aniline	1 U	3 U	1 UJ	3 U
Azobenzene	1 U	3 U	1 UJ	3 U
Benzoic acid	**18**	30 U	**12 J**	30 U
Benzyl alcohol	**5.9**	15 U	5 UJ	15 U
bis(2-Chloroethoxy)methane	1 U	3 U	1 UJ	3 U
bis(2-Chloroethyl)ether	1 U	3 U	1 UJ	3 U
Bis(2-ethylhexyl) phthalate	**0.36**	**0.63**	**0.61**	**2.8**
Diethyl phthalate	0.52 U	0.25 U	0.63 U	0.44 U
Butylbenzyl phthalate	0.25 U	0.25 U	0.25 U	0.25 U
Dimethyl phthalate	0.25 U	0.25 U	0.25 U	0.25 U
Di-n-butyl phthalate	0.25 U	0.25 U	0.25 U	0.25 U
Dinitro-o-cresol (4,6-Dinitro-2-methylphenol)	10 U	30 U	10 UJ	30 U
Di-n-octyl phthalate	0.25 U	0.25 U	0.25 U	0.25 U
Hexachlorobenzene	0.005 UJ	0.005 UJ	0.05 UJ	0.023 UJ
Dibenzofuran	**19**	**28**	**30 J**	**96**
Hexachlorocyclopentadiene	5 U	15 U	5 UJ	15 U
Hexachloroethane	0.005 UJ	0.005 UJ	0.05 UJ	0.005 UJ
Isophorone	1 U	3 U	1 UJ	3 U
Nitrobenzene	1 U	3 U	1 UJ	3 U
N-Nitrosodimethylamine	5 U	15 U	5 UJ	15 U
N-Nitrosodi-N-propylamine	5 U	15 U	5 UJ	15 U
N-Nitrosodiphenylamine	1 U	3 U	3.4 UJ	11 U
Pentachlorophenol	**3.4**	**1.7**	**1.9**	**1.5 J**
Phenol	**20**	**9.2**	**3.7 J**	**3.5**
PCB Aroclors (µg/L)				
Aroclor 1016	0.01 U	0.01 U	0.01 U	0.01 U
Aroclor 1221	0.01 U	0.01 U	0.01 U	0.01 U
Aroclor 1232	0.01 U	0.01 U	0.01 U	0.01 U
Aroclor 1242	0.01 U	0.01 U	0.018 U	0.03 U
Aroclor 1248	0.01 U	0.02 U	0.01 U	0.01 U
Aroclor 1254	0.025 U	0.04 U	0.1 U	0.1 U
Aroclor 1260	0.01 U	**0.012**	0.025 U	**0.042**
Aroclor 1262	0.01 U	0.01 U	0.01 U	0.01 U
Aroclor 1268	0.01 U	0.01 U	0.01 U	0.01 U
LWG RA Total PCB Aroclors (Calculated U = 1/2)	0.025 UT	**0.072 T**	0.1 UT	**0.137 T**
PCB Congeners (ng/l)				
PCB-001	**0.054**	**0.492 J**	**0.435**	**0.188 J**
PCB-002	**0.0363**	**0.13 J**	**0.22 J**	**0.239 J**
PCB-003	**0.0416**	**0.164 J**	**0.365**	**0.242 J**
PCB-004/010	0.053 U	1.04 U	0.527 U	0.263 U
PCB-005/008	0.053 U	1.04 U	**0.425 J**	0.263 U
PCB-006	0.053 U	1.04 U	0.527 U	0.263 U
PCB-007/009	0.053 U	1.04 U	0.527 U	0.263 U
PCB-011	0.185 UJ	1.04 U	0.527 U	0.263 U
PCB-012/013	0.053 U	1.04 U	0.527 U	0.263 U
PCB-014	0.053 U	1.04 U	0.527 U	0.263 U
PCB-015	0.246 UJ	1.04 U	0.835 UJ	2.83 UJ
PCB-016/032	0.0435 U	**0.388 J**	**0.882**	**0.666 J**
PCB-017	0.0265 U	0.52 U	**0.128 J**	0.2 UJ
PCB-018	0.0265 U	**0.341 J**	**0.375**	0.132 U
PCB-019	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-020/021/033	**0.0456**	**0.63**	**1.31**	**0.98**
PCB-022	**0.033**	**0.402 J**	**0.811**	0.45 UJ
PCB-023	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-024/027	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-025	0.0265 U	0.52 U	**0.276**	0.187 UJ
PCB-026	0.0265 U	**0.217 J**	**0.459**	**0.266**
PCB-028	0.0749 U	**0.963**	**2.31**	**1.69**
PCB-029	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-030	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-031	0.0762 U	**0.946**	**2.63**	**1.61**

Table 17
LWG FS Design Characterization SBLT Analytical Results

Sample ID[a]:	LWM-C11-A	LWM-C11-B	LWM-C11-C	LWM-C11-D
Sample Description:	First Leachate	Second Leachate	Third Leachate	Fourth Leachate
PCB-034	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-035	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-036	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-037	**0.0346**	**0.373 J**	**0.636**	**0.417**
PCB-038	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-039	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-040	0.0265 U	0.52 U	**0.676**	0.411 UJ
PCB-041/064/071/072	0.101 U	**1.58**	**3.35**	**2.39**
PCB-042/059	**0.0341**	**0.576**	**1.19**	**0.854**
PCB-043/049	**0.109**	**1.26**	**3.03**	**1.99**
PCB-044	0.141 U	**1.74**	**4.2**	**2.72**
PCB-045	0.0265 U	**0.223 J**	0.463 UJ	0.32 UJ
PCB-046	0.0265 U	**0.13 J**	**0.238 J**	**0.172**
PCB-047	0.0517 U	**0.498 J**	**1.22**	**0.921**
PCB-048/075	0.0265 U	**0.384 J**	**0.754**	**0.467**
PCB-050	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-051	0.0265 U	**0.16 J**	**0.181 J**	**0.108 J**
PCB-052/069	**0.181**	**1.91**	**4.54**	**2.92**
PCB-053	0.0265 U	**0.22 J**	**0.491**	**0.35**
PCB-054	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-055	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-056/060	**0.0772**	**1.49**	**3**	**1.97**
PCB-057	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-058	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-061/070	**0.203**	**2.61**	**6.12**	**3.67**
PCB-062	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-063	0.0265 U	0.52 U	**0.184 J**	0.132 U
PCB-065	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-066/076	**0.113**	**1.96**	**4.13**	**4.18**
PCB-067	0.0265 U	0.52 U	**0.192 J**	0.155 UJ
PCB-068	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-073	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-074	**0.0553**	**0.94**	**2.06**	**1.98**
PCB-077	0.0175 U	**0.397 J**	**0.389**	**0.287**
PCB-078	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-079	0.0265 U	**0.185 J**	0.263 U	0.132 U
PCB-080	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-081	0.0128 U	**0.195 J**	**0.109 J**	0.0957 U
PCB-082	**0.0534**	**0.559**	**0.884**	**0.517**
PCB-083	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-084/092	**0.195**	**1.32**	**3.36**	**1.92**
PCB-085/116	**0.0582**	**0.467 J**	**1.15**	**0.6**
PCB-086	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-087/117/125	**0.147**	**1.12**	**2.53**	**1.29**
PCB-088/091	0.0265 U	**0.368 J**	**0.885**	**0.536**
PCB-089	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-090/101	**0.391**	**3.21**	**8**	**4.65**
PCB-093	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-094	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-095/098/102	**0.279**	**2.19**	**5.42**	**3.13**
PCB-096	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-097	**0.13**	**0.844**	**1.96**	**1.05**
PCB-099	**0.152**	**1.21**	**3.05**	**1.87**
PCB-100	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-103	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-104	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-105	**0.133**	**1.14**	**2.77**	**1.27**
PCB-106/118	**0.358**	**2.56**	**6.93**	**3.17**
PCB-107/109	**0.0275**	0.52 U	**0.548**	**0.315**
PCB-108/112	0.0265 U	**0.211 J**	**0.365**	0.168 UJ
PCB-110	**0.488**	**2.97**	**8.15**	**4.07**
PCB-111/115	0.0265 U	0.52 U	**0.152 J**	**0.0906 J**
PCB-113	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-114	0.00891 U	0.198 U	**0.188 J**	0.12 U
PCB-119	0.0265 U	0.52 U	**0.199 J**	**0.126 J**
PCB-120	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-121	**0.0394**	0.52 U	0.263 U	**0.402**
PCB-122	0.0265 U	0.52 U	**0.12 J**	0.132 U
PCB-123	0.0102 U	0.255 U	0.155 U	0.128 U
PCB-124	0.0265 U	**0.193 J**	0.263 U	**0.168**
PCB-126	0.00943 U	**0.282 J**	0.1 U	0.125 U
PCB-127	0.0265 U	0.52 U	0.263 U	0.132 U

Table 17
LWG FS Design Characterization SBLT Analytical Results

Sample ID[a]:	LWM-C11-A	LWM-C11-B	LWM-C11-C	LWM-C11-D
Sample Description:	First Leachate	Second Leachate	Third Leachate	Fourth Leachate
PCB-128/162	**0.0747**	**0.818**	**1.38**	**0.659**
PCB-129	0.0265 U	**0.27 J**	**0.345**	0.132 U
PCB-130	0.0265 U	**0.308 J**	**0.635**	**0.329**
PCB-131	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-132/161	**0.14**	**1.35**	**3.15**	**2.03**
PCB-133/142	0.0265 U	**0.272 J**	**0.335**	**0.235**
PCB-134/143	0.0265 U	**0.341 J**	**0.56**	**0.331**
PCB-135	**0.0585**	**0.775**	**1.63**	0.935 UJ
PCB-136	**0.0523**	**0.714**	**1.52**	**1.05**
PCB-137	0.0265 U	**0.266 J**	**0.406**	**0.298**
PCB-138/163/164	**0.386**	**5.07**	**10.8**	**7.07**
PCB-139/149	**0.293**	**3.84**	**9.16**	**6.16**
PCB-140	0.0265 U	0.52 U	**0.14 J**	0.132 U
PCB-141	**0.0778**	**1.25**	**2.49**	**1.64**
PCB-144	0.0265 U	0.52 U	**0.6**	**0.307**
PCB-145	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-146/165	**0.0612**	**0.918**	**1.82**	**1.35**
PCB-147	0.0265 U	**0.161 J**	**0.187 J**	0.132 U
PCB-148	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-150	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-151	**0.0833**	**1.17**	**2.81**	**2.03**
PCB-152	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-153	**0.343**	**5.34**	**12**	**8.06**
PCB-154	0.0265 U	**0.157 J**	**0.149 J**	0.132 U
PCB-155	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-156	**0.0437**	**0.61**	**1.12**	**0.5**
PCB-157	**0.0121 J**	**0.283 J**	**0.207 J**	**0.159**
PCB-158/160	**0.05**	**0.649**	**1.25**	**0.647**
PCB-159	0.0265 U	0.52 U	**0.185 J**	0.132 U
PCB-166	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-167	0.0158 U	**0.311 J**	**0.446**	**0.264**
PCB-168	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-169	0.00959 U	**0.34 J**	0.0581 U	**0.114 J**
PCB-170	**0.0952**	**1.96**	**3.61**	**2.79**
PCB-171	0.0265 U	**0.464 J**	**1.11**	**0.857**
PCB-172	0.0265 U	**0.415 J**	**0.671**	**0.49**
PCB-173	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-174	**0.102**	**2.3**	**4.38**	**3.14**
PCB-175	0.0265 U	0.52 U	**0.226 J**	**0.133**
PCB-176	0.0265 U	0.52 U	**0.6**	**0.393**
PCB-177	**0.0624**	**1.15**	**2.56**	**1.91**
PCB-178	0.0265 U	**0.423 J**	**0.832**	**0.515**
PCB-179	**0.0428**	**0.822**	**1.76**	**1.21**
PCB-180	**0.219**	**4.66**	**10.1**	**6.51**
PCB-181	0.0265 U	0.52 U	**0.363**	**0.321**
PCB-182/187	0.0958 UJ	**2.28**	**5**	**3.26**
PCB-183	**0.0586**	**1.1**	**2.18**	**1.45**
PCB-184	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-185	0.0265 U	**0.351 J**	**0.581**	**0.342**
PCB-186	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-188	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-189	0.00469 U	**0.319 J**	**0.159 J**	**0.173**
PCB-190	0.0265 U	0.52 U	**0.766**	**0.611**
PCB-191	0.0265 U	0.52 U	**0.164 J**	0.14 UJ
PCB-192	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-193	0.0265 U	**0.307 J**	**0.538**	0.305 UJ
PCB-194	**0.0552**	**1.26**	**2.36**	**1.46**
PCB-195	**0.0276**	**0.605**	**0.978**	**0.703**
PCB-196/203	**0.0667**	**1.77**	**2.87**	**2.25**
PCB-197	0.0265 U	**0.168 J**	**0.123 J**	0.132 U
PCB-198	0.0265 U	0.52 U	**0.166 J**	0.132 U
PCB-199	**0.0511**	**1.66**	**2.72**	**1.15**
PCB-200	0.0265 U	**0.297 J**	**0.376**	0.157 UJ
PCB-201	0.0265 U	**0.283 J**	**0.404**	**0.214**
PCB-202	0.0265 U	**0.267 J**	**0.517**	**0.341**
PCB-204	0.0265 U	0.52 U	0.263 U	0.132 U
PCB-205	0.0265 U	**0.278 J**	**0.163 J**	0.132 U
PCB-206	**0.0812**	**1.48**	**3.23**	**2.11**
PCB-207	0.0265 U	**0.207 J**	**0.254 J**	**0.173**
PCB-208	0.0265 U	0.52 U	0.5 UJ	**0.381**
PCB-209	**0.137**	**2.66**	**4.71**	**3.48**
LWG RA Total PCB Congener (Calculated U = 1/2)	**8.1001100000000 2 JT**	**114.6535 JT**	**210.98455 JT**	**134.22945 JT**

Table 17
LWG FS Design Characterization SBLT Analytical Results

Sample ID[a]:	LWM-C11-A	LWM-C11-B	LWM-C11-C	LWM-C11-D
Sample Description:	First Leachate	Second Leachate	Third Leachate	Fourth Leachate
Pesticides (µg/L)				
2,4'-DDD (o,p'-DDD)	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
2,4'-DDE (o,p'-DDE)	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
2,4'-DDT (o,p'-DDT)	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
4,4'-DDD (p,p'-DDD)	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
4,4'-DDE (p,p'-DDE)	0.01 UJ	0.078 UJ	0.1 UJ	0.054 UJ
4,4'-DDT (p,p'-DDT)	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
LWG RA Sum DDD (Calculated U = 1/2)	0.01 UJT	0.01 UJT	0.1 UJT	0.01 UJT
LWG RA Sum DDE (Calculated U = 1/2)	0.01 UJT	0.078 UJT	0.1 UJT	0.054 UJT
LWG RA Sum DDT (Calculated U = 1/2)	0.01 UJT	0.01 UJT	0.1 UJT	0.01 UJT
LWG RA Total DDx (Calculated U = 1/2)	0.01 UJT	0.078 UJT	0.1 UJT	0.054 UJT
Aldrin	0.005 UJ	0.005 UJ	0.05 UJ	0.005 UJ
alpha-BHC	0.005 UJ	0.057 UJ	0.05 UJ	0.033 UJ
beta-BHC	0.024 UJ	0.19 UJ	0.22 UJ	0.056 UJ
alpha-Chlordane (cis-Chlordane)	0.005 UJ	0.005 UJ	0.05 UJ	0.005 UJ
beta-Chlordane (trans-Chlordane)	0.014 UJ	0.08 UJ	0.05 UJ	0.11 UJ
cis-Nonachlor	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
trans-Nonachlor	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
delta-BHC	0.005 UJ	0.032 UJ	0.05 UJ	0.005 UJ
Dieldrin	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
Endosulfan-alpha (I)	0.005 UJ	0.005 UJ	0.05 UJ	0.005 UJ
Endosulfan-beta (II)	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
Endosulfan sulfate	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
Endrin	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
Endrin aldehyde	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
Endrin ketone	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
gamma-BHC (Lindane)	0.005 UJ	0.047 UJ	0.063 UJ	0.005 UJ
Heptachlor	0.022 UJ	0.005 UJ	0.079 UJ	0.025 UJ
Heptachlor epoxide	0.005 UJ	0.005 UJ	0.05 UJ	0.005 UJ
Methoxychlor	0.05 UJ	0.05 UJ	0.5 UJ	0.05 UJ
Mirex	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
Oxychlordane	0.01 UJ	0.01 UJ	0.1 UJ	0.01 UJ
Toxaphene	0.5 UJ	0.5 UJ	5 UJ	0.5 UJ
Total Petroleum Hydrocarbons (mg/L)				
Total petroleum hydrocarbons	**6.3 A**	**4.7 JA**	**30 A**	**9.9 JA**
Diesel Range Hydrocarbons	**6.3**	**4.7 J**	**30**	**9.9 J**
Motor Oil Range	2.5 U	1 UJ	10 U	2.5 UJ

Notes:

Detected concentration is greater than one screening level

Detected concentration is greater than two screening levels

Detected concentration is greater than three screening levels

Detected concentration is greater than four screening levels

mg/L milligrams per liter

µg/L micrograms per liter

ng/l nanograms per liter

Bold Detected result

A The shown SBLT sample IDs are from a single composite sample created from sediment collected from station locations LWM-C11-A, LWM-C11-B, LWM-C11-C, and LWM-C11-D. Leachate was consecutively collected and analyzed from this composite sample four times.

U Compound analyzed, but not detected above detection limit

UJ Compound analyzed, but not detected above estimated detection limit

A The total individual analytes summed are limited and are considered below the ideal individual analyte results.

T Result is the value of a total or calculation

-- Results not reported or not applicable

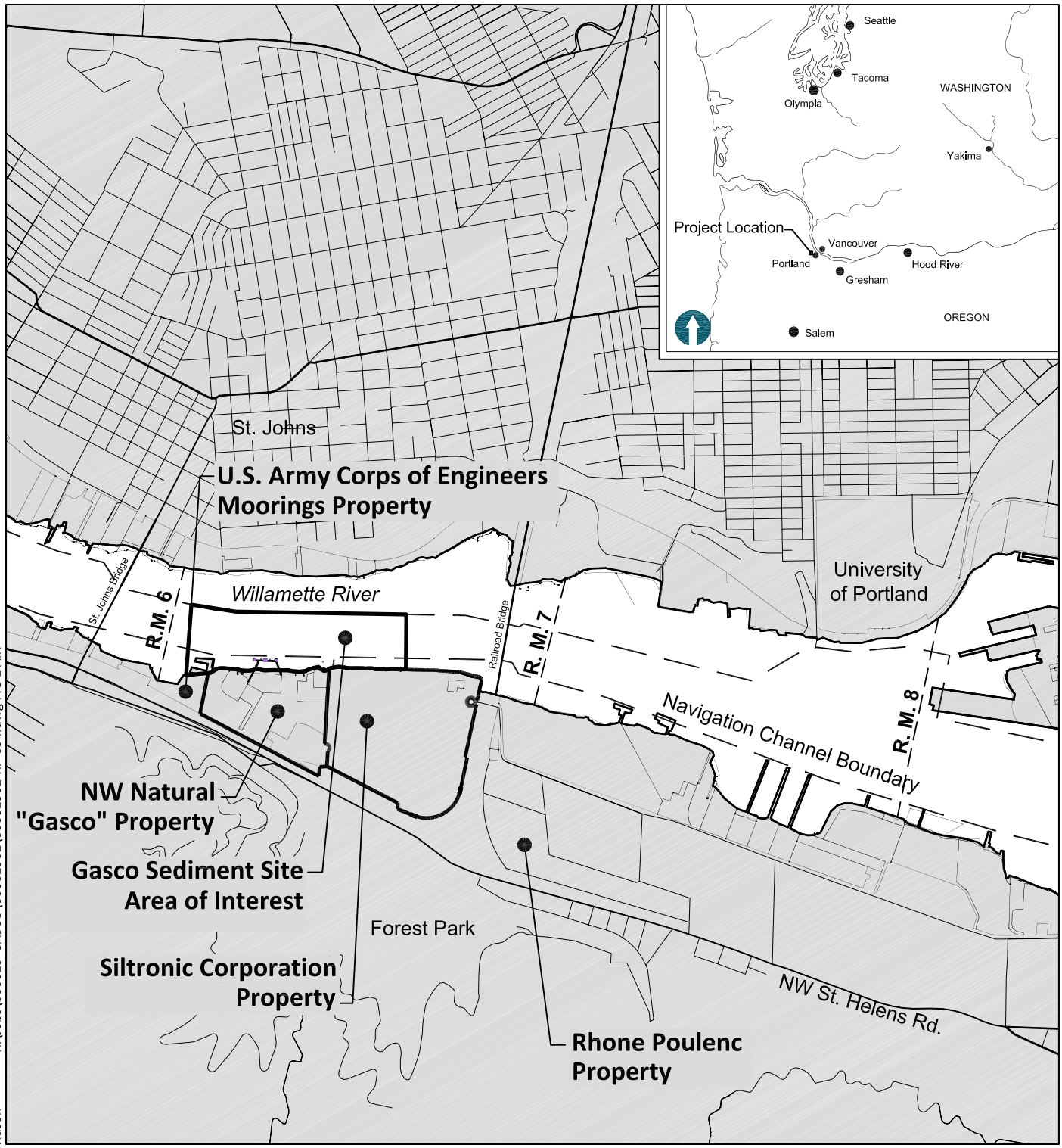
RA Portland Harbor Site risk assessment

N Normal field Sample

FD Field duplicate

Totals are calculated as the sum of all detected results and 1/2 the undetected result. If all are undetected results, the highest reporting limit value is reported as the sum.

FIGURES



NOTE: All locations are approximate.

0 2000
Scale in Feet

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

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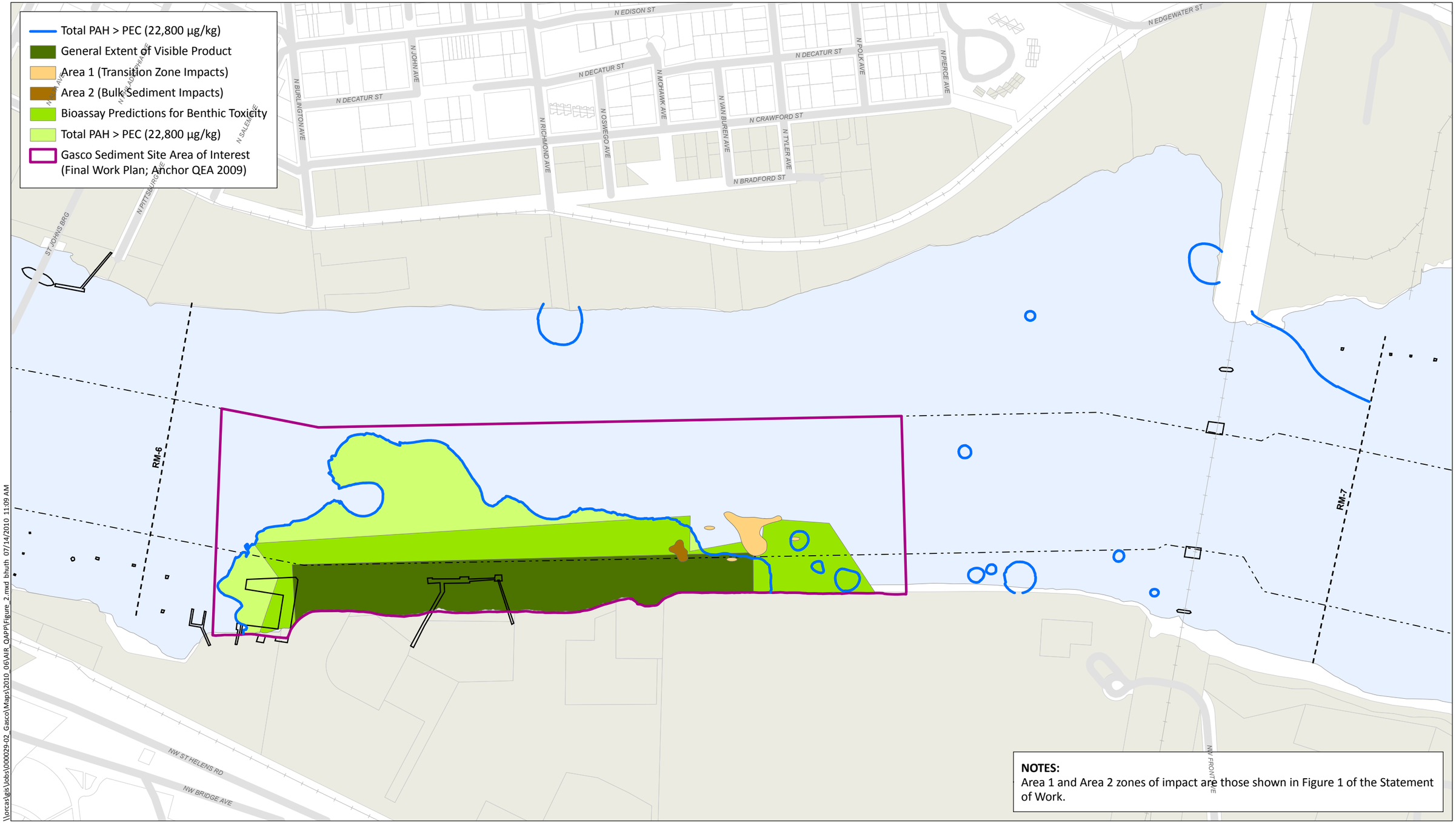
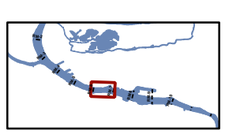
Figure 1
Site Vicinity Map
Final Project Area Identification Report
Gasco Sediments Cleanup Action

ANCHOR QEA





Feet
0 190 380 570 760

Figure 2
Potential Remediation Extents Based on the Data Available as of July 2009
Final Project Area Identification Report
Gasco Sediments Cleanup Action

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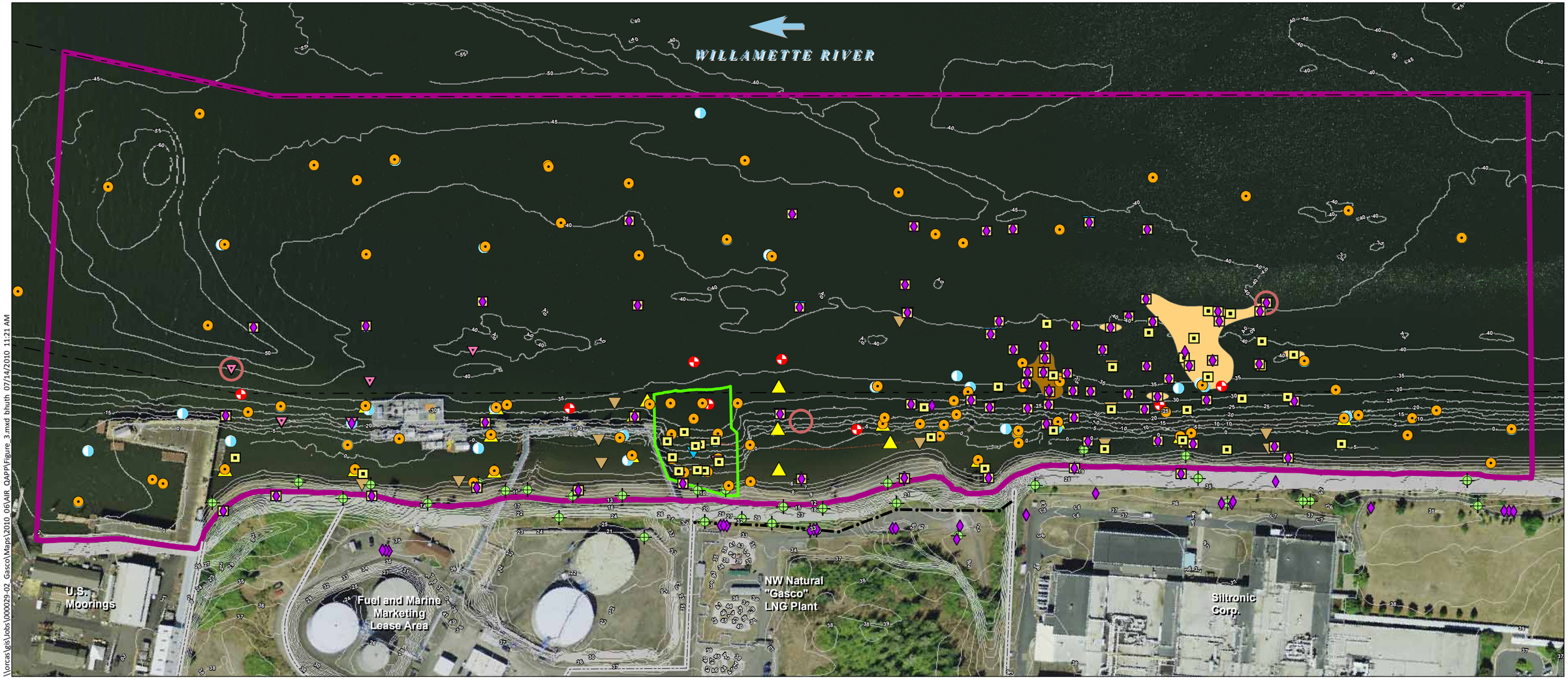

LEGEND

- Surface Water
- Groundwater
- Surface Sediment
- Subsurface Sediment
- Sediment Trap
- Soil
- TZW
- Bioassay Stations
- LWG Seepage Meter Locations
- Seepage Meter Location
- Acoustic Doppler Measurements
- Gasco Sediment Site Area of Interest (Final Work Plan; Anchor QEA 2009)
- Tar Body Removal Action Area (RAPP; Anchor 2005)
- Area 1 (Transition Zone Impacts)
- Area 2 (Bulk Sediment Impacts)
- Sheet Pile Wall
- River miles
- Navigation Channel
- Bathymetry/Topography
- Property Line

Feet
0 100 200 300 400

ANCHOR QEA

NOTES:
1. Area 1 and Area 2 zones of impact are those shown in Figure 1 of the Statement of Work.
2. Bathymetry surveyed by LWG 2009.
3. Topography surveyed by Spencer B. Gross, Inc 2006.
4. Arrow indicates direction of flow of river.
5. Aerial imagery from July 2007.

Figure 3
Summary of Sample Media Locations Used for Project Area Identification
Final Project Area Identification Report
Gasco Sediments Cleanup Action

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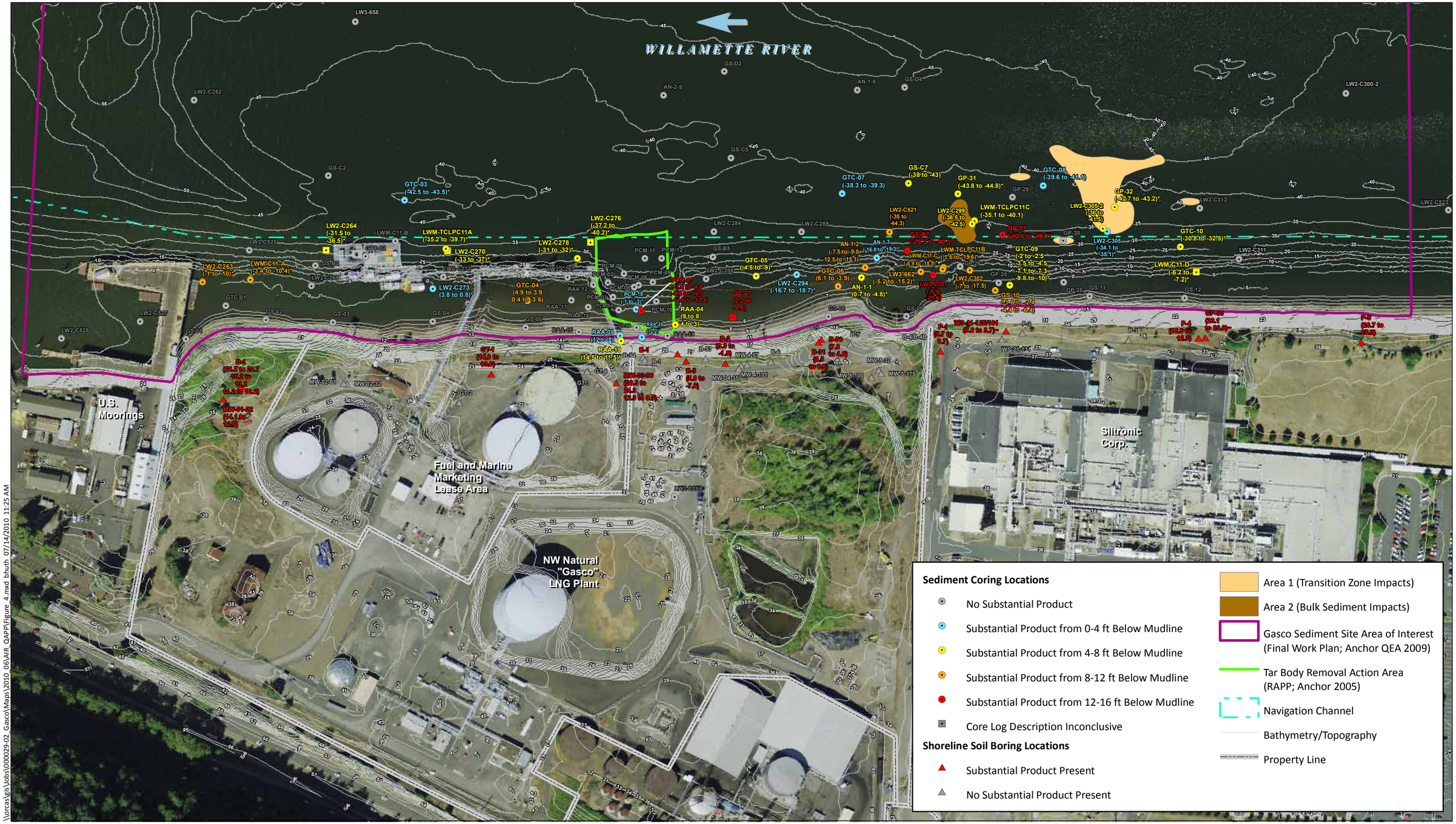

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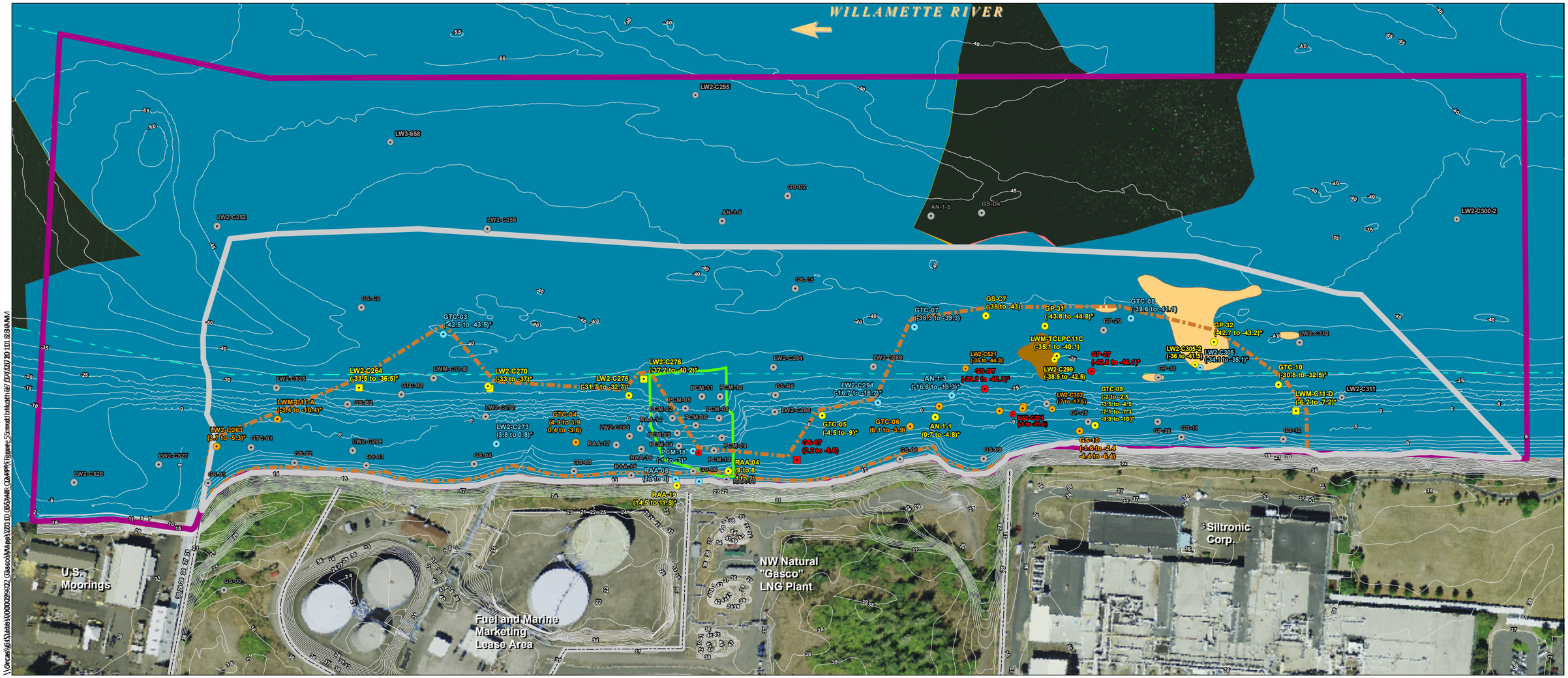
NOTES:
1. * = mudline elevation estimated based on bathymetry surveyed by LWG in 2009.
2. ~ = surface elevation estimated based on topography surveyed by Spencer B. Gross, Inc 2006.
3. B-56 (7.8 to 4.8) = Location ID (deepest observed elevation of substantial product in ft NAVD 88).
4. Locations GTC-09 and LWM-TCLPC-11B showed substantial product at the bottom of the core.
5. The substantial product extents are estimated based on visual observations based using substantial product definition in the SOW.
6. Area 1 and Area 2 zones of impact are those shown in Figure 1 of the Statement of Work.
7. Arrow indicates direction of flow of river.
8. Aerial imagery from July 2007.

ANCHOR QEA

Feet
0 100 200 300 400

Figure 4
Sediments and Riverbank Substantial Product Extents
Final Project Area Identification Report
Gasco Sediments Cleanup Action



Sediment Coring Locations

- No Substantial Product
- Substantial Product from 0-4 ft Below Mudline
- Substantial Product from 4-8 ft Below Mudline
- Substantial Product from 8-12 ft Below Mudline
- Substantial Product from 12-16 ft Below Mudline
- Core Log Description Inconclusive

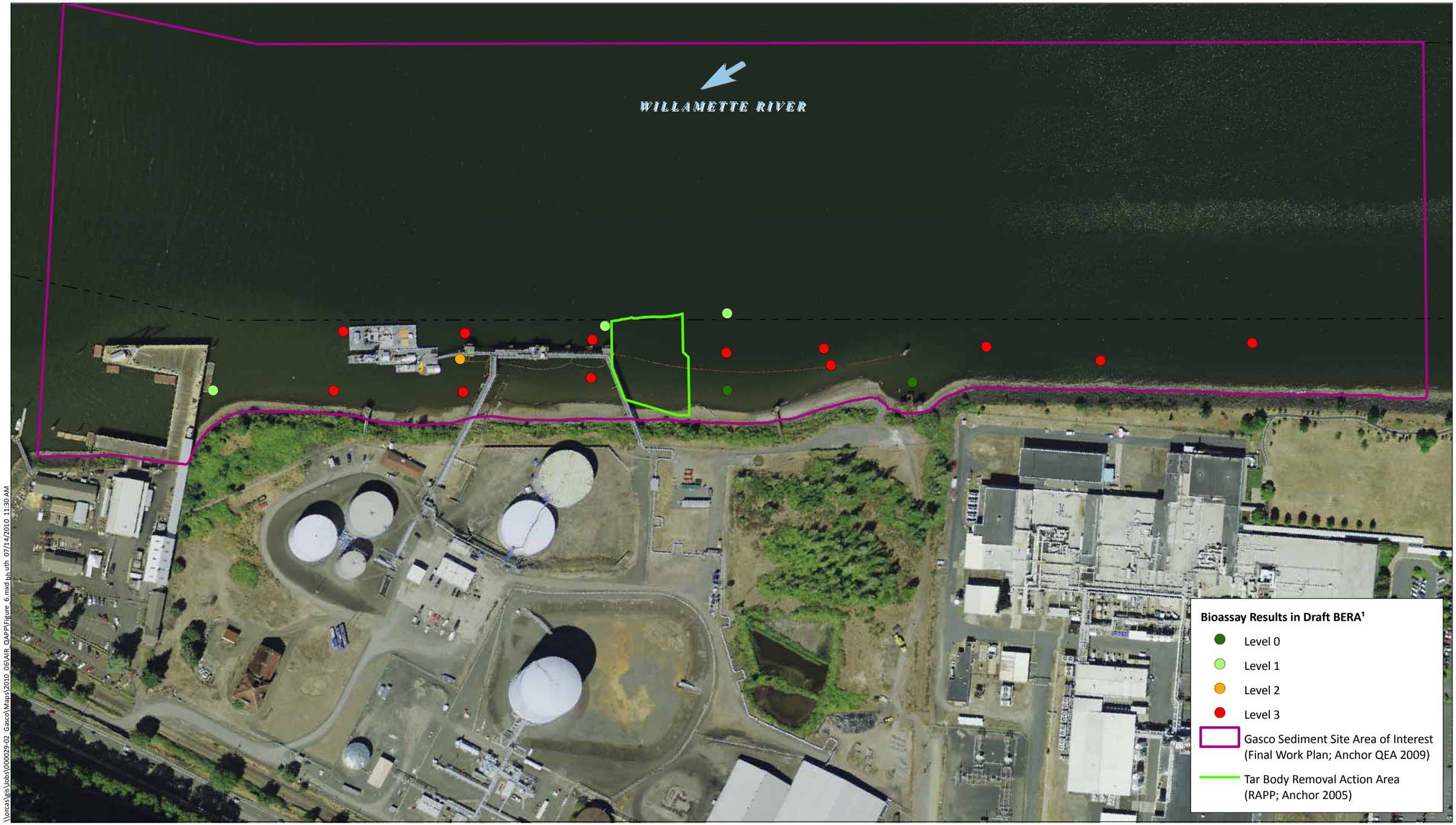
- Substantial Product Area
- Initial Project Area
- Gasco Sediment Site Area of Interest (Final Work Plan; Anchor QEA 2009)
- Area 1 (Transition Zone Impacts)
- Area 2 (Bulk Sediment Impacts)
- Tar Body Removal Action Area (RAPP; Anchor 2005)
- Navigation Channel
- Property Line
- Bathymetry/Topography

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. B-56 (7.8 to 4.8) = Location ID (deepest observed elevation of substantial product in ft NAVD 88).
4. Locations GTC-09 and LWM-TCLPC-11B showed substantial product at the bottom of the core.
5. The substantial product extents are estimated based on visual observations based using substantial product definition in the SOW.
6. Area 1 and Area 2 zones of impact are those shown in Figure 1 of the Statement of Work.
7. Arrow indicates direction of flow of river.
8. Aerial imagery from July 2007.

Feet
0 100 200 300 400

ANCHOR QEA

Figure 5
Initial Project Area Extents
Final Project Area Identification Report
Gasco Sediments Cleanup Action



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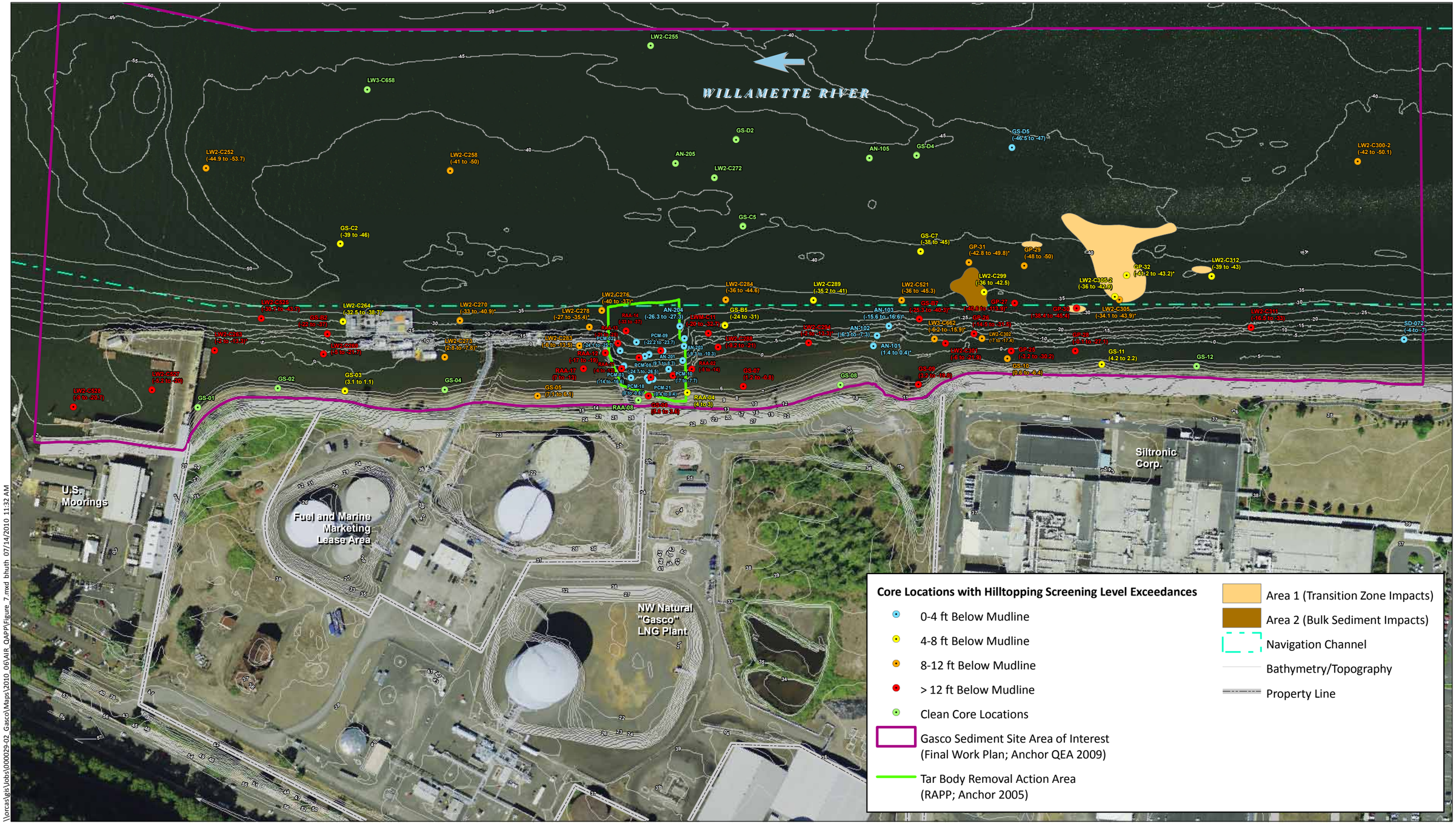
ANCHOR QEA

NOTE:
1. [1]Benthic Toxicity Thresholds are from Table 2-3 Toxicity Thresholds Based on the Calcasieu, Draft BERA, and EPA 2009 Procedures of Windward Environmental LLC, August 2009. Portland Benthic Toxicity Reanalysis Technical Memorandum. Values for the REV (L1) and low (L2) thresholds are obtained using the EPA 2009 method. Values for the high threshold (L3) is the "high threshold" value obtained using the Draft BERA Procedure.
2. Arrow indicates direction of flow of river.

Feet
0 100 200 300 400

Figure 6
Benthic Toxicity Threshold Exceedances
Final Project Area Identification Report
Gasco Sediments Cleanup Action



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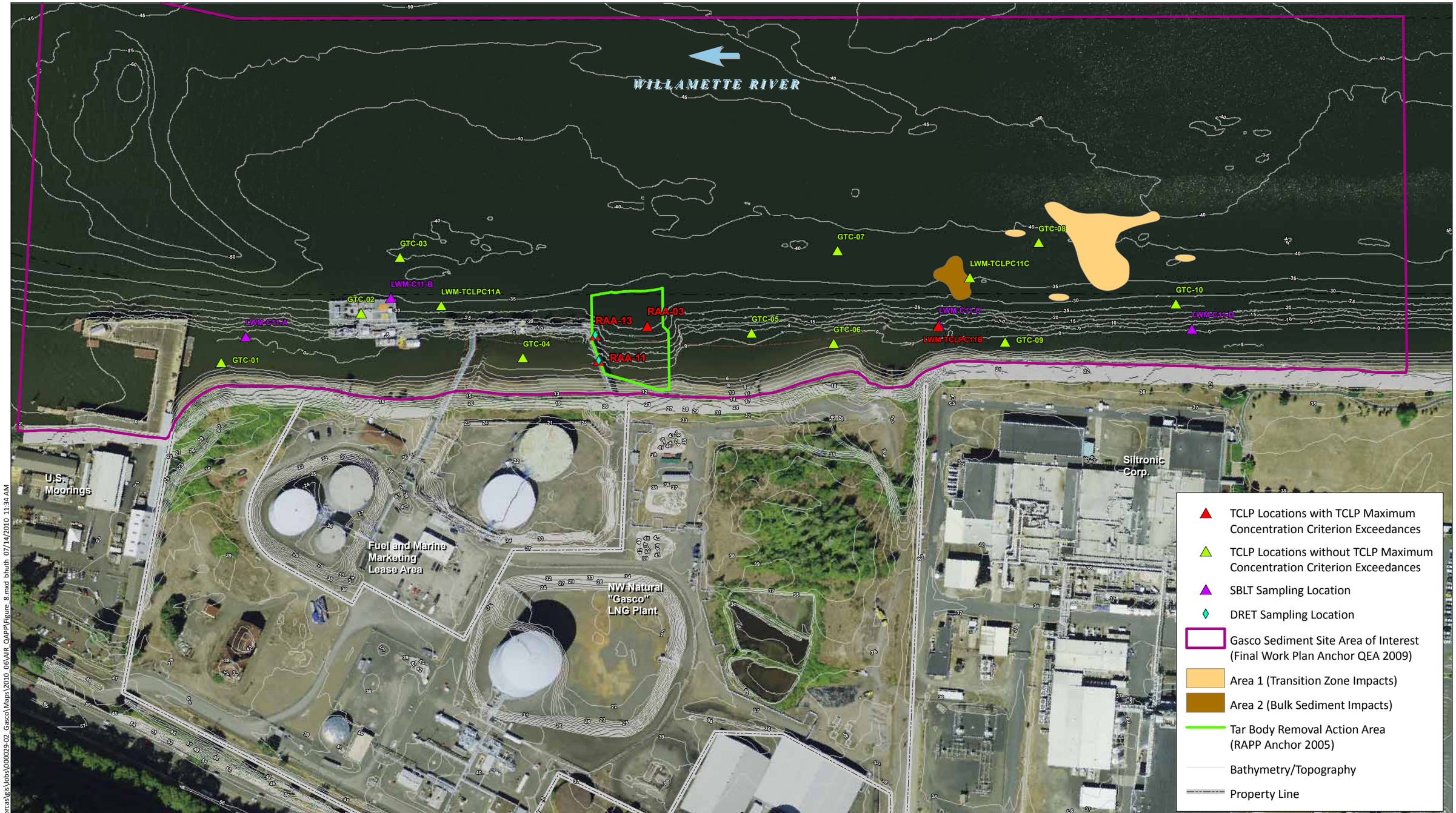
ANCHOR QEA

NOTES:
1. * = mudline elevation estimated based on 2009 bathymetry surface prepared by LWG.
2. GS-07 (-36 to -43) = Location ID (chemical exceedance elevation of substantial product in ft NAVD 88).
2. Area 1 and Area 2 zones of impact are those shown in Figure 1 of the Statement of Work.
3. Arrow indicates direction of flow of river.
4. Aerial imagery from July 2007.

Feet
0 100 200 300 400

Figure 7
Subsurface Sediment Hill Topping Screening Level Exceedances
Final Project Area Identification Report
Gasco Sediments Cleanup Action



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ANCHOR QEA

NOTE:
1. The area where locations RAA-03, RAA-11 and RAA-13 resided was removed during the tar body removal action so the results can no longer be directly applied to these locations.
2. Area 1 and Area 2 zones of impact are those shown in Figure 1 of the Statement of Work.
3. The four SBLT locations were composited to form a single sample for SBLT analysis.
4. Arrow indicates direction of flow of river.
5. Aerial imagery from July 2007.

Feet
0 100 200 300 400

Figure 8
TCLP and SBLT Locations and Exceedances of TCLP Criterion
Final Project Area Identification Report
Gasco Sediments Cleanup Action

APPENDIX A
DATA GAPS QAPP

FINAL
DATA GAPS QAPP

PROJECT AREA IDENTIFICATION REPORT
GASCO SEDIMENTS CLEANUP ACTION

Prepared for

U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Prepared by

Anchor QEA, LLC
6650 SW Redwood Lane
Portland, Oregon 97224

On behalf of

NW Natural
220 NW Second Avenue
Portland, Oregon 97209

July 2010

FINAL
DATA GAPS QAPP

GASCO SEDIMENTS CLEANUP ACTION

Approvals:

Project Manager Robert Wyatt, NW Natural	Date
QA/QC Manager Delaney Peterson, Anchor QEA	Date
EPA Project Coordinator Sean Sheldrake, EPA	Date
EPA QA Manager Ginna Grepo-Grove, EPA	Date

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Attachment 4 Laboratory Certifications and Accreditations
Attachment 5 Laboratory QA Plans

LIST OF ACRONYMS AND ABBREVIATIONS

AIR	Project Area Identification Report
AOC	Administrative Settlement Agreement and Order on Consent
ASTM	American Society for Testing and Materials
CCB	continuing calibration blanks
CCV	Continuing calibration verifications
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemicals of concern
DQOs	data quality objectives
DRET	Dredging Elutriate Test
EE/CA	Engineering Evaluation/Cost Analysis
EDD	Electronic Data Deliverable
EPA	U.S. Environmental Protection Agency
FC	field coordinator
Final Work Plan	*Final Work Plan: Gasco Sediments Cleanup Action*
FSP	Field Sampling Plan
HASP	Health and Safety Plan
HARN	High Accuracy Reference Network
ICV	initial calibration verification
PM	project manager
LDC	Laboratory Data Consultants
MDL	method detection limit
MFA	Maul Foster & Alongi, Inc.
µg/L	micrograms per liter
MNR	monitored natural recovery
MS/MSD	matrix spike/matrix spike duplicate
NAD	North American Datum
NAVD 88	North America Vertical Datum 1988
NELAP	National Environmental Laboratories Accreditation Program
NIST	National Institute of Standards and Technology
DEQ	Oregon Department of Environmental Quality
OSHA	Occupational Safety and Health Administration

Portland Harbor Site	Portland Harbor Superfund Site
PQL	practical quantitation limit
QA/QC	quality assurance/quality control
QAPP	Data Gaps Quality Assurance Project Plan
RL	reporting limit
RPD	relative percent difference
ROD	Record of Decision
SBLT	sequential batch leachate test
SDG	sample delivery group
Siltronic	Siltronic Corporation
SOP	standard operating procedures
SRM	Standard Reference Material
TCE	Trichloroethene
TOC	total organic carbon
TZW	transition zone water

1 DISTRIBUTION LIST

All group leaders and technical advisors will receive copies of this Data Gaps Quality Assurance Project Plan (QAPP) and any approved revisions of this plan. Once approved, this QAPP will be available to any authorized party by requesting a copy from the project managers, Robert J. Wyatt of NW Natural or Tom McCue of Siltronic Corporation (Siltronic).

This list identifies all individuals to receive one copy of the approved QAPP:

- EPA Project Coordinator – Sean Sheldrake
- EPA Region QA Manager – Ginna Grepo-Grove
- NW Natural Project Manager – Robert Wyatt
- Siltronic Project Manager – Tom McCue
- DEQ Project Coordinator – Dana Bayuk
- Anchor QEA Project Lead – Ryan Barth, P.E.
- MFA Project Lead – James Peale, R.G.
- Anchor QEA QA/QC Manager – Delaney Peterson
- MFA QA/QC Manager – Madi Novak
- Anchor QEA Field Coordinator – Joy Dunay
- MFA Field Coordinator – Scout Mauldin

The following Laboratory Managers will receive one copy of the QAPP and the FSP (Attachment 1 to the QAPP):

- ARI – Sue Dunnihoo
- Specialty Analytical – Marty French
- Northwestern Aquatic Sciences – Gerald Irissarri
- LDC – Stella Cuenco (Data validation)

2 PROBLEM DEFINITION AND BACKGROUND

Contaminants found in shoreline and offshore media adjacent to the NW Natural Gasco and Siltronic properties led to a determination by U.S. Environmental Protection Agency (EPA) that a cleanup adjacent to these properties is necessary to protect the public health, welfare, or the environment. Accordingly, NW Natural and Siltronic entered into the Administrative Settlement Agreement and Order on Consent (AOC; Docket No. CERCLA 10-2009-0255) with the EPA on September 9, 2009, to conduct an Engineering Evaluation/Cost Analysis (EE/CA), and to design a final remedy for the Gasco Sediments Site within the Portland Harbor Superfund Site (Portland Harbor Site). The AOC contemplates that construction of the remedy would be under a Consent Decree with EPA after the issuance of the Portland Harbor Site Record of Decision (ROD).

This QAPP is prepared consistent with the requirements of the AOC and the supporting scope of work described in the *Final Work Plan: Gasco Sediments Cleanup Action* (Final Work Plan; Anchor QEA 2010). The Final Work Plan requires additional investigation of data gaps in order to define the initial Project Area. The activities that NW Natural and Siltronic plan to implement when filling the data gaps are described in the Project Area Identification Report (AIR). This QAPP will ensure that sample collection and analytical activities are conducted in accordance with technically acceptable protocols so that data meet data quality objectives (DQOs). This QAPP provides DQOs and methods for meeting those objectives and includes the Field Sampling Plan (FSP; Attachment 1), which describes procedures for planning and executing field activities that will take place prior to development of the project EE/CA.

It is possible that additional data needs are identified through the EE/CA process, in which case additional investigations to fill identified data gaps may be conducted as part of the design phase. This QAPP will govern all phases of sampling and analysis for the project, and if later investigations are conducted, additional FSPs that are consistent with this QAPP will be presented to EPA at that time.

NW Natural and Siltronic's contractors (Anchor QEA, LLC, and Maul Foster & Alongi, Inc. [MFA], respectively) have also prepared Health and Safety Plans (HASPs; Attachments 2 and 3, respectively) that are designed to protect personnel from physical, chemical, and other hazards posed by the field sampling efforts described in the FSP (Attachment 1). The Anchor QEA HASP (Attachment 2) will govern all proposed field investigations described in the FSP except for field work related to the Area 1 investigations, which are governed by the MFA HASP

(Attachment 3). If any later design phase FSPs call for work not covered by the current HASPs, the HASPs will be modified as needed at that time.

This QAPP was prepared in accordance with EPA *Requirements for Quality Assurance Project Plans* (EPA 2001) and EPA *Guidance on Quality Assurance Project Plans* (EPA 2002a). Analytical quality assurance/quality control (QA/QC) procedures were also developed based on the analytical protocols and QA guidance of:

- EPA's Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods, 3rd Edition (EPA 1986)
- Guidance on Environmental Data Verification and Validation (EPA 2002b)
- Quality Assurance/Quality Control Guidance for Removal Activities (EPA 1990
- Contract Laboratory Program National Functional Guidelines for Data Review (EPA 2004, 2008)

2.1 Document Organization

EPA's guidance specifies the four following groups of information that must be included in a QAPP: Project Management, Data Generation and Acquisition, Assessment and Oversight, and Data Validation and Usability. Each group comprises several QAPP elements. EPA's guidance provides a suggested outline for the QAPP elements. However, the guidance indicates that certain elements may not be applicable to a given project, and that the elements need not be presented in the order presented in the guidance.

The remainder of this QAPP is organized into the following sections:

- Section 2 – Project Management
- Section 3 – Overview of Data Generation and Acquisition
- Section 4 – Assessments and Response Actions
- Section 5 – Data Validation and Usability
- Section 6 – References

3 PROJECT MANAGEMENT

This section identifies key project personnel, describes the rationale for conducting the studies, identifies the studies to be performed and their respective schedules, outlines project data quality objectives and criteria, lists training and certification requirements for sampling personnel, and describes documentation and record-keeping procedures. Figure A-1 provides a summary of the key project personnel and associated data consultants. .

3.1 Project/Task Organization

Responsibilities of the team members, as well as laboratory project managers, are described in this section.

Because the individuals listed below may change over time, this QAPP has been written to include "designee" as an alternate to the current project organization. The following paragraphs define their functional responsibilities.

The project managers (PMs) are **Robert Wyatt** of NW Natural and **Tom McCue** of Siltronic. The primary role of the project managers is to ensure compliance with the requirements.

The EPA project coordinator is **Sean Sheldrake**. The EPA project coordinator will be responsible for compliance with the EPA's Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) regulations. EPA is the lead agency for this work.

The Oregon Department of Environmental Quality (DEQ) project coordinator is **Dana Bayuk**. DEQ is the support agency for this work and will have the opportunity to review and provide comments on plans, reports, and other project deliverables to EPA.

The Anchor QEA and MFA project leads are **Ryan Barth, P.E.,** and **James Peale, R.G.** respectively. The project leads will act as the direct line of communication between Anchor QEA and MFA, and the PMs and are responsible for implementing activities described in this QAPP. They will also be responsible for production of work plans, producing all project deliverables, and performing the administrative tasks needed to ensure timely and successful completion of these studies. The project leads will provide the overall programmatic guidance to support staff and will ensure that all documents, procedures, and project activities meet the objectives contained within this QAPP. Resolution of project concerns or conflicts related to

technical matters will also be the responsibility of the project leads. Per the Final Work Plan (Anchor QEA 2010), Siltronic will lead work related to Area 1 investigations, and for this work James Peale, R.G., will be the project lead. Ryan Barth, P.E., will be the project lead for all other work and will coordinate with James Peale and the Siltronic project manager as necessary to complete the work.

The Anchor QEA and MFA field coordinators (FCs) will be **Joy Dunay** and **Scout Mauldin**, respectively. The FCs will be responsible for day-to-day technical and 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.

The Site Safety and Health Officer is **Tim Stone.** Mr. Stone will be responsible for managing on-site health and safety activities and will provide support to the project manager and field coordinator on health and safety issues.

Delaney Peterson and **Madi Novak** will serve as the Anchor QEA and MFA QA/QC managers, respectively. Madi Novak will provide QA oversight for both the field sampling and laboratory programs associated with the Area 1 investigations, ensuring that samples are collected and documented appropriately, coordinating with the analytical laboratories, ensuring data quality, overseeing data validation, and supervising project QA coordination. Delaney Peterson will fulfill the same role for the remainder of the field sampling activities.

Laurel Menoche and **A.J. Riddell** will serve as the Anchor QEA and MFA data managers, respectively. They will compile field observations and analytical data from laboratories into a database, review the data for completeness and consistency, append the database with qualifiers assigned by the data validator, and ensure that the data obtained is in a format suitable for inclusion in the appropriate databases and delivery to EPA. **A.J. Riddell** will manage all data associated with the Area 1 investigations and Laurel Menoche will manage all other data.

Sediment and soil chemical and physical testing conducted by Anchor QEA will be conducted at Analytical Resources, Inc. (ARI), located in Tukwila, Washington. ARI is accredited under the National Environmental Laboratories Accreditation Program (NELAP). Transition zone water (TZW) and groundwater chemical analysis performed by MFA in Area 1 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 American Society for Testing and Materials (ASTM) or Standard Method protocols. If more current analytical methods are available, the laboratory may use them. Sediment toxicity testing will be performed by Northwest Aquatic Sciences, located in Newport, Oregon. Sediment toxicity tests will adhere to EPA and ASTM test methods, as described in the previous sections. Copies of applicable NELAP certifications and state accreditations are provided in Attachment 4.

The laboratory managers will oversee all laboratory operations associated with the receipt of the environmental samples, chemical/physical/biological analyses, and laboratory report preparation for this project. The laboratory managers will review all laboratory reports and prepare case narratives describing any anomalies and exceptions that occurred during analysis.

The analytical testing laboratories will be responsible for the following:

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

The Data Validator will be **Stella Cuenco** of Laboratory Data Consultants (LDC), and she will serve as the primary contact to perform all applicable data validation for Anchor QEA and MFA.

4 PROJECT AND TASK DESCRIPTION

The objectives of the data gaps sampling and description of work and measurements to be performed are described in the following sections

4.1 Objectives

The objectives of the proposed field investigation activities are to fill data gaps to further delineate the Project Area and collect additional data to support completion of the EE/CA and design.

Although additional data gaps may be eventually identified, based on the data gaps analysis presented in the AIR, the following data needs have been identified for the Anchor QEA scope of work to support further refinement of the Project Area and completion of the EE/CA and design:

- Additional sediment bioassay data to refine the project boundary because spatial gaps exist for existing sediment bioassay data in some areas.
- Bulk sediment chemistry data at bioassay locations to provide synoptic data and at additional locations to fill spatial or volume sediment chemistry gaps.
- Visual observations of substantial product in sediment cores and riverbank borings in key areas to fill spatial or volume data gaps in the existing substantial product extents.
- Geotechnical (e.g., grain size, Atterberg limits, consolidation and tri-axial tests, etc.) and chemical mobility (e.g., leachate and elutriate tests) testing within sediment and riverbank soils to obtain additional data to support EE/CA alternatives evaluation and/or design.
- Riverbank soils chemistry to fill spatial volume data gaps.

The primary objective of the data gaps investigation to be performed by MFA is to confirm the present nature and extent of the trichloroethene (TCE) groundwater plume entering the Willamette River at Area 1 for the purpose of informing the remedial alternatives analysis. The secondary objective of the investigation is to provide data necessary to estimate in-river attenuation rates for TCE and its degradation products. These objectives are intended to provide data necessary to support the analysis of monitored natural recovery (MNR) in combination with upland source control as a likely practicable alternative for groundwater and TZW impacted by TCE and its degradation products. Degradation of TCE and its degradation products by native bacteria has already been confirmed by existing data.

This Data Gaps QAPP defines site-specific DQOs and details methods and quality QA/QC procedures for collecting and analyzing samples needed to fill the data gaps identified through the data gap identification process. This Data Gaps QAPP also describes the personnel, project organization, data handling, data validation, and database development procedures, as well as the protocols necessary to achieve required DQOs.

4.2 Description of Work and Measurements to be Performed

The FSP (Attachment 1) describes in detail the sampling station locations, equipment to be used, location control, sample nomenclature, sampling intervals and analyses, and sampling protocols which will be followed to address the data gap sampling objectives.

5 DATA QUALITY OBJECTIVES AND CRITERIA

The primary DQO for this project is to ensure that the data collected are of known and acceptable quality so that the project objectives described can be achieved. Data quality objectives for the project as described in *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA 2006) are presented in Table A-1. The quality of the laboratory data is assessed by precision, accuracy, representativeness, comparability, and completeness (also known as the "PARCC" parameters). Definitions of these parameters and the applicable QC procedures are included in this section. Applicable quantitative goals for these data quality parameters are listed or referenced in Tables A-2, A-3, and A-4.

5.1 Precision

Precision is the ability of an analytical method or instrument to reproduce its own measurement. It is a measure of the variability, or random error, in sampling, sample handling, and in laboratory analysis. The ASTM recognizes two levels of precision: repeatability—the random error associated with measurements made by a single test operator on identical aliquots of test material in a given laboratory, with the same apparatus, under constant operating conditions; and reproducibility—the random error associated with measurements made by different test operators, in different laboratories, using the same method but different equipment to analyze identical samples of test material (ASTM 2002).

In the laboratory, "within-batch" precision is measured using replicate sample or QC analyses and is expressed as the relative percent difference (RPD) between the measurements. The "batch-to-batch" precision is determined from the variance observed in the analysis of standard solutions or laboratory control samples from multiple analytical batches.

Field precision will be evaluated by the collection of blind field duplicates for chemistry samples at a frequency of 5 percent of samples analyzed. Field chemistry duplicate precision will be screened against a RPD of 50 percent for sediment samples and 35 percent for water samples. However, no data will be qualified based solely on field homogenization duplicate precision.

Precision measurements can be affected by the nearness of a chemical concentration to the method detection limit (MDL), where the percent error (expressed as RPD) increases. The equation used to express precision is as follows:

$$RPD = \frac{(C_1 - C_2) \times 100\%}{(C_1 + C_2)/2}$$

Where:

RPD	=	relative percent difference
C1	=	larger of the two observed values
C2	=	smaller of the two observed values

5.2 Accuracy

Accuracy is a measure of the closeness of an individual measurement (or an average of multiple measurements) to the true or expected value. Accuracy is determined by calculating the mean value of results from ongoing analyses of laboratory-fortified blanks, standard reference materials, and standard solutions. In addition, laboratory-fortified (i.e., matrix-spiked) samples are also measured; this indicates the accuracy or bias in the actual sample matrix. Accuracy is expressed as percent recovery (%R) of the measured value, relative to the true or expected value. If a measurement process produces results for which the mean is not the true or expected value, the process is said to be biased. Bias is the systematic error either inherent in a method of analysis (e.g., extraction efficiencies) or caused by an artifact of the measurement system (e.g., contamination). Analytical laboratories utilize several QC measures to eliminate analytical bias, including systematic analysis of method blanks, laboratory control samples, and independent calibration verification standards. Because bias can be positive or negative, and because several types of bias can occur simultaneously, only the net, or total, bias can be evaluated in a measurement.

Laboratory accuracy will be evaluated against quantitative laboratory fortified blank, matrix spike and surrogate spike recovery performance criteria provided by the laboratory. Accuracy can be expressed as a percentage of the true or reference value, or as a %R in those analyses where reference materials are not available and spiked samples are analyzed. The equation used to express accuracy is as follows:

$$\%R = 100\% \times (S-U)/Csa$$

Where:

%R	=	percent recovery
S	=	measured concentration in the spiked aliquot
U	=	measured concentration in the unspiked aliquot
Csa	=	actual concentration of spike added

Field accuracy will be controlled by adherence to sample collection procedures outlined in the FSP (Attachment 1).

5.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition. For the sampling program, the list of analytes has been identified to provide a comprehensive assessment of the known and potential contaminants at the Gasco Sediments Site.

5.4 Comparability

Comparability expresses the confidence with which one data set can be evaluated in relation to another data set. For this program, comparability of data will be established through the use of standard analytical methodologies and reporting formats, and of common traceable calibration and reference materials.

5.5 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness will be calculated as follows:

$$C = \frac{\text{(Number of acceptable data points)} \times 100}{\text{(Total number of data points)}}$$

The DQO for completeness for all components of this project is 90 percent. Data that have been qualified as estimated because the QC criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

5.6 Sensitivity

Analytical sensitivities must be consistent with or lower than the screening levels identified in Tables 1-1, 1-2, 1-3, and 1-14 of the FSP (Attachment 1) in order to demonstrate compliance with this QAPP. When they are achievable, target detection limits specified will be at least a factor of 2 less than the analyte's corresponding regulated criteria value.

The MDL is defined as the minimum concentration at which a given target analyte can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. Laboratory practical quantitation limits (PQLs) or reporting limits (RLs) are defined as the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. Laboratory MDLs and RLs will be used to evaluate the method sensitivity and/or applicability prior to the acceptance of a method for this program.

The sample-specific MDL and RL will be reported by the laboratory and will take into account any factors relating to the sample analysis that might decrease or increase the reporting limit (e.g., dilution factor, percent moisture, sample volume, and sparge volume). In the event that the MDL and RL are elevated for a sample due to matrix interferences and subsequent dilution or reduction in the sample aliquot, the data will be evaluated by Anchor QEA and the laboratory to determine if an alternative course of action is required or possible. If this situation cannot be resolved readily (i.e., detection limits less than criteria are achieved), EPA will be contacted to discuss an acceptable resolution. The sample-specific RL will be the value provided in the project database.

In regards to the Area 1 investigation, the reporting limits for TCE and its degradation products in water are generally below the screening levels presented in the FSP, with the exception of the DEQ Residential tap water RBC for TCE (0.022 micrograms per liter [µg/L]) and the EPA RSL for vinyl chloride (0.016 µg/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 micrograms per liter in water, the laboratory will advise the MFA project manager to evaluate the need for further, lower-level analysis.

6 SPECIAL TRAINING REQUIREMENTS/CERTIFICATIONS

For sample preparation tasks, it is important that field crews are trained in standardized sample collection requirements, so that the samples collected and the data generated from the samples are consistent among the field crew. All field crew are fully trained in the collection and processing of surface sediment, bioassay, subsurface sediment vibracoring, riverbank borings, TZW, and groundwater collection methods; decontamination protocols; visual inspections; and sample transport and chain-of-custody procedures.

The 29 CFR 1910.120 Occupational Safety and Health Administration (OSHA) regulations require training to provide employees with the knowledge and skills enabling them to perform their jobs safely and with minimum risk to their personal health. All sampling personnel will have completed the 40-hour HAZWOPER training course and 8-hour refresher courses, as necessary, to meet the OSHA regulations. In addition, as required by EPA's letter dated November 5, 2009 to NW Natural and Siltronic regarding EPA's comments on the *Capture Zone Field Test Plan* prepared by Anchor AEQ (Anchor QEA 2009), all Anchor QEA and MFA field personnel that complete the data gaps investigation will be will be enrolled in a medical surveillance program in compliance with OSHA standards (29 CFR 1910.120(f). This program is detailed in the Anchor QEA and MFA HASPs (Attachments 2 and 3, respectively).

7 DOCUMENTATION AND RECORDS

This project will require central project files to be maintained at the Anchor QEA office conducting the work. Project records will be stored and maintained in a secure manner. Each project team member is responsible for filing all necessary project information or providing it to the person responsible for the filing system. Individual team members may maintain files for individual tasks, but must provide such files to the central project files upon completion of each task. A project-specific index of file contents is to be kept with the project files. Hard copy documents will be kept on file at Anchor QEA or at a document storage facility throughout the duration of the project, and all electronic data will be maintained in the database at Anchor QEA. MFA will provide copies of all MFA-generated records to Anchor QEA so that a complete record file can be maintained in one location.

Deviations from the QAPP or FSP will be discussed with the project leads prior to implementation. Project leads will contact the on-site EPA oversight contractor to discuss the deviation and proposed path forward. Upon approval of a path forward the project leads will give notice to proceed to the FC. All deviations will be documented in all associated field forms and logbook.

7.1.1 Field Records

All documents generated during the field effort are controlled documents that become part of the project file. Field team members will keep a daily record of significant events, observations, and measurements on field forms. All field activities will be recorded on forms specific to the collection activity and will be maintained by the FCs. Field forms will be the main source of field documentation for all field activities. The on-site field representative will record on the field log form information pertinent to the investigation program. The sampling documentation will contain information on each sample collected, and will include at a minimum the following information:

- Project name
- Field personnel on site
- Facility visitors
- Weather conditions
- Field observations
- Maps and/or drawings
- Date and time sample collected

- Sampling method and description of activities
- Identification or serial numbers of instruments or equipment used
- Presence of substantial product (as defined in the AIR)
- Deviations from the QAPP
- Conferences associated with field sampling activities

Entries for each day will begin on a new form. The person recording information must enter the date and time and initial each entry. Additional specific field reporting requirements and checklists for each study are defined in the FSP (Attachment 1). In general, sufficient information will be recorded during sampling so that reconstruction of the event can occur without relying on the memory of the field personnel. In addition to the field forms, the FC will keep a field logbook to record daily activities.

The field forms and field logbook will be on water-resistant, durable paper for adverse field conditions. Notes will be taken in indelible waterproof blue or black ink. Errors will be corrected by crossing out with a single line, dating, and initialing. Each form will be marked with the project name, number, and date. The field forms will be scanned into Anchor QEA's project file directory as convenient during the sampling event or upon completion of each sampling event.

7.1.2 Analytical and Chemistry Records and Deliverables

Analytical data records will be retained by the laboratories used and in the Anchor QEA central project files in the office conducting the work. For all analyses, the data reporting requirements will include those items necessary to complete data validation, including copies of all raw data. Laboratory analytical reports will be provided to Anchor QEA in electronic format, including the scanned PDF of the report and the Electronic Data Deliverable (EDD) in the Anchor QEA EQuIS 5 format. The analytical laboratory will be required, where applicable, to report the following:

- **Project Narrative.** This summary, in the form of a cover letter, will discuss problems, if any, encountered during any aspect of analysis. This summary should discuss but is not be limited to QC, sample shipment, sample storage, and analytical difficulties. Any problems encountered—actual or perceived—and their resolutions will be documented in as much detail as appropriate.

- **Chain-of-custody Records.** Legible copies of the chain-of-custody forms will be provided as part of the data package. This documentation will include the time of receipt and condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented on a sample receipt form. The form must include all sample shipping container temperatures measured at the time of sample receipt.
- **Sample Results.** The data package will summarize the results for each sample analyzed. The summary will include the following information when applicable:
  - Field sample identification code and the corresponding laboratory identification code
  - Sample matrix
  - Date of sample preparation
  - Date and time of analysis
  - Weight and/or volume used for preparation/analysis
  - Final dilution volumes or concentration factor for the analysis
  - Identification of the instrument used for analysis
  - Method detection limits and method reporting limits accounting for sample-specific factors (e.g., dilution, total solids)
  - Analytical results with reporting units identified
  - Data qualifiers and their definitions
- **QA/QC Summaries.** This section will contain the results of the laboratory QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results (see previous bullet point). No recovery or blank corrections will be made by the laboratory. The required summaries are listed below; additional information may be requested.
- **Calibration Data Summary.** This summary will report the concentrations of the initial calibration and daily calibration standards, and the date and time of analysis. The response factor, percent relative standard deviation, percent difference, and retention time for each analyte will be listed, as appropriate. Results for standards to indicate instrument sensitivity will be documented.
- **Internal Standard Area Summary.** The stability of internal standard areas will be reported.
- **Method Blank Analysis.** The method blank analysis associated with each sample and the concentration of all compounds of interest identified in these blanks will be reported.

- **Surrogate Spike Recovery.** This will include all surrogate spike recovery data for organic compounds. The name and concentration of all compounds added, percent recoveries, and range of recoveries will be listed.
- **Matrix Spike Recovery.** This will include all matrix spike recovery data. The name and concentration of all compounds added, percent recoveries, and range of acceptable recoveries will be listed. The recoveries and RPD for all matrix spike duplicate analyses will be reported.
- **Matrix Duplicate.** This will include the percent recovery and associated RPD for all matrix duplicate analyses.
- **Laboratory Control Sample.** All laboratory control sample recovery data will be reported. The name and concentration of all compounds added, percent recoveries, and range of acceptable recoveries will be listed. The recoveries and RPD for all laboratory control sample duplicate analyses will be included.
- **Relative Retention Time.** This will include a report of the relative retention time of each analyte detected in the samples for both primary and confirmational analyses for applicable methods.
- **Original Data.** Legible copies of the original data generated by the laboratory will include:
  - Sample preparation, identification of preparation method used, and cleanup logs
  - Instrument specifications and analysis logs for all instruments used on days of calibration and analysis
  - Calculation worksheets for inorganic analyses
  - Reconstructed ion chromatograms for all sample, standard, blank, calibration, spike, replicate, and reference material results
  - Original printouts of full scan chromatograms and quantitation reports for all gas chromatography (GC) and/or GC/mass spectrometry (MS) sample, standard, blank, calibration, spike, replicate, and reference material results
  - Enhanced spectra of detected compounds with associated best-match spectra for each sample

All instrument data shall be fully restorable at the laboratory from electronic backup. Laboratories will be required to maintain all records relevant to project analyses for a minimum of seven years. Data validation reports will be maintained in the central project files with the analytical data reports.

7.1.3 Data Reduction

Data reduction is the process by which original data (analytical measurements) are converted or reduced to a specified format or unit to facilitate analysis of the data. Data reduction requires that all aspects of sample preparation that could affect the test result, such as sample volume analyzed or dilutions required, be taken into account in the final result. It is the laboratory analyst's responsibility to reduce the data, which are subjected to further review by the laboratory manager and the QA/QC managers. Data reduction may be performed manually or electronically. If performed electronically, all software used must be demonstrated to be true and free from unacceptable error.

7.1.4 Data Report

The data gaps sampling data will be reported in the EE/CA and Data Report. The report, at a minimum, will contain the following information:

- A statement of the purpose of the investigation.
- A summary of the field sampling, field data, and laboratory analytical procedures (reference will be made to this QAPP). Deviations, whether intended or unintended, will be documented. Failure to meet sampling or data quality objectives of sufficient magnitude that lead to rejection of results will be well documented, as necessary.
- Investigation locations will be presented on associated figures. Coordinates will be reported in an accompanying table for all stations. All vertical geographical coordinates will be relative to the North America Vertical Datum 1988 (NAVD88) 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.
- Chemical analysis result data tables summarizing chemical and conventional variables.
- An interpretation of the results against the appropriate regulatory criteria to be developed and finalized in coordination with EPA, as described in Section 3.0 of the AIR.
- Copies of complete laboratory data packages, as appendices or attachments.
- Copies of applicable sections of the field logs, as appendices or attachments.
- Copies of validation reports and/or findings, as appendices or attachments.

Chemistry data will be compared to applicable screening levels presented in the EE/CA and Data Report.

8 OVERVIEW OF DATA GENERATION AND ACQUISITION

All sampling will be conducted following standard procedures. In general, all sampling procedures will comply with EPA protocols or other approved sample collection standards established for the study area.

8.1 Sampling Process Design

The rationale for the sampling process design is described in Section 6 of the AIR.

8.2 Sampling Methods

The sampling methods utilized are described the FSP (Attachment 1). Sediment sampling methods are in Sections 3.2.1 and 3.3.1; soils in Sections 3.4.1.2 and 3.4.2.3; and groundwater in Section 4.1.

8.3 Sample Handling and Custody

Sample handling and custody procedures are described in the FSP (Attachment 1). Sediment and soil procedures are in Sections 3.9 and groundwater procedures are in Section 4.5.

8.4 Analytical Methods

This section summarizes the target chemical and physical analyses for the various media sampled. All sample analyses will be conducted in accordance with EPA-approved methods and this QAPP. Chemical and physical testing will be conducted at the selected analytical laboratory. The selected analytical laboratory will be accredited under NELAP. Prior to analysis, all samples will be maintained according to the appropriate holding times and temperatures for each analysis. Tables 1-1, 1-2, 1-3, and 1-14 of the FSP (Attachment 1) present the proposed analytes, the analytical methods to be used, and the targeted reporting limits for each matrix.

Prior to the analysis of the samples, the laboratory 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, and 1-14 of the FSP (Attachment 1), if technically feasible. If required reporting limits are not achieved, some modifications to the methods may be necessary. These modifications from the specified analytical methods will be provided by the

laboratory at the time of establishing the laboratory contract, and must be approved by EPA prior to implementation.

In completing chemical analyses for this project, the contract laboratory is expected to meet the following minimum requirements:

- Adhere to the methods outlined in this QAPP, including methods referenced for each analytical procedure Tables 1-1, 1-2, 1-3, and 1-14 of the FSP [Attachment 1])
- Deliver scanned and electronic data as specified
- Meet reporting requirements for deliverables
- Meet turnaround times for deliverables
- Implement QA/QC procedures discussed in the QAPP including data quality objectives, laboratory QC requirements, and performance evaluation testing requirements
- Notify the project QA/QC manager(s) of any QAPP QA/QC problems when they are identified to allow for quick resolution
- Allow laboratory and data audits to be performed, if deemed necessary

8.5 QA/QC

Field and laboratory activities must be conducted in such a manner that the results meet specified quality objectives and are fully defensible. Guidance for QA/QC is derived from the protocols developed for EPA SW-846 (1986), the *EPA Contract Laboratory Program* (EPA 2004, 2008), and other cited methods.

8.5.1 Field QC

Anchor QEA personnel will identify and label samples in a consistent manner to ensure that field samples are traceable and that labels provide all information necessary for the laboratory to conduct required analyses properly. Samples will be placed in appropriate containers and preserved for shipment to the laboratory.

8.5.1.1 Sample Containers

Sample containers and preservatives will be provided by the laboratory. The laboratory will maintain documentation certifying the cleanliness of bottles and the purity of preservatives provided.

8.5.1.2 Sample Identification and Labels

Each sample will have an adhesive plastic or waterproof paper label affixed to the container and will be labeled at the time of collection. The following information will be recorded on the container label at the time of collection:

- Project name
- Sample identification
- Date and time of sample collection
- Preservative type (if applicable)
- Analysis to be performed

Samples will be uniquely identified with a sample identification that at a minimum specifies sample number, sample location, and type of sample. Specific sample ID schemes are provided in the FSP (Attachment 1).

8.5.1.3 Field QA Sampling

Field QA procedures will consist of following procedures for acceptable practices for collecting and handling of samples. Adherence to these procedures will be complemented by periodic and routine equipment inspection.

Field QA samples will be collected along with the environmental samples. Field QA samples are useful in identifying possible problems resulting from sample collection or sample processing in the field. The collection of field QA samples includes equipment wipe/rinsate, filter/rinsate blank, field blanks, trip blanks, and field duplicates. Field QA samples will be collected at a frequency of one per sampling event or one in 20 samples collected (Table A-5). Any field QA sample result that significantly exceeds the acceptance criteria listed in Table A-6 will be evaluated by the QA/QC managers to determine if field procedure modifications should be considered. These exceedances will also be narrated in the Data Report. Sample data will not be qualified based solely on field QA results.

Upon request by EPA, EPA or its authorized representatives may take split and/or duplicate samples, as specified in Section 3.5 of the Statement of Work (SOW).

Field QA samples will also include the collection of enough sample volume to ensure that the laboratory has sufficient amounts to run the program-required analytical QA/QC (matrix

spike/matrix spike duplicate [MS/MSD]) samples for analysis as specified in Table A-5. For sediment and soil samples, enough volume will be collected to run MS/MSD on any sample. For groundwater, additional sample volume to meet this requirement will be collected at a frequency of one per sampling event or one in 20 samples collected, whichever is more frequent. The samples designated for MS/MSD analyses should be clearly marked on the chain-of-custody.

All field QA samples will be documented on the field forms and verified by the QA/QC manager or designee.

8.5.2 Laboratory QC

The QA plan for each laboratory used in this investigation is included as Attachment 5. Laboratory QC procedures, where applicable, include initial and continuing instrument calibrations, standard reference materials, laboratory control samples, matrix replicates, matrix spikes, surrogate spikes (for organic analyses), and method blanks. Table A-5 lists the frequency of analysis for laboratory QA/QC samples, and Tables A-2, A-3, and A-4 summarize the data quality objectives for precision, accuracy, and completeness.

Results of the QC samples from each sample group will be reviewed by the analyst immediately after a sample group has been analyzed. The QC sample results will then be evaluated to determine if control limits have been exceeded. If control limits are exceeded in the sample group, the QA/QC manager will be contacted immediately, and corrective action (e.g., method modifications followed by reprocessing the affected samples) will be initiated prior to processing a subsequent group of samples.

8.5.2.1 Laboratory Instrument Calibration and Frequency

An initial calibration will be performed on each laboratory instrument to be used at the start of the project, after each major interruption to the analytical instrument, and when any ongoing calibration does not meet method control criteria. An initial calibration verification (ICV) will be analyzed following each initial calibration and will meet method criteria prior to analysis of samples. Continuing calibration verifications (CCV) will be performed daily prior to any sample analysis to track instrument performance. The frequency of CCVs varies with method. For GC/MS methods, one will be analyzed every 12 hours. For GC, metals, and inorganic methods, one will be analyzed for every 10 field samples, or daily, whichever is more frequent.

If the ongoing continuing calibration is out of control, the analysis must come to a halt until the source of the control failure is eliminated or reduced to meet control specifications. All project samples analyzed while instrument calibration was out of control will be reanalyzed.

Instrument blanks or continuing calibration blanks (CCB) provide information on the stability of the baseline established. Continuing calibration blanks will be analyzed immediately prior to or following continuing calibration verification at the instrument for each type of applicable analysis.

8.5.2.2 Laboratory Duplicates/Replicates

Analytical duplicates provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Analytical duplicates and replicates are subsamples of the original sample that are prepared and analyzed as a separate sample.

8.5.2.3 MS and MSD

Analysis of MS samples provides information on the extraction efficiency of the method on the sample matrix. By performing duplicate MS analyses, information on the precision of the method is also provided.

8.5.2.4 Method Blanks

Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis. The method blank for all analyses must be less than the method reporting limit of any single target analyte/compound. If a laboratory method blank exceeds this criterion for any analyte/compound, and the concentration of the analyte/compound in any of the samples is less than five times the concentration found in the blank (10 times for common contaminants), analyses must stop and the source of contamination must be eliminated or reduced.

8.5.2.5 Laboratory Control Samples

Laboratory control samples are analyzed to assess possible laboratory bias at all stages of sample preparation and analysis. The laboratory control sample is a matrix-dependent spiked sample prepared at the time of sample preparation along with the preparation of samples and

MSs. The laboratory control sample will provide information on the precision of the analytical process, and when analyzed in duplicate, will provide accuracy information as well.

8.5.2.6 Standard Reference Materials

Standard reference materials are substances of the same or similar matrix to the project samples and contain a known concentration of target analyte(s). These materials are prepared and analyzed in the same manner as routine samples and in the same preparation and analytical batch. The recovery of the target analyte(s) provide information on interferences caused by the sample matrix.

8.5.2.7 Laboratory Deliverables

Data packages will be checked for completeness immediately upon receipt from the laboratory to ensure that data and QA/QC information requested are present. QC sample frequencies will be compared to the criteria in Table A-5.

8.6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

This section describes procedures for testing, inspection, and maintenance of field and laboratory equipment.

8.6.1 Field Instruments/Equipment

Anchor QEA and MFA maintain inventories of field instruments and equipment. The frequency and types of maintenance will be based on the manufacturer's recommendations and/or previous experience with the equipment.

The FCs will be responsible for the preparation, documentation, and implementation of the preventative maintenance. The equipment maintenance information will be documented in the instrument's calibration log. The frequency of maintenance is dependent on the type and stability of the equipment, the methods used, the intended use of the equipment, and the recommendations of the manufacturer. Detailed information regarding the calibration and frequency of equipment calibration is provided in specific manufacturer's instruction manuals.

All maintenance records will be verified prior to each sampling event. The FCs will be responsible for verifying that required maintenance has been performed prior to using the equipment in the field.

The subcontractor responsible for navigation will confirm proper operation of the navigation equipment daily. This verification may consist of internal diagnostics or visiting a location with known coordinates to confirm the coordinates indicated by the navigation system. No other field equipment requires testing or calibration. The winch line and samplers will be inspected daily for any mechanical problems. Any problems will be noted in the field logbook and corrected prior to continuing sampling operations.

8.6.2 Laboratory Instruments/Equipment

The laboratories selected will maintain an inventory of instruments and equipment and the frequency of maintenance will be based on the manufacturer's recommendations and/or previous experience with the equipment.

The laboratories selected will have a preventative maintenance program, as detailed in their QA Plans, organized to maintain proper instrument and equipment performance, and to prevent instrument and equipment failure during use. The program considers instrumentation, equipment, and parts that are subject to wear, deterioration, or other changes in operational characteristics, the availability of spare parts, and the frequency at which maintenance is required. Any equipment that has been overloaded, mishandled, gives suspect results, or has been determined to be defective will be taken out of service, tagged with the discrepancy noted, and stored in a designated area until the equipment has been repaired. After repair, the equipment will be tested to ensure that it is in proper operational condition. The QA/QC managers will be promptly notified in writing if defective equipment casts doubt on the validity of analytical data. The QA/QC managers will also be notified immediately regarding any delays due to instrument malfunctions that could impact holding times. Laboratories will be responsible for the preparation, documentation, and implementation of the preventative maintenance program. All maintenance records will be checked according to the schedule on an annual basis and recorded by the responsible individual. A laboratory QA/QC manager or designee shall be responsible for verifying compliance.

8.7 Instrument Calibration

Proper calibration of equipment and instrumentation is an integral part of the process that provides quality data. Instrumentation and equipment used to generate data must be calibrated at a frequency that ensures sufficient and consistent accuracy and reproducibility.

8.7.1 Field Instrument/Equipment Calibration

Field equipment will be calibrated prior to each sampling event according to manufacturer's recommendations using manufacturer's standards. A calibration check will be performed at the beginning of the day. The equipment, calibration, and maintenance information will be documented in the instrument calibration log. The frequency of calibration is dependent on the type and stability of the equipment, the methods used the intended use of the equipment, and the recommendations of the manufacturer. Detailed information regarding the calibration and frequency of equipment calibration is provided in specific manufacturer's instruction manuals.

Equipment that fails calibration or becomes inoperable during use will be removed from service and tagged (time and date of action) to prevent inadvertent use. Such equipment will be satisfactorily recalibrated or repaired and tagged (date and time of return to service) prior to use.

The following field equipment will require calibration before use and periodically during sampling activities in Area 1:

- pH meter
- Conductivity meter
- Dissolved oxygen meter
- Turbidity meter
- Thermometer
- Photoionization detector or flame ionization detector

8.7.2 Laboratory Instrument/Equipment Calibration

As part of their QC program, the chemistry laboratories selected will perform two types of calibrations. A periodic calibration is performed at prescribed intervals (i.e., balances, drying ovens, refrigerators, and thermometers), and operational calibrations are performed daily, at a specified frequency, or prior to analysis (i.e., initial calibrations) according to method

requirements. Calibration procedures and frequency are discussed in the laboratory QA Plan. Calibrations are discussed in the laboratory standard operating procedures (SOPs) for analyses.

The laboratory QA/QC manager will be responsible for ensuring that the laboratory instrumentation is calibrated in accordance with specifications. Implementation of the calibration program shall be the responsibility of the respective laboratory Group Supervisors. Recognized procedures (EPA, ASTM, or manufacturer's instructions) shall be used when available.

Physical standards (i.e., weights or certified thermometers) shall be traceable to nationally recognized standards such as the National Institute of Standards and Technology (NIST). Chemical reference standards shall be NIST Standard Reference Materials (SRMs) or vendor certified materials traceable to these standards.

The calibration requirements for each method and respective corrective actions shall be accessible, either in the laboratory SOPs or the laboratory's QA Plan for each instrument or analytical method in use. All calibrations shall be preserved on electronic media.

8.8 Inspection/Acceptance Requirements for Supplies and Consumables

Inspection and acceptance of field supplies, including laboratory-prepared sampling bottles, will be performed by the FCs. All primary chemical standards and standard solutions used in this project either in the field or laboratory will be traceable to documented, reliable, commercial sources. Standards will be validated to determine their accuracy by comparison with an independent standard. Any impurities found in the standard will be documented.

8.9 Non-direct Measurements

Non-direct measurements are data obtained from existing data sources, not directly measured or generated in this project. Non-direct measurements are discussed in detail in Sections 2, 3, and 4 of the AIR.

8.10 Laboratory Data Management

ARI and Specialty Analytical will provide data to the Anchor QEA data manager in the EQuIS electronic data deliverable format. Laboratory data, which is electronically provided and loaded into the database, will undergo a 10 percent electronic verification against the laboratory

data package. The laboratory data will undergo a Level III manual validation. Qualifiers, if assigned, will be entered manually. The accuracy of all manually entered data will be verified by a second party. Data tables and reports will be exported from EQuIS to MS Excel tables.

8.11 Field Data Management

Field data sheets will be checked for completeness and accuracy by the FCs prior to delivery to the data managers. All data generated in the field will be documented on hard copy and provided to the office data managers, who are responsible for the data's entry into the database. All manually entered data will be checked by a second party. Field documentation will be filed in the Anchor QEA central project file of the office generating the data (after data entry and checking are complete. Field data compiled by the MFA data manager will be provided to the Anchor QEA data manager along with copies of the field documentation for entry into the overall database and central project files maintained by Anchor QEA.

8.12 Biological Testing

Sediment toxicity testing will be conducted to determine whether chemicals of concern (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 ASTM Method E 1706-00 (ASTM 2000) and EPA 600/R-99/064 (EPA 2000).

Two sediment toxicity tests will be conducted on the surface sediment samples designated in the FSP:

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

General information pertaining to the sediment toxicity tests is provided below. The FSP (Attachment 1) contains specifics of the sediment toxicity testing requirements and QA/QC procedures.

8.12.1 Negative Controls

Negative control sediments are used in the amphipod and midge bioassays to check various aspects of laboratory performance (for example, organism health and overlying water quality). Negative control sediments are clean sediments in which the test organism normally lives and which are expected to produce low mortality. The negative control sediment will be collected at

Beaver Creek, Lincoln County or other location the EPA deems acceptable and as coordinated with EPA for this project. The physical and chemical characteristics of this sediment will be determined prior to test initiation. Tables 1-6 and 1-7 of the FSP (Attachment 1) provide a summary of performance criteria for control samples.

8.12.2 Reference Sediment

Reference sediments will also be included with each bioassay. 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 (TOC). Reference sediments will be collected from upriver reach sampling locations used in the Reference Envelope Approach specified in the *Portland Harbor RI/FS Baseline Ecological Risk Assessment* (Integral et al. 2009). Locations of reference station coordinates will be reported, with an accuracy of plus or minus 3 meters. Reference sediment samples will also be tested for total solids, total volatile solids, total organic carbon, grain size, ammonia, and sulfides.

8.12.3 Replication

Eight laboratory replicates of test sediments, reference sediments, and negative controls will be run for each bioassay.

8.12.4 Positive Controls

A positive control will be run for each bioassay. The positive control to be used for the sediment toxicity test will be a toxic control in which a reference toxicant is used to establish the relative sensitivity of the test organism. Cadmium will be used as the positive control toxicant in the *H. azteca* test and potassium chloride will be used in the *C. dilutus* test.

8.12.5 Water Quality Monitoring

Bioassays require that proper water quality conditions be maintained to ensure survival of the organisms, and to ensure that undue stress is not exerted on the organisms unrelated to test sediments. For the 28-day *H. azteca* test, total ammonia, hardness, and alkalinity will be measured at test initiation and termination. Conductivity will be measured weekly. Dissolved oxygen and pH will be measured three times a week, and temperature measured daily. For the 10-day *C. dilutus* test, total ammonia, conductivity, pH, hardness, and alkalinity will be measured at test initiation and termination. Dissolved oxygen and temperature will be

measured daily. Monitoring will be conducted for all test and reference sediments and negative controls (including seawater controls).

Parameter measurements must be within the limits specified for each bioassay (Tables 1-6 and 1-7 of the FSP [Attachment 1]). Interstitial salinity will be documented at test initiation for the amphipod bioassay. Measurements for each treatment will be made on a separate chemistry beaker set up to be identical to the other replicates within the treatment group, including the addition of test organisms.

9 ASSESSMENTS AND RESPONSE ACTIONS

Once data are received from the laboratory, a number of QC procedures will be followed to provide an accurate evaluation of the data quality. Specific procedures will be followed to assess data precision, accuracy, and completeness.

A full data quality review will be performed by LDC, in accordance with EPA National Functional Guidelines (EPA 2004, 2008). The data will be evaluated in accordance with this QAPP. All chemical data will be reviewed with regard to the following, as appropriate to the particular analysis:

- COC documentation
- Holding times
- Instrument calibration
- Method blanks
- Detection limits
- Reporting limits
- Surrogate recoveries
- MS/MSD recoveries
- Laboratory control sample recoveries
- Laboratory and field duplicate RPDs

The results of the data quality review, including text assigning qualifiers in accordance with the EPA National Functional Guidelines and a tabular summary of qualifiers, will be generated by the data manager and submitted to the project QA/QC managers for final review and confirmation of the validity of the data (EPA 2004, EPA 2008). A copy of the LDC validation report will be submitted by the QA/QC managers and will be presented as an appendix to the EE/CA and Data Report.

9.1 Compliance Assessments

Laboratory and field performance audits consist of on-site reviews of QA systems and equipment for sampling, calibration, and measurement. Laboratory audits will not be conducted as part of this study; however, all laboratory audit reports will be made available to the project QA/QC managers upon request. The laboratory is required to have written procedures addressing internal QA/QC; these procedures have been submitted (in the QAPP) and will be reviewed by the project QA/QC managers to ensure compliance with the QAPP.

The laboratory must ensure that personnel engaged in sampling and analysis tasks have appropriate training. The laboratory will, as part of the audit process, provide for consultant's review of written details of any and all method modifications planned. Laboratory non-conformances will be documented and submitted to the QA/QC managers for review. All non-conformances will be discussed in the final data report. Field data will be verified by the database manager. These tasks include:

- Post-processed differential correction of GPS coordinates
- Sample parameter review (depth, sample name, sample matrix, unit, etc.)
- Field QC assignment (duplicates assigned to parent, equipment blanks assigned to samples, etc).

The database manager will work with the FC and the project leads to correct any questionable or incomplete data. All changes to field forms will be signed and dated by the personnel making the change.

9.2 Response and Corrective Actions

The following sections identify the responsibilities of key project team members and actions to be taken in the event of an error, problem, or nonconformance to protocols identified in this document.

9.2.1 Field Activities

The FCs will be responsible for correcting equipment malfunctions during the field sampling effort. The project QA/QC managers will be responsible for resolving situations identified by the FCs that may result in noncompliance with this QAPP. All corrective measures will be immediately documented in the field logbook.

9.2.2 Laboratory

The laboratory is required to comply with their SOPs. The laboratory managers will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this QAPP. All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data.

The laboratory managers will be notified immediately if any QC sample exceeds the project-specified control limits. The analyst will identify and correct the anomaly before continuing with the sample analysis. The laboratory managers will document the corrective action taken in a memorandum submitted to the QA/QC managers within five days of the initial notification. A narrative describing the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, and re-extraction) will be submitted with the data package in the form of a cover letter.

9.3 Reports to Management

Quality assurance reports to management include verbal status reports, written reports on field sampling activities and laboratory processes, data validation reports, and final project reports. These reports shall be the responsibility of the QA/QC managers.

Progress reports will be prepared by the FCs following each sampling event. The QA/QC managers will also prepare progress reports after the sampling is completed and samples have been submitted for analysis, when information is received from the laboratory, and when analysis is complete. The status of the samples and analysis will be indicated with emphasis on any deviations from the QAPP. A data report will be written after validated data are available for each sampling event. These reports will be delivered electronically to the Anchor QEA project lead.

10 DATA VALIDATION AND USABILITY

This section describes the processes that will be used to review project data quality.

10.1 Data Review, Validation, and Verification

Ninety percent of the data will undergo an EPA Level III validation and 10 percent of the data undergo an EPA Level IV validation. This level of validation is comparable to Washington State's "QA2" evaluation and will result in data designated as "Category 1 QA2" per the LWG data evaluation process (Integral et al. 2009). During the validation process, analytical data will be evaluated for method quality control and laboratory quality control compliance, and their validity and applicability for program purposes will be determined. Based on the findings of the validation process, data validation qualifiers may be assigned. The validated project data, including qualifiers, will be entered into the project database, thus enabling this information to be retained or retrieved, as needed.

10.2 Validation and Verification Methods

Data validation includes signed entries by the field and laboratory technicians on field data sheets and laboratory datasheets, respectively; review for completeness and accuracy by the FCs and laboratory managers; review by the data managers for outliers and omissions; and the use of QC criteria to accept or reject specific data. All data will be entered into the EQuIS database and a raw data file printed. Ten percent verification of the database raw data file will be performed by a second data manager or designee. All manually entered data and all assigned qualifiers will be verified. Any errors found will be corrected on the raw data printout sheet. After the raw data is checked, the top sheet will be marked with the date the checking is completed and the initials of the person doing the checking. Any errors in the raw data file will be corrected, and the database established.

All laboratory data will be reviewed and verified to determine whether all DQOs have been met, and that appropriate corrective actions have been taken, when necessary. The QA/QC managers or designee will be responsible for the final review of all data generated from analyses of samples.

The first level of review will take place in the laboratory as the data are generated. The laboratory department manager or designee will be responsible for ensuring that the data generated meet minimum QA/QC requirements and that the instruments were operating under

acceptable conditions during generation of data. DQOs will also be assessed at this point by comparing the results of QC measurements with pre-established criteria as a measure of data acceptability.

The analysts and/or laboratory department manager will prepare a preliminary QC checklist for each parameter and for each sample delivery group (SDG) as soon as analysis of an SDG has been completed. Any deviations from the DQOs listed on the checklist will be brought to the attention of the laboratory managers to determine whether corrective action is needed and to determine the impact on the reporting schedule.

Data packages will be checked for completeness immediately upon receipt from the laboratory to ensure that data and QA/QC information requested are present. Data quality will be assessed by a reviewer using the current National Functional Guidelines for data review (EPA 2004, 2008), *Guidance on Environmental Data Verification and Validation* (EPA 2002b), and *Quality Assurance/Quality Control Guidance for Removal Activities* (EPA 1990) by considering the following:

- Holding times
- Initial calibrations
- Continuing calibrations
- Method blanks
- Surrogate recoveries
- Detection limits
- Reporting limits
- Laboratory control samples
- MS/MSD samples
- Standard reference materials

The data will be validated in accordance with the project specific DQOs described above, analytical method criteria, and the laboratory's internal performance standards based on their SOPs.

10.3 Reconciliation with User Requirements

The QA/QC manager will review data after each survey to determine if DQOs have been met. If data do not meet the project's specifications, the QA/QC manager will review the errors and

determine if the problem is due to calibration/maintenance, sampling techniques, or other factors, and will suggest corrective action. It is expected that the problem would be able to be corrected by retraining, revision of techniques, or replacement of supplies/equipment; if not, the DQOs will be reviewed for feasibility. If specific DQOs are not achievable, the QA/QC manager will recommend appropriate modifications. Any revisions will require approval by EPA. If matrix interference is suspected to have attributed to the exceedance, adequate lab documentation must be presented to demonstrate that instrument performance and/or laboratory technique did not bias the result. In cases where the DQOs have been exceeded and corrective actions did not resolve the outlier, data will be qualified per National Functional Guidelines (EPA 1999, 2008). In these instances, the usability of the data will be determined by the extent of the exceedance.

11 REFERENCES

Anchor QEA, LLC (Anchor QEA). 2009. Capture Zone Test Plan: Gasco Sediments Cleanup Action. Prepared for NW Natural, under Docket No. CERCLA 10-2009-0255. Portland, Oregon. November 2009.

Anchor QEA. 2010. Final Work Plan: Gasco Sediments Cleanup Action. Prepared for NW Natural, under Docket No. CERCLA 10-2009-0255. Portland, Oregon. January 2010.

American Society for Testing and Materials (ASTM). 2000. Standard test methods for measuring the toxicity of sediment-associated contaminants with freshwater invertebrates, E1706-00. ASTM International

ASTM. 2002. Standard Practices for Use of the Term Precision and Bias in ASTM Test Methods, 177-90a. ASTM International.

Integral Consulting, Inc., Windward Environmental, LLC, Kennedy/Jenks Consultants, and Anchor QEA, LLC. 2009. Draft Portland Harbor RI/FS Remedial Investigation Report. Prepared for The Lower Willamette Group. October 27, 2009.

U.S. Environmental Protection Agency (EPA). 1986. Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods, 3rd Edition. EPA SW-846, 1986.

EPA. 1990. Quality Assurance/Quality Control Guidance for Removal Activities. EPA/9360.4-01 EPA/540/G-90/004. April, 1990.

EPA. 2000. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates. EPA600/R-99/064. March 2000.

EPA. 2001. EPA Requirements for Quality Assurance Project Plans. EPA/240/B-01/003. March 2001.

EPA. 2002a. Guidance for Quality Assurance Project Plans. EPA/240/R-02/009. December 2002.

EPA. 2002b. Guidance on Environmental Data Verification and Data Validation. EPA/240/R-02/004, November 2002.

EPA. 2004. Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. EPA540-R-04-004. October 2004.

EPA. 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA QA/G-4. February 2006.

EPA. 2008. Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review. U.S. Environmental Protection Agency, Office of Emergency Response. EPA 540/R-99/008. October 2008.

TABLES

Table A-1
Data Quality Objectives

Data Quality Objective	Description
State the Problem	Contaminants found in shoreline and offshore media adjacent to the NW Natural Gasco and Siltronic properties led to a determination by EPA that a cleanup adjacent to these properties is necessary to protect the public health, welfare, or the environment.
Identify the Goal of the Study	The purpose of this study is to investigate the data gaps in order to define the initial Project Area in which to perform the cleanup and collect additional data to support completion of the Engineering Evaluation/Cost Analysis (EE/CA) and design.
Identify Information Inputs	The additional data required for this study include: 1. Additional sediment bioassay data to refine the project boundary because spatial gaps exist for existing sediment bioassay data in some areas. 2. Bulk sediment chemistry data at bioassay locations to provide synoptic data and at additional locations to fill spatial or volume sediment chemistry gaps. 3. Visual observations of substantial product in sediment cores and riverbank borings in key areas to fill spatial or volume data gaps in the existing substantial product extents. 4. Geotechnical (e.g., grain size, Atterberg limits, consolidation and tri-axial tests, etc.) and chemical mobility (e.g., leachate and elutriate tests) testing within sediment and riverbank soils to obtain additional data to support EE/CA alternatives evaluation and/or design. 5. Riverbank soils chemistry to fill spatial volume data gaps.
Define the Boundaries of the Study	The general area currently under consideration for the Project Area is shown in Figure 1.2-1 of the *Final Work Plan: Gasco Sediments Cleanup Action* (Anchor QEA 2010) and is the offshore areas and riverbanks adjacent to the Gasco and Siltronic properties.

Table A-1
Data Quality Objectives

Data Quality Objective	Description
Develop the Analytic Approach	Collect 19 surface sediment grab samples for bulk chemistry analyses and benthic toxicity (using two sediment toxicity tests: the 10-day survival and growth test using the midge *Chironomus dilutus* (formerly C. tentans) and the 28-day survival and growth test using the amphipod *Hyalella azteca*). To further refine the Probable Benthic Risk Areas (PRBAs), surface sediment grab samples for benthic toxicity testing are proposed at a single location in the nearshore area just upstream of the U.S. Moorings dock, along two transects within the navigation channel, and at three locations on a transect on the upstream portion of the initial Project Area. A single location is also proposed in Area 1 and Area 2. Collect up to 25 sediment cores for inspection for presence of substantial product. In addition, samples of surficial and subsurface sediments will be collected from these cores and submitted for laboratory analyses for bulk chemistry. Sediment core locations are proposed in areas to attempt to further refine or define the channel ward upstream and downstream extents of substantial product within the initial Project Area. Contingency cores are proposed in a number of secondary locations to attempt to further delineate the lateral extents of substantial product beyond product identified in the proposed sediment cores. Figure 2 of the Field Sampling Plan (FSP; Attachment 1 to the Data Gaps Quality Assurance Project Plan [QAPP]) shows the locations proposed for these sediment grab samples and sample cores. Tables 1 through 10 of the Final AIR show analyte lists and screening levels for chemicals of concern (COCs) and bioassays.
Specify Performance or Acceptance Criteria	Ensure through data review and validation that the analytical data for collected samples are within acceptable quality limits as defined by applicable EPA protocols and in Sections 7 and 8 of the QAPP and summarized in the Tables A-1 to A-6 of the QAPP.
Develop the Plan for Obtaining Data	Presented in the FSP (Attachment 1 to the QAPP).

Table A-2
Data Quality Objectives for Bulk Sediments

Parameter	Precision (duplicates)	Laboratory Control Spike Recoveries	Matrix Spike Recoveries	Completeness
Grainsize/ Atterberg Limits/ Specific Gravity/ Moisture Content	+/- 20% RPD	NA	NA	90%
Total Solids	+/- 20% RPD	NA	NA	90%
pH, Corrosivity, Ignitability	+/- 20% RPD	NA	NA	90%
Total organic carbon	+/- 20% RPD	80-120% R	75-125% R	90%
Total cyanide	+/- 20% RPD	80-120% R	75-125% R	90%
Ammonia	+/- 20% RPD	80-120% R	75-125% R	90%
Sulfide	+/- 20% RPD	80-120% R	75-125% R	90%
Total metals	+/- 20% RPD	80-120% R	75-125% R	90%
Volatile organic compounds	+/- 35% RPD	80-120% R	75-125% R	90%
Semi-volatile organic compounds	+/- 35% RPD	50-150% R	50-150% R	90%
PCBs	+/- 35% RPD	50-150% R	50-150% R	90%
Pesticides	+/- 35% RPD	50-150% R	50-150% R	90%
TPH-DX	+/- 35% RPD	50-150% R	50-150% R	90%

Notes:
RPD Relative percent difference
R Recovery

Table A-3
Data Quality Objectives for DRET and SBLT

Parameter	Precision (duplicates)	Laboratory Control Spike Recoveries	Matrix Spike Recoveries	Completeness
Available cyanide	+/- 20% RPD	80-120% R	75-125% R	90%
Free Cyanide	+/- 20% RPD	80-120% R	75-125% R	90%
Total cyanide	+/- 20% RPD	80-120% R	75-125% R	90%
Total metals	+/- 20% RPD	80-120% R	75-125% R	90%
Volatile organic compounds	+/- 30% RPD	80-120% R	75-125% R	90%
Semi-volatile organic compounds	+/- 30% RPD	50-150% R	50-150% R	90%
PCBs	+/- 30% RPD	50-150% R	50-150% R	90%
Pesticides	+/- 30% RPD	50-150% R	50-150% R	90%
Herbicides	+/- 30% RPD	50-150% R	50-150% R	90%
TPH-DX	+/- 30% RPD	50-150% R	50-150% R	90%

Notes:

RPD Relative percent difference

R Recovery

Table A-4
Data Quality Objectives for Groundwater

Parameter	Precision (duplicates)	Laboratory Control Spike Recoveries	Matrix Spike Recoveries	Completeness
Volatile organic compounds	+/- 20% RPD	80-120% R	75-125% R	90%

Notes:

RPD Relative percent difference

R Recovery

Table A-5
Laboratory QC Sample Analysis Frequency

Analysis Type	Initial Calibration	Ongoing Calibration	LCS/SRM[b]	Replicates	Matrix Spikes	Matrix Spike Duplicates	Method Blanks	Surrogate Spikes
Grainsize/Atterberg Limits/Specific Gravity/ Moisture Content	Each batch	NA	NA	1 per 20 samples	NA	NA	NA	NA
Total Solids, pH, Corrosivity, Ignitability	Each batch	NA	NA	1 per 20 samples	NA	NA	NA	NA
Total organic carbon	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	1 per 20 samples	NA
Cyanide/Ammonia/Sulfide	Daily or each batch	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	1 per 20 samples	NA
Metals	Daily	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	NA	1 per 20 samples	NA
TPH-G, TPH-DX	As needed [a]	1 per 10 samples	1 per 20 samples	1 per 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
SVOCs	As needed [a]	Every 12 hours	1 per 20 samples	1 per 20 samples[c]	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
Pesticides/PCBs/Herbicides	As needed [a]	1 per 10 samples	1 per 20 samples	1 per 20 samples[c]	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample
Volatile organics	As needed [a]	Every 12 hours	1 per 20 samples	1 per 20 samples[c]	1 per 20 samples	1 per 20 samples	1 per 20 samples	Every sample

Notes:

a Initial calibrations are considered valid until the ongoing continuing calibration no longer meets method specifications. At that point, a new initial calibration is performed.

b When a standard reference material is available it may be used in lieu of an LCS.

c The matrix spike/matrix spike duplicated (MS/MSD) analysis is considered the "laboratory duplicate" for these methods.

Table A-6
Field QC Samples Acceptance Criteria

Field Quality Control Sample	Frequency of Analysis	Acceptance Criteria
Field Blank	1 per sampling equipment per sampling event	Non-detect; less than 5-times sample concentration; or sample result is non-detect
Rinsate Wipe/Blank	1 per sampling equipment per sampling event	Non-detect; less than 5-times sample concentration; or sample result is non-detect
Filter/Rinsate Blank	1 per sampling equipment per sampling event	Non-detect; less than 5-times sample concentration; or sample result is non-detect
Trip Blank	Each cooler with VOC samples	Non-detect; less than 5-times sample concentration; or sample result is non-detect
Field Duplicate	1 per 20 samples	± 50 percent RPD

Notes:

RPD Relative percent difference

FIGURES

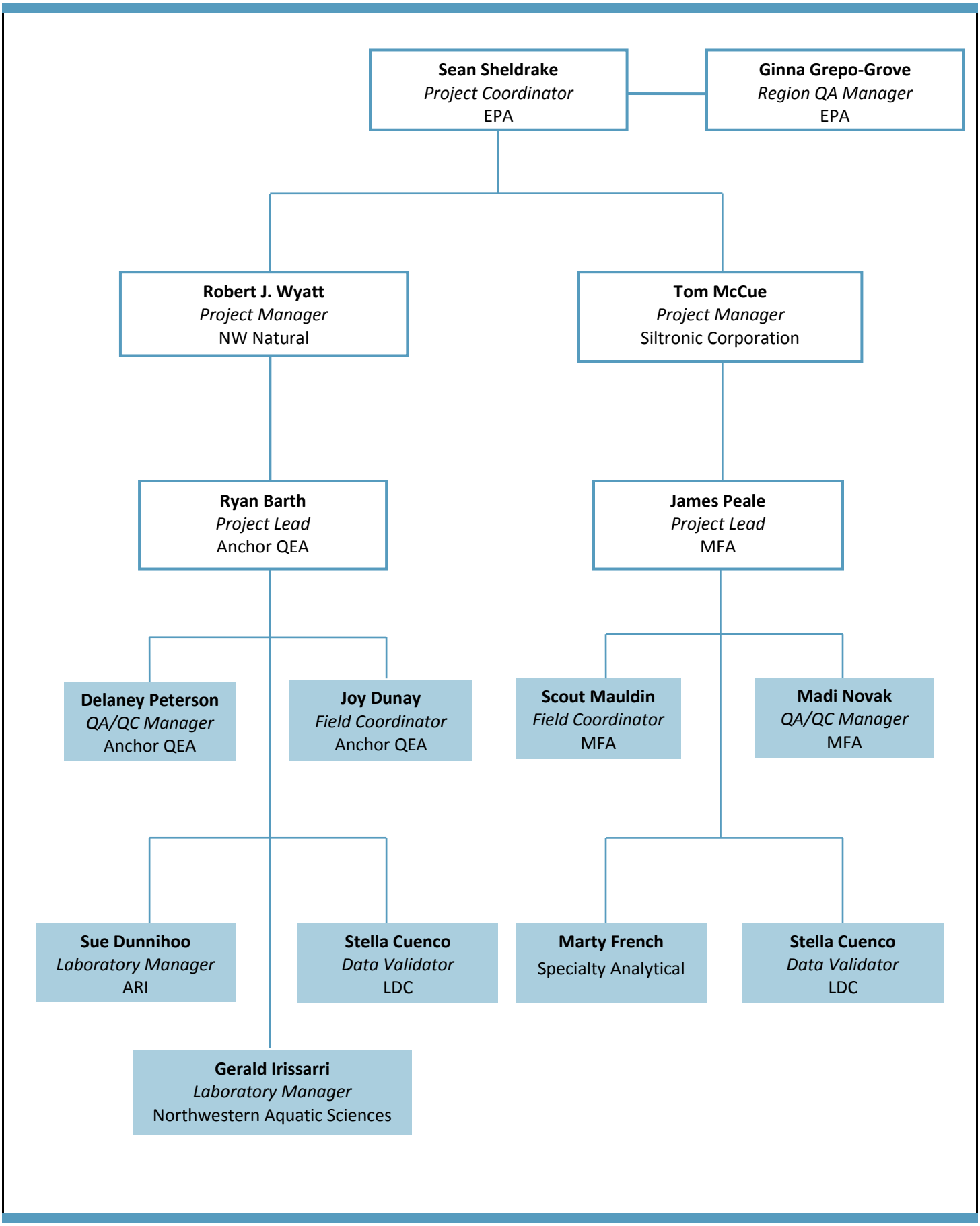

Figure A-1
Project Organization Chart
Data Gaps Quality Assurance Project Plan
Gasco Sediments Cleanup Action

ANCHOR QEA

ATTACHMENT 1
FIELD SAMPLING PLAN

FINAL
FIELD SAMPLING PLAN

DATA GAPS QAPP
GASCO SEDIMENTS CLEANUP ACTION

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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.

7 REFERENCES

Anchor Environmental, LLC (Anchor). 2008. Portland Harbor RI/FS Draft Final Sediment Chemical Mobility Testing – Field Sampling Plan. Prepared for the Lower Willamette Group. June 13.

ASTM. 2003. Standard test methods for measuring the toxicity of sediment-associated contaminants with fresh water invertebrates. ASTM Standard Method No. E 1706-00. ASTM annual book of standards volume 11.05, American Society for Testing and Materials, West Conshohocken, PA.

DiGiano, F. A., Miller, C. T., and Yoon, J. 1995. "Dredging elutriate test development." Contract Report D-95-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. NTIS No. AD A299 354, August 1995.

Hahn and Associates, Inc. (HAI). 2008. Investigation Derived Waste Management Plan. February 26, 2008.

Integral Consulting, Inc., Windward Environmental, LLC, Kennedy/Jenks Consultants, and Anchor QEA, LLC. 2009. Draft Portland Harbor RI/FS Remedial Investigation Report. Prepared for The Lower Willamette Group. October 27, 2009.

MacDonald Environmental. 2002. Calcasieu Estuary remedial investigation/feasibility study (RI/FS): Baseline ecological risk assessment (BERA). Prepared for CDM Federal Programs Corp. September 2002. MacDonald Environmental Services, Ltd., Nanaimo, BC.

MacDonald, D.D., and P.F. Landrum. 2008. An evaluation of the approach for assessing risks to the benthic invertebrate community at the Portland Harbor Superfund site. Preliminary draft. Prepared for US Environmental Protection Agency. September 2008. MacDonald Environmental Sciences, Ltd., Nanaimo, BC, and Landrum and Associates, Ann Arbor, MI.

Oregon Department of Environmental Quality (DEQ). 2005. Erosion and Sediment Control Manual, Appendix F: Sediment Control BMPs. April 2005.

U.S. Army Corp of Engineers (USACE). 2003. Evaluation of Dredged Material Proposed for Disposal at Island, Nearshore, or Upland Confined Disposal Facilities — Testing Manual. Engineer Research and Development Center. ERDC/EL January 2003

U.S. Environmental Protection Agency (EPA). 1986. Test methods for evaluating solid waste. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. SW-846. September (update 1, July 1992; update 2a, August 1993; update 2, September 1994; update 2b, January 1995).

EPA. 1993. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods – 3rd Edition, Update 4A. EPA SW-846, August 1993.EPA. 2008. EPA e-mail dated October 14, 2008 to Lower Willamette Group (from E. Blischke to R. Wyatt) regarding benthic evaluation for Portland Harbor. US Environmental Protection Agency Region 10, Oregon Operations Office, Portland, OR.

EPA. 2000. Methods for measuring the toxicity and bioaccumulation of sediment-associated contaminants with freshwater invertebrates. Second edition. EPA 600/R-99/064. US Environmental Protection Agency, Duluth, MN.

EPA. 2001. Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. EPA/823/B-01-022, October 2001.

EPA. 2008. EPA e-mail dated October 14, 2008 to Lower Willamette Group (from E. Blischke to R. Wyatt) regarding benthic evaluation for Portland Harbor. U.S. Environmental Protection Agency Region 10, Oregon Operations Office, Portland, OR.

EPA. 2009. EPA e-mail dated July 17, 2009, to Lower Willamette Group (from E. Blischke to R. Wyatt) regarding Portland Harbor RI/FS: interpretation of sediment bioassay results. U.S. Environmental Protection Agency Region 10, Oregon Operations Office, Portland, OR.

Windward Environmental, LLC (Windward). 2007a. Portland Harbor RI/FS Round 3B QAPP Addendum 10 Appendix A: Sediment Toxicity Testing QAPP. Attachment No. 2. Test Protocol for the 28-Day Chronic Sediment Toxicity Test with *Hyalella azteca*. Prepared for The Lower Willamette Group. December 2007.

Windward. 2007b. Portland Harbor RI/FS Round 3B QAPP Addendum 10 Appendix A: Sediment Toxicity Testing QAPP. Attachment No. 3. Test Protocol for the 10-Day Acute Sediment Toxicity Test with *Chironomus dilutus*. Prepared for The Lower Willamette Group. December 2007.

Windward. 2009a. Toxicity Reanalysis Technical Memorandum. Prepared for The Lower Willamette Group. November 13, 2009.

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° 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° 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 organisms.

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

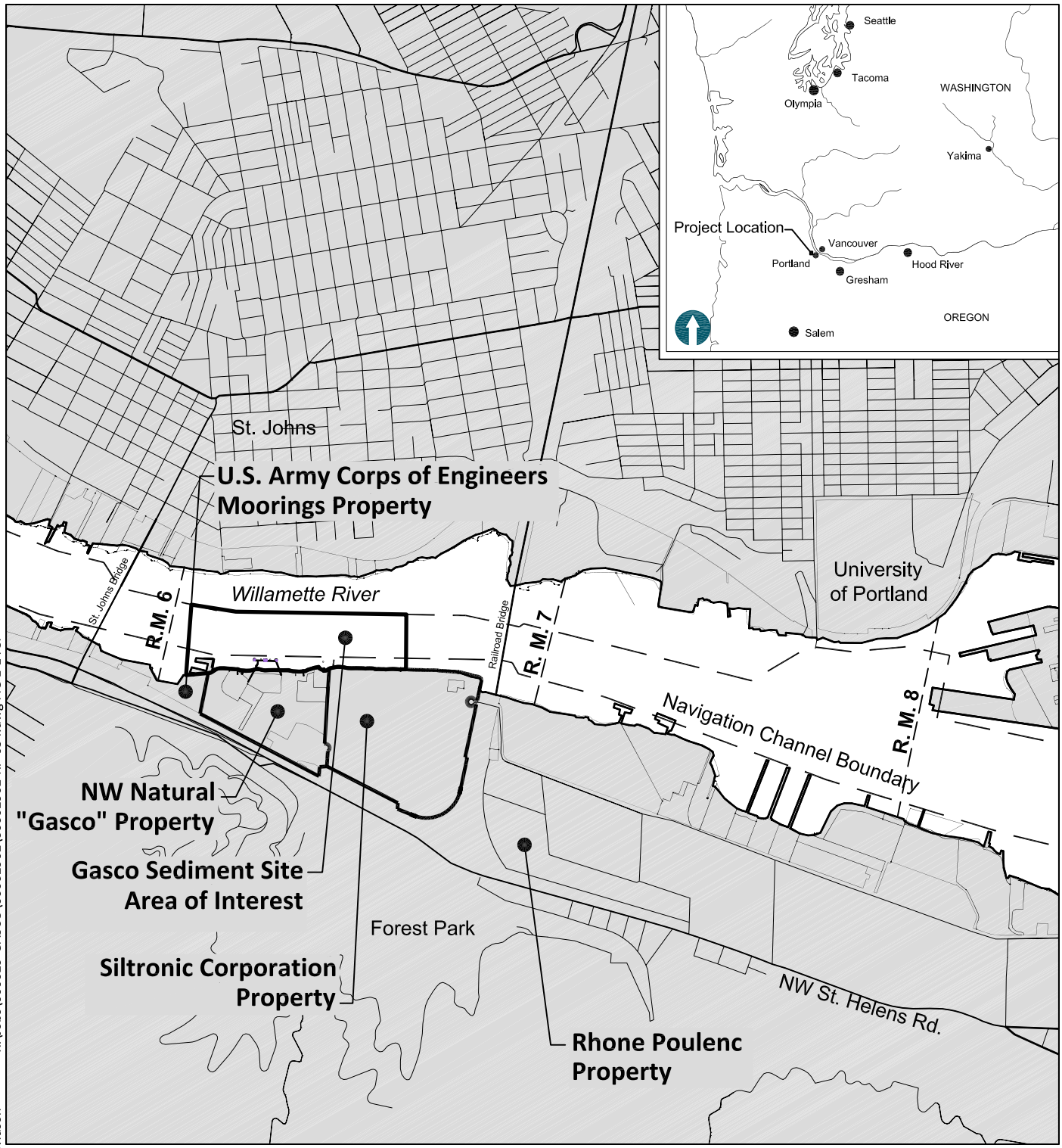
Table 1-14
Analytes, Analysis Methods, and Targeted Reporting Limits – SBLT

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



NOTE: All locations are approximate.

0 2000
Scale in Feet

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

Jul 14, 2010 10:55am cdavidson

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

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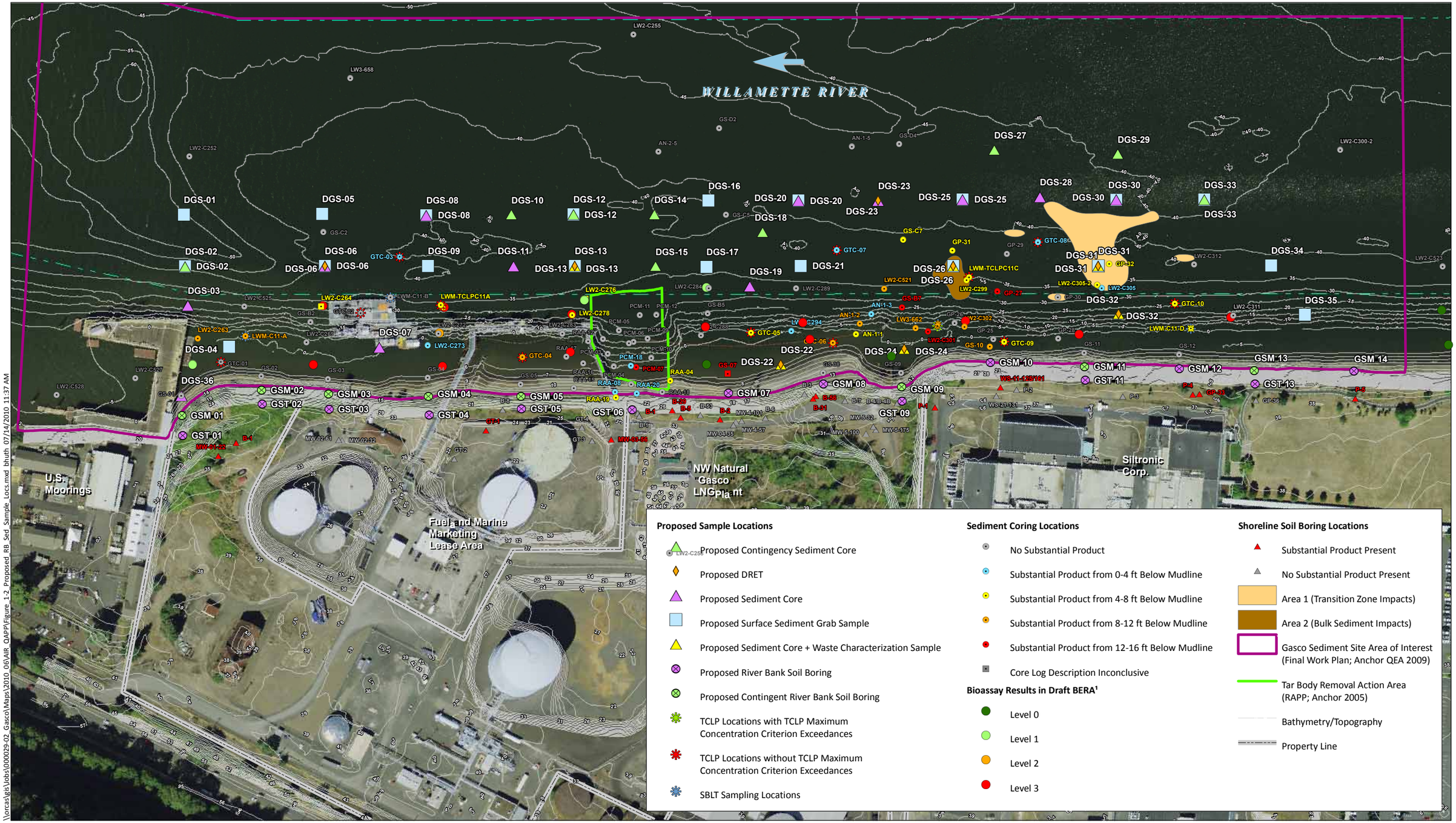

\\orcas\gis\Jobs\000029-02_Gasco\Maps\2010_06\AIR_QAPP\Figure_1-2_Proposed_RB_Sed_Sample_Locs.mxd bhuth 07/14/2010 11:37 AM

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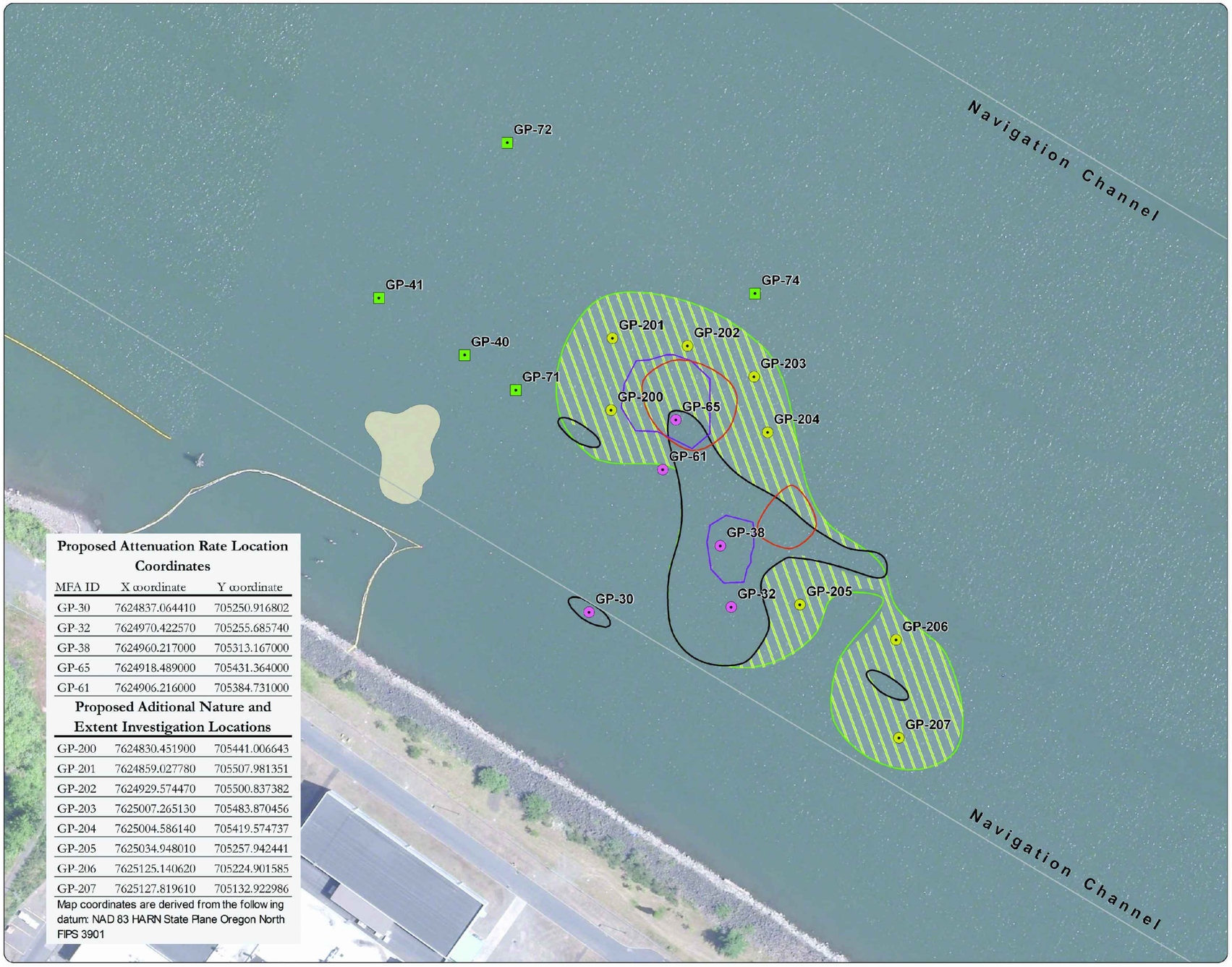
NOTES:
1. * = mudline elevation estimated based on bathymetry surveyed by LWG in 2009.
2. ~ = surface elevation estimated based on topography surveyed by Spencer B. Gross, Inc 2006.
3. Locations GTC-09 and LWM-TCLPC-11B showed substantial product at the bottom of the core.
4. The substantial product 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

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 following datum: NAD 83 HARN State Plane Oregon North FIPS 3901

Legend

- CVOCs ND in TZW (see note 1)
- Proposed Additional Nature and Extent Investigation Area Locations
- Proposed Attenuation Rate Locations
- Army Corps of Engineers Navigation Channel
- Area 2
- Area 1
- Trichloroethene
- cis-1,2-DCE
- Vinyl Chloride
- Proposed Additional Nature and Extent Investigation Area

Notes:
1. CVOCs ND in TZW = TCE and its degradation products (DCE isomers and vinyl chloride) were not detected in transition zone water (TZW) above standard method reporting limits at these locations.

0 45 90
Feet

Source: Aerial photograph (2008) and obtained from Metro Data Resource Center; navigation channel obtained from Army Corps of Engineers.

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p. 360 694 2691 | www.maulfoster.com

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

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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:**

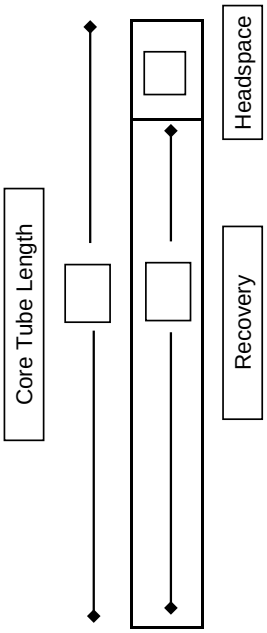
Field Collection Coordinates:
Lat/Northing: | Long/Easting:

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:

Elevation: Datum:

Obs. Well Install. Yes No

Boring _____ Date _____ Sheet _____ of ____
Job _____ Job No. _____
Logged By _____ Weather _____
Drilled By _____
Drill Type/ Method _____
Sampling Method
Bottom of Boring _____ ATD Water Level Depth _____

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 2
ANCHOR QEA HEALTH AND SAFETY PLAN

FINAL

ANCHOR QEA HEALTH AND SAFETY PLAN

DATA GAPS QAPP

GASCO SEDIMENTS CLEANUP ACTION

Prepared for

U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Prepared by

Anchor QEA, LLC
6650 SW Redwood Lane
Portland, Oregon 97224

On behalf of

NW Natural
220 NW Second Avenue
Portland, Oregon 97209

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LIST OF ACRONYMS AND ABBREVIATIONS

AIR	Project Area Identification Report
AED	Automated External Defibrillator
AOC	Administrative Settlement Agreement and Order on Consent
AST	Aboveground Storage Tank
BTEX	benzene, toluene, ethylbenzene, xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CPR	cardiopulmonary resuscitation
CRZ	contamination reduction zone
CSO	combined sewer overflow
DNAPL	dense non-aqueous phase liquid
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
FC	Field Coordinator
FID	flame ionization detector
FSP	Field Sampling Plan
HASP	Health and Safety Plan
MFA	Maul Foster & Alongi, Inc.
MSDS	Material Safety Data Sheets
OSHA	Occupational Safety and Health Administration
OVM	organic vapor monitor
PAH	polycyclic aromatic hydrocarbon
PBRA	probable benthic risk area
PEC	project emergency coordinator
PEL	permissible exposure limit
PFD	personal flotation device
PID	photoionization detector
Portland Harbor Site	Portland Harbor Superfund Site
PPE	personal protective equipment
Ppm	parts per million
QAPP	Data Gaps Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act

RM	river mile
Siltronic	Siltronic Corporation
SOW	Statement of Work
SS	Site Supervisor
SSHO	Site Safety and Health Officer
TCE	trichloroethene
TPH	total petroleum hydrocarbons
TSD	Treatment, storage, and disposal
TZW	transition zone water
USACE	U.S. Army Corps of Engineers
vibracore	vibratory core sampler
VOCs	volatile organic compounds

1 INTRODUCTION

Contaminants found in shoreline and offshore media adjacent to the NW Natural Gasco and Siltronic Corporation (Siltronic) properties led to a determination by U.S. Environmental Protection Agency (EPA) that a cleanup adjacent to these properties is necessary to protect the public health, welfare, or the environment. Accordingly, NW Natural and Siltronic entered into the Administrative Settlement Agreement and Order on Consent (AOC; Docket No. CERCLA 10-2009-0255) with the EPA on September 9, 2009, to conduct an Engineering Evaluation/Cost Analysis (EE/CA), and to design a final remedy for the Gasco Sediments Site within the Portland Harbor Superfund Site (Portland Harbor Site). The AOC contemplates that construction of the remedy would be under a Consent Decree with EPA after the issuance of the Portland Harbor Site Record of Decision (ROD). Additional investigation to fill identified data gaps will be conducted as part of the design phase as described in the Project Area Identification Report (AIR) and attached Data Gaps Quality Assurance Project Plan (QAPP; Appendix A to the AIR). This Health and Safety Plan (HASP; Attachment 2 to the QAPP) is designed to protect Anchor QEA personnel from physical, chemical, and other hazards posed by field sampling efforts detailed in the Field Sampling Plan (FSP; Attachment 1 to the QAPP).

Maul Foster Alongi, Inc. (MFA), has prepared a separate HASP (Attachment 3 to the QAPP) to protect MFA personnel from physical, chemical, and other hazards posed by the Area 1 field sampling efforts detailed in the FSP (Attachment 1 to the QAPP).

Field activities covered under this HASP include subsurface drilling conducted from a drill rig operating from the top of the riverbank and on the riverbank slope, the collection of subsurface sediments using vibratory coring equipment operated from a vessel, and the collection of surficial sediments using a van Veen power grab operated from a vessel. The methods for drilling and the collection of subsurface cores and surficial sediment are detailed in the FSP (Attachment 1 to the QAPP).

2 SITE DESCRIPTION AND PROJECT SCOPE

The Gasco Sediments Site is located along the western bank of the Lower Willamette River within the Portland Harbor, a heavily industrialized reach downstream and north of downtown Portland, Oregon. As shown on Figure 1 of the AIR, the Gasco Sediment Site Area of Interest is adjacent to the Gasco and Siltronic properties located between river mile (RM) 6 and RM 6.7. The Area of Interest also includes a portion of the federally-maintained Lower Willamette River navigational channel and extends from the river sediments up to the top of the bank slope, ending where the generally level portions of the Gasco Sediments Site begin, as defined in the Statement of Work (SOW) attached to the AOC.

The field sampling activities necessary to fill the data gaps identified in Section 5 of the AIR include the following:

- 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 initial Project Area boundary.
- Sediment bioassay toxicity and surface sediment chemistry data to refine the probable benthic risk area (PBRA) and initial Project Area boundary.
- Surface and subsurface sediment chemistry data to provided data to refine the horizontal and vertical extent of screening level exceedances 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 screening level exceedances and initial Project Area boundary.
- Transition zone water (TZW) and groundwater chemistry sampling 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 Resource Conservation and Recovery Act (RCRA) hazardous waste or Special Waste (as defined in the SOW) in the Project Area, and the extents of such wastes.

3 HAZARD EVALUATION AND CONTROL MEASURES

This section covers potential chemical and physical hazards that may be associated with the proposed field activities and presents control measures to address these potential hazards. Section 3.4 and Table 2-1 present the activity hazard analysis, which lists the potential hazards associated with each site activity and the recommended site control to be used to minimize each potential hazard. Confined space entry will not be necessary for this project; therefore, hazards associated with this activity are not discussed in this HASP.

3.1 Exposure Routes

Potential routes of exposure to chemicals include inhalation, dermal contact, and ingestion of dust, mist, gas, vapor, or liquid. Exposure will be minimized by using safe work practices and by wearing the appropriate personal protective equipment (PPE). Further discussion of PPE requirements is presented in Section 6.

3.1.1 Inhalation

Inhalation of particulates, dust, mist, gas, or vapor during the planned activities is possible. Whenever possible the coring equipment will be oriented so that personnel are upwind of the coring location. An organic vapor monitor (OVM) a photoionization detector (PID) or flame ionization detector (FID) will be used to monitor ambient air in the breathing zone within the work area for organic compounds. Section 8.2 and Table 2-2 describe OVM action levels and response procedures. A daily air monitoring log form is presented in Attachment 2-2.

3.1.2 Dermal Contact

Dermal contact with potentially contaminated soil, sediment, or groundwater during shoreline and vessel-based coring operations is possible. Direct contact will be minimized through the use of appropriate PPE and decontamination procedures.

3.1.3 Ingestion

Ingestion of contaminants is a less likely route of exposure than inhalation or dermal contact for many of the contaminants of concern. Direct ingestion of contaminants can occur by inhaling airborne dust, mist, or vapors or swallowing contaminants trapped in the upper respiratory tract. Indirect ingestion can occur by introducing the contaminants into the mouth by way of food, tobacco, fingers, or other carriers. Although ingestion of contaminants can occur, proper

decontamination/contamination reduction procedures should eliminate the probability of this route of exposure.

3.2 Chemical Hazards

Metals, volatile organic compounds (VOCs), petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), and free product sourced from manufactured gas plant (MGP) have been detected in water, sediment, and riverbank soils within the initial Product Area during past site activities. Concentrations that may be encountered during the field activities are listed in Appendix D of the Project Area Identification Report and Data Gaps QAPP. In addition, there is some potential for exposure to hydrogen sulfide gas from native soil and hexane, which in rare cases may be used as a decontamination liquid.

3.2.1 VOCs

VOCs known to be present at the site include chlorinated VOCs [vinyl chloride, trichloroethylene (TCE), and 1,2-Dichloroethane (1,2-DCE)] and volatile components of gasoline [benzene, toluene, ethylbenzene, and xylenes (BTEX)]. The primary exposure routes for VOCs during the planned activities are inhalation, dermal contact, and ingestion of contaminated soil, sediment, dust, or water.

VOCs readily volatilize and are primarily an inhalation concern. The BTEX compounds are known or suspected human carcinogens. Chlorinated volatile compounds are known to cause cancer in animals and the target organs primarily affected by prolonged exposure to chlorinated volatiles compounds are the central nervous system, liver, eyes and skin.

An OVM equipped with a photo-ionization detector will be used to monitor ambient air and the breathing zone for VOCs. Respiratory protection will be employed if elevated levels of organic compounds are measured by the OVM, if odors are present, or other conditions warrant its use. Air monitoring action levels are presented in Table 2-2.

3.2.2 Metals

The primary exposure routes for metals during the planned activities are inhalation or ingestion of dust particles. Metals may also be indirectly ingested, as described in Section 3.1.3. A secondary route of exposure to metals is dermal contact. The target organs primarily affected

by prolonged exposure to metals are the respiratory tract, gastrointestinal tract, central nervous system, kidneys, and liver.

Prolonged exposure to metals through any of the potential routes of exposure is not expected. Skin will be washed immediately when exposed to soil, sediment, dust, or water potentially impacted by metals.

3.2.3 TPHs

Total petroleum hydrocarbons (TPHs) likely at the project site include tar and oil related materials in sediments and soils, which contain benzene and aromatic hydrocarbons. Gasoline, diesel, fuel, and waste oil, and heavier hydrocarbons such as grease may also be present associated with sampling equipment. The primary exposure routes for petroleum hydrocarbons during the planned activities are inhalation, dermal contact, and ingestion of contaminated soil, sediment, dust, or water. Lighter petroleum hydrocarbons such as gasoline and benzene readily volatilize and are primarily an inhalation concern (as described in Section 3.2.1), whereas the primary route of exposure to heavier petroleum hydrocarbons such as aromatic hydrocarbons, oil, and grease is dermal contact. The target organs primarily affected by prolonged exposure to petroleum hydrocarbons are the respiratory system, central nervous system, kidneys, liver, and skin. Prolonged dermal contact with petroleum hydrocarbons can cause irritation or dermatitis.

As described in Section 3.2.1, an OVM equipped with a photo-ionization detector will be used to monitor ambient air and the breathing zone for TPH compounds that have volatized. Respiratory protection will be employed if elevated levels of organic compounds are measured by the OVM, if odors are present, or other conditions warrant its use. Air monitoring action levels are presented in Table 2-2. Petroleum hydrocarbons such as gasoline are also flammable and can be a physical hazard when present in high concentrations. Physical hazards associated with flammable compounds are addressed in Section 3.3.10. Combustion of petroleum hydrocarbons can produce carbon dioxide, carbon monoxide, aldehydes, fumes, smoke (particulate matter), and other products of incomplete combustion. Intentional and inadvertent combustion of petroleum hydrocarbons is not expected during sampling activities; however, personnel will be removed from the area should a fire occur.

3.2.4 PAHs

PAHs are petroleum hydrocarbons which are relatively nonvolatile due to their large molecular structure and high molecular weight. Consequently, the primary route of exposure to PAHs is through dermal contact. PAHs may also be indirectly ingested as described in Section 3.1.3. Inhalation of PAHs is unlikely due to their nonvolatile nature. Dermal or eye contact with PAHs can cause irritation or burning.

3.2.5 Hydrogen Sulfide

Hydrogen sulfide is a naturally occurring gas often associated with organic clay and peat. Hydrogen sulfide gas is potentially toxic through inhalation, ingestion, and contact with the skin and eyes. Inhalation can result in respiratory irritation, rhinitis, and edema of the lungs. Inhalation of hydrogen sulfide gas can result in headache, dizziness, and agitation. Acute exposure at high concentrations may result in coma and death as a result of respiratory failure. Hydrogen sulfide gas has a distinct rotten egg odor, and will be noted if encountered in the field.

3.2.6 Hexane

If necessary to achieve adequate decontamination of equipment, a hexane rinse may be applied to remove hydrocarbon-type compounds. Exposure to high concentrations of hexane usually occurs by inhalation. Effects of inhalation may be slow and shallow breathing, possible tachycardia, vertigo or giddiness, nausea, and vomiting. Dermal exposure may result in dermatitis or conjunctival irritation. Eye exposure will cause irritation and requires irrigation.

3.3 Physical Hazards

3.3.1 Slips Trips and Falls

As with all fieldwork sites, personnel should exercise caution to prevent slips on slick surfaces. In particular, sampling from a floating platform requires careful attention to minimize the risk of falling down or falling overboard. The same care should be used in rainy conditions. Wearing boots with good tread, made of material that does not become overly slippery when wet, can minimize slips.

Trips are always a hazard on the uneven deck of a boat or in a cluttered work area. The deck of the vessel may have numerous stationary fittings and tie-downs that present potential tripping

hazards. Personnel will keep work areas as free as possible from items that interfere with walking and will be aware of stationary obstacles on deck.

Falls may be avoided by working as far away from exposed edges as possible. For this project, the potential for falling is associated primarily with deployment and recovery of sampling equipment over the bow of the vessel, boarding and disembarking the vessel at the dock, and while walking along the shoreline composed of loose rocks. Personnel will keep walkways and work areas clear when possible and use caution when walking along the shoreline and the riverbank slope.

3.3.2 Soil and Sediment Sampling Equipment

Subsurface soil samples will be collected using a Rotosonic drill rig operated onshore on the top of bank and slope of riverbank areas. In-water subsurface sediment samples will be collected using a vibratory core sampler (vibracore) methods operated from a vessel. In-water surficial sediments will be collected using either a hydraulic or gravity driven van Veen grab sampling device. Prior to initiation of sampling on the uplands or sampling vessel, there will be a training session for all field personnel pertaining to the equipment that will be used on the uplands or onboard the sampling vessel. The captain will review vessel-specific hazards and safety procedures and will point out the location and proper use of all safety equipment. For example, field personnel will be shown the locations of all fire extinguishers, flotation rings, and first aid kits and their appropriate uses.

3.3.3 Precautions When Working Around Heavy Equipment

The following precautions will be taken to minimize heavy equipment hazards:

- All equipment must have back-up alarms
- Personnel must make eye contact with the operator before approaching the equipment and remain safely outside the swing radius of the equipment
- Personnel must wear orange visibility vests in addition to standard Level D PPE
- Personnel must never stand on track-hoe tracks to communicate with the operator
- Operators must be aware of personnel in the area and use proper hand signals before maneuvering
- Operators must wear hard hats when operating machines and when going to and from their equipment

- Operators must use spotters and be cautious when maneuvering equipment within 15 feet of overhead power lines and utility pole guy wires, and maintain safe distances at all times (greater than 10 feet)
- Provisions will be made to prevent the unauthorized start-up of equipment when personnel leave the site at the end of the shift, such as battery ignition locks

3.3.4 Falling Overboard

It is anticipated that the majority of the sampling will be conducted from a vessel. As with any work from a floating platform, there is a chance of falling overboard. A U. S. Coast Guard-approved personal flotation device (PFD) for each crew person will be available in the boat at all times. PFDs will be worn and properly buckled and zipped as appropriate, by all personnel while working on or over water, regardless of work zone. PFDs will be checked daily and will be in good condition and of the proper size for the intended wearer. The use of hydrostatic life vests are not anticipated, however, if used they will be checked each day prior to donning to confirm that the carbon dioxide cartridge is ready for use.

3.3.5 Uneven Work Surfaces

Slips and trips on uneven surfaces such as a rip rap slope can be particularly hazardous. Care will be taken when setting up drilling equipment at the top of the riverbank and along the slope of the riverbank to provide an area for field personnel working on or near the drilling equipment. Wearing boots with good tread that are made of material that does not become overly slippery when wet can minimize slips. Sturdy work gloves shall be worn to protect the hands against sharp or rough rocky surfaces.

3.3.6 Manual Lifting and Material Handling

Equipment and samples must be lifted and carried both aboard the vessel and along the shoreline. Back strain can result if lifting is done improperly. During any manual handling tasks, personnel should lift with the load supported by their legs and not their backs. For heavy loads, an adequate number of people will be used, or if possible, a mechanical lifting/handling device. Leather gloves will be worn when handling metal, wire rope, sharp debris, or transporting material (wood, piping, drums, etc.).

3.3.7 Heat Stress

Scheduled sampling operations will be occurring in late Summer or Fall, so high temperatures may be encountered. The potential for heat stress may occur if impermeable PPE is worn or if strenuous work is performed under hot conditions with inadequate water. When the core body temperature rises above 100.4° F, the body cannot sweat to cool down, and heat stress can occur. Heat stress may be identified by the following symptoms: dizziness, profuse sweating, skin color change, vision problems, confusion, nausea, fatigue, fainting, and clammy skin. Personnel exhibiting such symptoms will be removed to a cool shady area, given water, and allowed to rest. Fresh drinking water will be provided aboard the vessel. All field team members will monitor their own condition and that of their co-workers to detect signs of heat stress.

3.3.8 Hypothermia

Hypothermia is abnormal lowering of the core body temperature caused by exposure to a cold environment. Wind chill as well as wetness or water immersion can play a significant role. Typical signs of hypothermia include fatigue, weakness, lack of coordination, apathy, and drowsiness. Confusion is a key symptom of hypothermia. Shivering and pallor are usually absent, and the face may appear puffy and pink.

Body temperatures below 90° F require immediate treatment to restore the temperature to normal. Current medical practice recommends slow warming of the individual followed by professional medical care. Moving the person to a sheltered area and wrapping them in a blanket can accomplish this portion of the task. If possible, the person should be placed in a warm room. In emergencies where body temperature falls below 90° F and shelter is not available, a sleeping bag, blankets, and body heat from another individual can be used to help raise body temperature.

3.3.9 Weather

In general, field team members will be equipped for the normal range of weather conditions. The designated field coordinator (FC) will be aware of current weather conditions and of the potential for those conditions to pose a hazard to the field crew. Some conditions that might force work stoppage are electrical storms, high winds, or high waves resulting from winds.

3.3.10 Flammable Hazards

Petroleum hydrocarbons are flammable in moderate to high concentrations. Therefore smoking, open flames, and unprotected ignition sources will not be allowed in the work area. An OVM will be used to measure concentrations of organic vapors (i.e., benzene) in the work area. If elevated OVM measurements persist, work will be suspended until corrective measures are taken to ensure a safe work environment.

3.3.11 Biological Hazards

Direct contact with Willamette River water may be hazardous due to the potential for combined sewer overflow (CSO) contamination. All field crew will avoid contact with potential biological or infectious materials, wear PPE as appropriate, and wash hands and face as soon as possible after contact and before eating or drinking.

3.4 Activity Hazard Analysis

The activity hazard analysis summarizes the field activities to be performed during borehole drilling and sediment sampling activities, outlines the hazards associated with each activity, and presents controls that can reduce or eliminate the risk of the hazard occurring.

Table 2-1 presents the activity hazard analysis for the following activities:

- Drilling activities including soil sample collection
- Vibratory core drilling and core processing activities
- Surface sediment sample collection
- Sediment sample handling, packaging, processing, and shipping
- Equipment decontamination

4 WORK ZONES AND ACCESS CONTROL

The vessel captain, onshore boring operator, and the FC will delineate the boundaries of the work zones aboard the vessel and shoreline and will inform the field crews of the arrangement. The purpose of the zones is to limit the migration of sample material out of the zones and to restrict access to active work areas by defining work zone boundaries.

4.1 Vessel Sediment Sampling Work Zones

The following zones are vessel sediment sampling work zones:

- **Exclusion zone:** The exclusion zone encompasses the sampling vessel where **s**ediment sampling and processing will occur. The sediment sampling area will encompass the the bow of the sampling vessel when collecting vibracores and van Veen grabs, where the samplers will be deployed and recovered. This area will be considered the exclusion zone only when samples are being handled on the vessel. The exclusion zone will be clearly communicated to all field personnel and adequately demarcated.
- **Contamination reduction zone (CRZ):** The CRZ during sediment handling is the entire vessel deck, except as noted in the preceding paragraph. Decontamination of both personnel and equipment will occur in this zone to prevent the transfer of chemicals of concern to the support zone. For surface sediment and core processing, the CRZ will consist of an area surrounding the exclusion zone where decontamination of both personnel and equipment will occur.
- **Support zone:** On the sampling vessel, the support zone will be located in the cabin of the vessel or on the vessel deck when contaminated sediments are not on deck.

Sampling staff will instruct people to stay outside the exclusion zone while sample processing is occurring. Only staff required to enter the exclusion zone should be in the exclusion zone to avoid tracking contaminants into the contaminant reduction and support zones. Only personnel that are current with HAZWOPER compliance and Occupational Safety and Health Administration (OSHA) medical monitoring standards will be present on the vessel.

4.2 Onshore Soil Sampling Work Zones

The following zones are onshore soil sampling work zones:

- **Exclusion zone:** The exclusion zone will enclose the entire perimeter of the track-rig and will include the area where sampling is taking place. The exclusion zone will

encompass an area 1.5-times the height of the drill rig tower around the drill rig where practical. Where topography and structures preclude this area, adjustments will be made in the field. Only the coring crew may enter this zone unless assistance is required by other personnel. The exclusion zone will also include a nearby core processing area along the shoreline or on top of the bank area. Cores will likely be processed under fold-up canopies and the exclusion zone will encompass the entire area under the canopy where cores will be processed or where contact to contaminated soil and sediments is possible. The drill contractor coring crew will transport the sediment core tubes to this zone. Entry and exit to this zone will be through a designated access point.

- **CRZ:** The CRZ during sediment handling will encompass the area surrounding the Exclusion zone. Decontamination of both personnel and equipment will occur in this zone to prevent the transfer of chemicals of concern to the support zone. Entry and exit between zones will be through a designated access point.
- **Support zone:** On-shore, the support zone will be located in the on-site trailer or outside the CRZ.

Sampling staff will instruct people to stay outside the exclusion zone where samples are collected and where sample processing is occurring.

4.3 Decontamination Area

All contaminated materials will be properly captured and disposed. A station within the CRZ will be set up for decontaminating sample processing equipment and personnel gear such as boots or PPE. The station will have the buckets, brushes, soapy water, rinse water, or wipes necessary to perform decontamination operations. Plastic bags will be provided for expendable and disposable materials. The decontamination fluids will be stored in sealable containers and will be disposed of in accordance with the procedures presented in Section 9.3.

4.4 Access Control

Security and control of access to the sampling vessel and onshore area will be the responsibility of the captain, site supervisor (SS), and/or site safety and health officer (SSHO). Additional security measures may be placed into affect by NW Natural, as required by national security threat levels determined by the federal government. Access to the vessel and onshore areas will only be granted to necessary project personnel and authorized visitors. Any security or access control problems will be reported to the client or appropriate authorities.

5 SAFE WORK PRACTICES

Following common sense rules will minimize the risk of exposure or accidents at a work site. These general safety rules will be followed on site:

- Always use the buddy system
- Be aware of overhead and underfoot hazards at all times
- Do not eat, drink, smoke, or perform other hand-to-mouth transfers in the work zones
- Get immediate first aid for all cuts, scratches, abrasions, or other minor injuries
- Report all accidents and close calls, no matter how minor, to the FC
- Be alert to your own and other workers' physical condition
- Do not climb over or under obstacles of questionable stability
- Make eye contact with equipment operators before moving into the range of their equipment
- Work during daylight hours

6 PERSONAL PROTECTIVE EQUIPMENT AND SAFETY EQUIPMENT

Appropriate PPE will be worn for all tasks as protection against potential hazards. In addition, a PFD will be required when working on the vessel. Prior to donning PPE, the workers will inspect their equipment for any defects that might render the equipment ineffective.

All fieldwork for all tasks will be conducted in Level D, modified Level D, or Level C PPE as discussed below in Sections 6.1, 6.2, and 6.3, respectively. Situations requiring PPE beyond Level C are not anticipated for this project. Should the FC determine that PPE beyond Level C is necessary at a given sampling station, the FC will notify the SSHO to select an appropriate corrective action.

6.1 Level D Personal Protective Equipment

Workers performing general activities in which skin contact with contaminated materials is unlikely and in which inhalation risks are not expected will wear Level D PPE. Level D PPE includes the following:

- Chemical-resistant, steel-toed boots
- Leather, cotton, or chemical-resistant gloves, as the type of work requires
- Safety glasses
- Hard hat (if overhead hazard exists)
- Hearing protection, if necessary

6.2 Modified Level D Personal Protective Equipment

Workers performing activities where skin contact with contaminated materials is possible will wear chemical-resistant outer gloves and an impermeable outer suit. The type of outerwear will be chosen according to the types of chemical contaminants that might be encountered. Modified Level D PPE includes the following:

- Outer garb such as rain gear or rubber or vinyl aprons
- Chemical-resistant steel-toed boots
- Surgical rubber inner gloves
- Chemical-resistant outer gloves
- Safety glasses (or face shield, if significant splash hazard exists)
- Hard hat (if overhead hazard exists)
- Hearing protection, if necessary

6.3 Level C Personal Protective Equipment

If elevated concentrations of vapors are measured with the OVM (see Section 8.2 and Table 2-2), significant contaminant odors are noted, or significant amounts of airborne particulate matter are generated, health and safety requirements may be upgraded to Level C if implementation of engineering controls (i.e., fans) do not decrease the airborne concentrations to acceptable levels. Level C PPE includes the equipment listed under modified Level D plus the following:

- Half-face or full face respirator
- Organic vapor/acid gas cartridges, if appropriate
- Particulate filter cartridge, if appropriate

6.4 Safety Equipment

In addition to PPE that will be worn by shipboard personnel, basic emergency and first aid equipment will also be provided and easily accessible in an unlocked location known to all field personnel prior to the start of any activities. Equipment will include:

- A copy of this HASP
- PFD
- First aid kit adequate for the number of personnel
- Emergency eyewash

Anchor QEA and/or subconsultants will provide this equipment, which must be at the location(s) where field activities are being performed. Equipment will be checked daily to ensure its readiness for use. PFDs will be inspected daily and will be in good condition and of the proper size for the intended wearer. PFDs will be worn and properly buckled and zipped as appropriate, by all personnel on or over water, regardless of work zone. In addition to the safety equipment listed above, an Automated External Defibrillator (AED) will be located in the on-site trailer or other unlocked location or in a locked "break glass" type container, which will be located in the Support Zone. The location of the AED will be discussed as part of the morning safety meetings. All field crew will be trained on the procedures for proper use of the AED and the user manual will be kept with the AED at all times. The AED will be inspected to confirm readiness for use on a daily basis.

7 MEDICAL SURVEILLANCE PROGRAM

As required by EPA's letter dated November 5, 2009, to NW Natural and Siltronic regarding EPA's comments on the *Capture Zone Field Test Plan* prepared by Anchor AEQ (Anchor QEA 2009), all Anchor QEA field personnel that complete the data gaps field investigations will be will be enrolled in a medical surveillance program in compliance with OSHA standards (29 CFR 1910.120(f). These employees will have medical examinations and consultations made available to them by Anchor QEA on the following schedule:

- Prior to assignment
- At least once every 12 months, unless the attending physician believes a longer interval (not greater than biennially) is appropriate
- At termination of employment or reassignment to an area where the employee would not be covered if the employee has not had an examination within the last 6 months
- As soon as possible upon notification that the employee has developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards, or that the employee has been injured or exposed above the PEL or published exposure levels in an emergency situation
- At more frequent times, if the examining physician determines that an increased frequency of examination is medically necessary

The content of medical examinations or consultations made available to employees shall be determined by the attending physician but shall include, at a minimum, a medical and work history with special emphasis on symptoms related to the handling of hazardous substances and health hazards, and to fitness for duty including the ability to wear any required PPE under conditions (i.e., temperature extremes) that may be expected at the work site.

The attending physician shall provide Anchor QEA with a written opinion for each examined employee that contains the following information:

- Whether the employee has any detected medical conditions that would place the employee at an increased risk of impairment of the employee's health from hazardous waste operations work, emergency response, or respirator use
- Any recommended limitations on the employee's assigned work
- A statement that the employee has been informed of the results of the medical examination and any medical conditions that require further examination or treatment

The written opinion obtained by Anchor QEA shall not reveal specific findings or diagnoses unrelated to occupational exposures. Medical surveillance and other employee-related medical records shall be retained for at least the duration of employment plus 30 years.

8 MONITORING PROCEDURES FOR SITE ACTIVITIES

A monitoring program that addresses the potential site hazards will be maintained. The monitoring program includes self-monitoring by the field crew and monitoring with instruments.

8.1 Crew Self Monitoring

All personnel will be instructed to look for and inform each other of any deleterious changes in their physical or mental condition during the performance of all field activities. Examples of such changes are as follows:

- Headaches
- Dizziness
- Nausea
- Blurred vision
- Cramps
- Irritation of eyes, skin, or respiratory system
- Changes in complexion or skin color
- Changes in apparent motor coordination
- Increased frequency of minor mistakes
- Excessive salivation or changes in papillary response
- Changes in speech ability or speech pattern
- Symptoms of heat stress or heat exhaustion (Section 3.3.7)
- Symptoms of hypothermia (Section 3.3.8)

If any of these conditions develop, the affected person(s) will be moved from the immediate work location and evaluated. If further assistance is needed, personnel at the local hospital will be notified, and an ambulance will be summoned if the condition is thought to be serious. If the condition is the result of sample collection or processing activities, procedures and/or PPE will be modified to address the problem.

8.2 Real-time Air Monitoring Equipment

Organic vapor concentrations shall be monitored in the field using an organic vapor monitor such as a PID or FID. During soil boring and sediment sample collection and processing, organic vapor measurements shall be taken in the breathing zone of workers while additional

area monitoring may be conducted at the well head, auger point, etc. to gather background and environmental impact information.

Other real-time air monitoring equipment, such as a hydrogen cyanide meter, may be utilized depending upon the scope of work and compounds of concern. Air monitoring results shall be documented on the air monitoring log form presented in Attachment 2-2.

8.2.1 Equipment Calibration and Maintenance

Calibration and maintenance of air monitoring equipment shall follow manufacturer specifications and must be documented. Re-calibration and adjustment of air monitoring equipment shall be completed daily and as site conditions and equipment operation warrant. Records of air monitoring equipment calibration and adjustment information will be recorded in the field logbook or daily log form.

8.2.2 Air Monitoring Action Levels

Air monitoring action levels have been developed for this project and are listed in Table 2-2. The table stipulates the chemical concentrations in the worker's breathing zone that require an upgrade in level of PPE.

9 DECONTAMINATION

Decontamination is necessary to prevent the migration of contaminants from the work zone(s) into the surrounding environment and to minimize the risk of exposure of personnel to contaminated materials that might adhere to PPE. The following sections discuss personnel and equipment decontamination. The following supplies will be available to perform decontamination activities:

- Wash and rinse buckets
- Tap water and phosphate-free detergent (i.e., Alconox)
- Hexane (or similar type solution) for more robust equipment decontamination
- Scrub brushes
- Distilled/deionized water
- Deck pump with pressurized freshwater hose (aboard the vessel)
- Paper towels and plastic garbage bags

9.1 Minimization of Contamination

The following measures will be observed to prevent or minimize exposure to potentially contaminated materials:

Personnel:

- Do not walk through spilled sediment or soil
- Do not handle, touch, or smell sediment or soil directly
- Make sure PPE has no cuts or tears prior to use
- Protect and cover any skin injuries
- Stay upwind of airborne dusts and vapors
- Do not eat, drink, chew tobacco, or smoke in the work zones

Sampling Equipment and Vessel/Drill Rig:

- Use care to avoid getting sampled media on the outside of sample containers
- If necessary, bag sample containers before filling with sampled media
- Place clean equipment on a plastic sheet to avoid direct contact with contaminated media
- Keep contaminated equipment and tools separate from clean equipment and tools

- Fill sample containers over a plastic tub to contain spillage
- Clean up spilled material immediately to avoid tracking around the vessel or drill rig

9.2 Personal Decontamination

The FC will ensure that all site personnel are familiar with personnel decontamination procedures. Personnel will perform decontamination procedures, as appropriate, when exiting work areas. Following is a description of the procedure:

Decontamination Procedure:

- Wash and rinse outer gloves and boots in portable buckets
- If suit is heavily soiled, rinse it off
- Remove outer gloves, inspect and discard if damaged, leave inner gloves on
- Remove inner gloves and wash hands if taking a break
- Don necessary PPE before returning to work
- Dispose of soiled PPE before leaving for the day

9.3 Handling of Investigation-Derived Waste

All remaining sediment, fluids used for decontamination of sampling equipment, and core collection disposable wastes (e.g., gloves, paper towels, foil, etc.) will be placed into appropriate containers and staged on-site for characterization and eventual disposal.

IDW will be placed into sealable containers and temporarily staged on site. Representative (composite) samples of the IDW will be collected and analyzed for the following:

- Free liquids (by paint filter test)
- VOCs (by EPA Method 8260B)
- Diesel- and Oil-range hydrocarbons (by NWTPH-Dx)
- Gasoline-range hydrocarbons (by NWTPH-Gx)
- Total Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver (by EPA Method 6010/7000)
- Total Cyanide (by EPA Method 335.4)
- PAHs (by EPA Method 8270C SIM)

Analytical results will be screened to characterize the waste as non-hazardous, a special waste (as defined in SOW Section 3.6.3.1), a listed hazardous waste, or a characteristic hazardous waste, and to identify any other special handling or disposal requirements. Should the results indicate that analytes are not present at concentrations above 20-times the associated TCLP criteria, the waste will not be identified as a characteristic hazardous waste or a special waste. Should an analyte be present at concentrations above this level, a representative sample will be collected to and submitted for appropriate TCLP analysis to confirm whether the wastes is a special waste or a RCRA hazardous waste. Once the characterization is complete, the appropriate final waste disposal options will be determined and the waste will be transported by a licensed contractor to the selected disposal location.

The decontamination fluids 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 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 an AST located at the MW-6 dense non-aqueous phase liquid (DNAPL) extraction system.

All disposable wastes will be placed into two heavy duty plastic bags (that is, double-bagged) and stored in sealable containers until the sediment IDW generated from the investigation has been characterized. If the sediment IDW is characterized as non-hazardous, the waste will be removed from the sealable container and transported to a Subtitle D landfill for disposal. If the sediment IDW is characterized as either a listed or characteristic RCRA waste, the sealed container(s) of disposable wastes will be transported to and disposed of at the facility selected for disposal of the sediment IDW.

10 TRAINING REQUIREMENTS

Individuals performing work at locations where potentially hazardous materials and conditions may be encountered must meet specific training requirements. It is not anticipated that personnel will encounter hazardous concentrations of contaminants in sampled material, so training will consist of site-specific instruction for all personnel and oversight of inexperienced personnel for one working day. The following sections describe the training requirements for work at this site.

10.1 Project Specific Training

All Anchor QEA personnel must read this HASP and be familiar with its contents before beginning work. They shall acknowledge reading the HASP by signing the field team HASP review form contained in Attachment 2-1. The form will be kept in the project files.

The FC or a designee will provide and document project-specific training during the project kickoff meeting and whenever new Anchor QEA workers arrive for fieldwork. Anchor QEA personnel will not be allowed to begin work until project-specific training is completed and documented by the FC. Training will address the HASP and all health and safety issues and procedures pertinent to field operations. Training will include, but will not be limited to, the following topics:

- Activities with the potential for chemical exposure
- Activities that pose physical hazards, and actions to control the hazards
- Ship access control and procedures
- Use and limitations of PPE
- Decontamination procedures
- Emergency procedures
- Use and hazards of sampling equipment
- Location of emergency equipment on the vessel
- Vessel safety practices

In addition, since field activities are occurring within the Portland Harbor Superfund Site, all workers in the exclusion zone or CRZ must have 40-hour HAZWOPER training in accordance with OSHA. An updated 8-hour HAZWOPER refresher training is required for all workers in the exclusion zone or CRZ whose 40-hour HAZWOPER training certificate is more than one year old.

10.2 Daily Safety Briefings

The FC or a designee will present tailgate safety briefings before the start of each day's activities. These tailgate safety briefings will outline the activities expected for the day, update work practices and hazards, and address any specific concerns associated with the work location, and review emergency procedures and routes. The tailgate safety briefings will be documented in the logbook. A checklist of daily safety briefing topics will be conducted and supplemented with the following topics:

- Hazard Exposure Routes
- Chemical Hazards
- Physical Hazards
- Biological Hazards (by direct contact with river water)
- Mitigation Procedures
- Vessel Safety
- Safety Communication
- Lines of Authority
- Description of first aid kit and AED locations, including a discussion of usage (initial comprehensive training session and a brief daily overview
- Over water safety and PFD usage

A daily safety briefing log form is presented in Attachment 2-2.

11 RECORDING AND RECORD KEEPING

The FC or a designee will record health- and safety-related details of the project in the field logbook. The logbook must be bound and the pages must be numbered consecutively. Entries will be made with indelible ink. At a minimum, each day's entries must include the following information:

- Project name or location
- Names of all personnel
- Level of PPE worn and any other specifics regarding PPE
- Weather conditions
- Type of fieldwork being performed

The person maintaining the entries will initial and date the bottom of each completed page. Blank space at the bottom of an incompletely filled page will be lined out. Each day's entries will begin on the first blank page after the previous workday's entries.

As necessary, other documentation will be obtained or initiated by the FC. Other documentation may include field change requests, medical and training records, exposure records, accident/incident report forms, OSHA Form 200s, and material safety data sheets. Attachment 2-1 contains copies of key health and safety forms.

12 EMERGENCY RESPONSE PLAN

As a result of the health and safety hazards associated with the field sampling and sample handling activities, the potential exists for an emergency situation to occur. Emergencies may include personal injury, exposure to hazardous substances, fire, explosion, or release of toxic or non-toxic substances (spills). OSHA regulations require that an emergency response plan be available for use onboard to guide actions in emergency situations.

Onshore organizations will be relied upon to provide response in emergency situations. The local fire department and ambulance service can provide timely response. Anchor QEA personnel and subcontractors will be responsible for identifying an emergency situation, providing first aid if applicable, notifying the appropriate personnel or agency, and evacuating any hazardous area. Shipboard personnel will attempt to control only very minor hazards that could present an emergency situation, such as a small fire, and will otherwise rely on outside emergency response resources.

The following sections address key safety personnel, authority and responsibilities of key personnel, pre-emergency preparation, identify individual(s) who should be notified in case of emergency, provide a list of emergency telephone numbers, offer guidance for particular types of emergencies, and provide directions and a map for getting from any sampling location to a hospital.

12.1 Key Safety Personnel

The following people share responsibility for health and safety at the site. See Section 12.2 of this HASP for a description of the role and responsibility of each.

Project Manager: Ryan Barth	Office: (206) 287-9130 Cell: (206) 719-3605
Field Coordinator: Joy Dunay	Office: (206) 287-9130 Cell: (206) 909-0776
Site Safety and Health Officer: Tim Stone	Office: (503) 670-1108 Cell: (503) 475-9150
Field Personnel:	
Doug Laffoon	Cell: (206) 459-2738
Gabe Nagler	Cell: (541) 844-8405
Matt Wilson	Cell: (503) 347-8511
Nathan Soccorsy	Cell: (480) 272-2805
David Gillingham	Cell: (206) 719-8857
Ross Pickering	Cell: (206) 334-0889

12.2 Authority and Responsibilities of Key Personnel

This section describes the authority and responsibilities of key Anchor QEA project personnel. The names and contact information for the following key safety personnel are listed in the Section 12.1 of this HASP. Should key site personnel change during the course of the project, a new list will be established and posted immediately at the site. The emergency phone number for the site is **911**, and should be used first for all medical, fire, and police emergencies.

12.2.1 Project Manager

The PM provides overall direction for the project. The PM is responsible for ensuring that the project meets the client's objectives in a safe and timely manner. The PM is responsible for providing qualified staff for the project and adequate resources and budget for the health and safety staff to carry out their responsibilities during the field work. The PM is in regular contact with the FC and SSHO to ensure that appropriate health and safety procedures are implemented into each project task.

The PM has authority to direct response operations; the PM assumes total control over project activities but may assign responsibility for aspects of the project to others. In addition, the PM:

- Oversees the preparation and organization of background review of the project, the work plan, and the field team.
- Ensures that the team obtains permission for site access and coordinates activities with appropriate officials.
- Briefs the FC and field personnel on specific assignments.
- Together with the FC, sees that health and safety requirements are met.
- Consults with the SSHO regarding unsafe conditions, incidents, or changes in site conditions or the Scope of Work.

12.2.2 Field Coordinator

The FC reports to the PM and has authority to direct response operations and assumes control over on-site activities. The FC will direct field activities, coordinate the technical and health and safety components of the field program, and is responsible in general for enforcing the HASP and Corporate HASP. The FC will be the primary point of contact for all field personnel and visitors and has direct responsibility for implementation and administration of this HASP. The FC and any other member of the field crew have the authority to stop or suspend work in the event of an emergency, if conditions arise that pose an unacceptable health and safety risk to the field crew or environment, or if conditions arise that warrant revision or amendment of this HASP.

The functions of the FC related to this HASP include but are not necessarily limited to the following:

- Conduct and document daily safety meetings, or designate an alternate FC in his or her absence
- Execute the work plan and schedule
- Periodic field health and safety inspections to ensure compliance with this HASP
- Oversee implementation of safety procedures
- Implement worker protection levels
- Enforce site control measures to ensure that only authorized personnel are allowed on site
- Notify, when necessary, local public emergency officials (all personnel on site may conduct this task as needed)

- Follow-up on incident reports to the PM
- Periodically inspect protective clothing and equipment for adequacy and safety compliance
- See that protective clothing and equipment are properly stored and maintained
- Perform or oversee air monitoring in accordance with this HASP
- Maintain and oversee operation of monitoring equipment and interpretation of data from the monitoring equipment
- Monitor workers for signs of stress, including heat stress, cold exposure, and fatigue.
- Require participants to use the "buddy" system
- Provide (via implementation of this HASP) emergency procedures, evacuation routes, and telephone numbers of the local hospital, poison control center, fire department, and police department
- Communicate incidents promptly to the PM
- Maintain communication with the SSHO on site activities
- If applicable, ensure decontamination and disposal procedures are followed
- Maintain the availability of required safety equipment
- Advise appropriate health services and medical personnel of potential exposures.
- Notify emergency response personnel in the event of an emergency. Coordinate emergency medical care

The FC will record health-and-safety-related details of the project in the field logbook. At a minimum, each day's entries must include the following information:

- Project name or location
- Names of all on-site personnel
- Level of PPE worn and any other specifics regarding PPE
- Weather conditions
- Type of field work being performed

The FC will have completed the required OSHA 40-hour HAZWOPER training and annual updates, the 8-hour Supervisor training, current first aid and cardiopulmonary resuscitation (CPR) training, and medical monitoring clearance, if applicable. Other certifications or training may be stipulated based on client or site requirements.

12.2.3 Site Safety and Health Officer

Anchor QEA's SSHO will be responsible for managing on-site health and safety activities and will provide support to the PM and FC on health and safety issues. The specific duties of the SSHO are to:

- Provide technical input into the design and implementation of this HASP.
- Advise on the potential for occupational exposure to project hazards, along with appropriate methods and/or controls to eliminate site hazards.
- Ensure that a hazard assessment has been performed and that the adequacy of the PPE selected was evaluated as required by 29 CFR 1910.132(d), 1910.134, 1926.25, and 1926.55, and is duly noted by the signatures and date appearing on the Certification Page of this document.
- Consult with the FC on matters relating to suspending site activities in the event of an emergency.
- Verify that all on-site Anchor QEA personnel and subcontractors have read and signed the HASP Acknowledgement Form.
- Review daily the on-site health and safety activities for effectiveness and modify as needed.
- Verify that corrective actions resulting from deficiencies identified by daily health and safety reviews and observations are implemented and effective.

The SSHO will have completed the required OSHA 40-hour HAZWOPER training and annual updates, the 8-hour Supervisor training, and have medical monitoring clearance, if applicable. In addition, the SSHO will have current training in first aid and CPR.

12.2.4 Field Personnel

All project field personnel will attend a project-specific meeting conducted by the FC concerning safety issues and project work task review before beginning work. All field crew must be familiar with and comply with this HASP. Subcontractors will be responsible for developing and complying with their own company HASP. The field crew has the responsibility to immediately report any potentially unsafe or hazardous conditions to the FC, and all members of the field crew have the authority to stop or suspend work if conditions arise that pose an unacceptable health and safety risk to the field crew or environment or if conditions arise that warrant revision or amendment of this HASP.

The field team reports to the FC for on-site activities and is responsible for

- Reviewing and maintaining a working knowledge of this HASP
- Safe completion of on-site tasks required to fulfill the work plan
- Compliance with the HASP
- Attendance and participation in daily safety meetings
- Notification to the FC of existing or potential safety conditions at the site
- Reporting all incidents to the FC
- Demonstrating safety and health conscious conduct

12.3 Pre-Emergency Preparation

Before the start of field activities, the FC will ensure that preparation has been made in anticipation of emergencies. Preparatory actions include the following:

- All field personnel meeting with the FC (if working on land) or the captain (if on vessel) and equipment handlers concerning the emergency procedures in the event that a person is injured. Appropriate actions for specific scenarios will be reviewed. These scenarios will be discussed and responses determined before the sampling event commences.
- A training session given by the FC and captain informing all field personnel of emergency procedures, locations of emergency equipment and their use, and proper evacuation procedures.
- A training session given by senior staff operating field equipment, to apprise field personnel of operating procedures and specific risks associated with that equipment.
- Ensuring that field personnel are aware of the existence of the emergency response plan, its location, and ensuring that a copy of the HASP accompanies the field team(s).

12.4 Project Emergency Coordinator

The FC will serve as the Project Emergency Coordinator (PEC) in the event of an emergency. The FC will designate a replacement for times when he is not onboard or is not serving as the PEC. The designation will be noted in the logbook. The PEC will be notified immediately when an emergency is recognized. The PEC will be responsible for evaluating the emergency situation, notifying the appropriate emergency response units, coordinating access with those units, and directing interim actions onboard before the arrival of emergency response units.

The PEC will notify the SSHO and the PM as soon as possible after initiating an emergency response action. The PM will have responsibility for notifying the client.

12.5 Emergency Response Contacts

All personnel must know whom to notify in the event of an emergency situation, even though the FC has primary responsibility for notification. Table 2-3 lists the names and phone numbers for emergency response services and individuals.

12.6 Emergency Response and Alerting Procedures

Each field team will carry a cell phone and an air horn that are in good working order. Cell phone coverage is good at the site. Site communications will be done with either a cell phone or the air horn. If there is any type of emergency that requires the Site to be evacuated (e.g., severe thunderstorm), the FC or any other site personnel recognizing the condition will blow the air horn three times. When the horn sounds, all personnel will meet at the emergency meeting location (the site entrance near the guard shack when on the upland portion of the site, Figure 2-1, and either the site entrance near the guard shack or the Cathedral Park boat ramp if working in the river, depending on the circumstances). All other emergency notifications that do not require evacuation (e.g., a person falling overboard) will be conducted using a cell phone. Emergency phone numbers are listed in Table 2-3.

In the event of an emergency, immediate action must be taken by the first person to recognize the event. The following steps will be used as a guideline:

- Survey the situation to ensure that it is safe for you and the victim. Do not endanger your own life. Do not enter an area to rescue someone who has been overcome unless properly equipped and trained. Ensure that all protocols are followed. If applicable, review Material Safety Data Sheets (MSDS) to evaluate response actions for chemical exposures.
- Call the appropriate emergency number (**911**) or direct someone else to do this immediately (see Section 12.1). Explain the physical injury, chemical exposure, fire, or release and location of the incident.
- Have someone retrieve the nearest first aid kit and AED, if available.
  - **Note:** Only use an AED if you have been properly trained.
- Decontaminate the victim without delaying life-saving procedures (see Section 12.8).

- Administer first aid and CPR, if properly trained, until emergency responders arrive.
- Notify the PM and the FC.
- Complete the appropriate incident investigation reports.

12.7 Recognition and Prevention of Emergency Situations

Everyone on site is responsible to monitor the environment for conditions that could lead to a release or an injury. Emergency situations will generally be recognizable by observation. The site team must take steps needed to respond to such observations. An injury or illness will be considered an emergency if it requires treatment by a medical professional and cannot be treated with simple first-aid techniques.

12.8 Decontamination

In the case of evacuation, decontamination procedures will be performed only if doing so does not further jeopardize the welfare of site workers. If an injured individual is also heavily contaminated and must be transported by emergency vehicle, the emergency response team will be told of the type of contamination. To the extent possible, contaminated PPE will be removed, but only if doing so does not exacerbate the injury. Plastic sheeting will be used to reduce the potential for spreading contamination to the inside of the emergency vehicle.

12.9 Fire

Personnel will attempt to control only small fires, should they occur. If an explosion appears likely, personnel will follow evacuation procedures specified by the captain or FC in the training session. If a fire cannot be controlled with a fire extinguisher that is part of the required safety equipment, personnel will either withdraw from the vicinity of the fire or use additional firefighting equipment, or evacuate the boat or upland area as specified by the captain or FC in the training session.

12.10 Personal Injury

In the event of serious personal injury, including unconsciousness, possibility of broken bones, severe bleeding or blood loss, burns, shock, or trauma, the first responder will immediately do the following:

- Administer first aid, if qualified

- If not qualified, seek out an individual who is qualified to administer first aid, if time and conditions permit
- Notify the PEC of the incident, the name of the individual, the location, and the nature of the injury

The PEC will immediately do the following:

- Notify the captain and the appropriate emergency response organization
- Assist the injured individual
- Follow the emergency procedures for retrieving or disposing equipment reviewed in the training session, and leave the site en route to the predetermined land-based emergency pick-up
- Designate someone to accompany the injured individual to the hospital
- If an emergency situation (i.e., broken bones or injury where death is imminent without immediate treatment) occurs, the FC or captain will call 911 and arrange to meet the response unit at the nearest accessible dock
- Notify the SSHO and the PM

If the PEC determines that emergency response is not necessary, he may direct someone to decontaminate and transport the individual by vehicle to the nearest hospital. Directions and a map showing the route to the hospital are in Section 12.13 and Figures 2-2 and 2-3.

If a worker leaves the ship or the upland work site to seek medical attention, another worker should accompany him or her to the hospital. When in doubt about the severity of an injury or exposure, always seek medical attention as a conservative approach and notify the PEC.

The PEC will have responsibility for completing all accident/incident field reports, OSHA form 200s, and other required follow-up forms.

12.11 Overt Personal Exposure or Injury

If an overt exposure to toxic materials occurs, the first responder to the victim will initiate actions to address the situation. The following actions should be taken, depending on the type of exposure:

Skin Contact:

- Wash/rinse the affected area thoroughly with copious amounts of soap and water
- If eye contact has occurred, eyes should be rinsed for at least 15 minutes using the eyewash that is part of the emergency equipment onboard and in the lab
- After initial response actions have been taken, seek appropriate medical attention

Inhalation:

- Move victim to fresh air
- Seek appropriate medical attention

Ingestion:

- Seek appropriate medical attention

Puncture Wound or Laceration:

- Seek appropriate medical attention

12.12 Spills and Spill Containment

As necessary, spill control measures will be used to contain contaminated materials that may enter into clean areas. Plastic sheeting, sorbent pads, sorbent booms, or a spill control system will be used to prevent spills and contain contaminated material.

If a spill occurs, the SSHO will immediately discuss the event with USEPA or its oversight contractor to evaluate the need for reporting. Any spill will be reported consistent with state and federal law. In the case of a reportable spill, the National Response Center (800 -424-8802) and Oregon Emergency Response System (800-452-0311) will be notified by the SSHO (Tim Stone or designee) or the PM (Ryan Barth).

12.13 Emergency Route to the Hospital

The name, address, and telephone number of the hospital that will be used to provide medical care is as follows:

Legacy Good Samaritan Hospital and Medical Center
1015 NW 22ndAvenue
Portland, Oregon 97210
(503) 413-7711

Figure 2-2 is a map of the route from the uplands project site (7900 NW St. Helens Road, Portland, Oregon, 97210) to the Legacy Good Samaritan Hospital and Medical Center. Directions are as follows (travel time is approximately 11 minutes):

1. Start out going Southeast on NW ST HELENS RD. Continue to follow NW ST HELENS RD/US-30.
2. Continue onto US -30 NW YEON AVE.
3. Turn RIGHT onto NW NICOLAI ST.
4. Turn LEFT onto NW 24th ST.
5. Turn LEFT onto NW LOVEJOY ST.
6. End at 1015 NW 22nd Ave. Portland, Oregon

Figure 3-3 is a map of the route from the boat launch area at Cathedal Park, St. Johns, Oregon to the Legacy Good Samaritan Hospital and Medical Center. Directions are as follows (travel time is approximately 15 minutes):

1. Depart the Cathedral Park parking lot and proceed up the hill on N. BALTIMORE AVE.
2. Turn RIGHT at the light onto N. IVANHOE ST.
3. Turn RIGHT onto N. PHILADELPHIA ST. and cross over the St. Johns Bridge.
4. Turn LEFT onto NW BRIDGE AVE.
5. Merge onto NW ST. HELENS RD, U.S HWY-30
6. Continue on US -30, NW YEON AVE.
7. Turn RIGHT onto NW NICOLAI ST.
8. Turn LEFT onto NW 24th ST.
9. Turn LEFT onto NW LOVEJOY ST.
10. End at 1015 NW 22nd Ave. Portland, Oregon

13 HEALTH AND SAFETY PLAN APPROVAL RECORD

By their signature, the undersigned certify that this HASP is approved and that it will be used to govern health and safety aspects of fieldwork conducted by Anchor QEA personnel to investigate areas associated within the Removal Action Area.

Anchor QEA Project Manager Date

Anchor QEA Site Supervisor Date

Anchor QEA Site and Safety Health Officer Date

14 REFERENCES

Anchor QEA, LLC (Anchor QEA). 2009. Capture Zone Test Plan: Gasco Sediments Cleanup Action. Prepared for NW Natural, under Docket No. CERCLA 10-2009-0255. Portland, Oregon. November 2009.

Anchor Environmental, LLC (Anchor). 2004. "NW Natural 'Gasco' Site – Removal Action Work Plan." Prepared for the US Environmental Protection Agency, May 2004.

U.S. Environmental Protection Agency (EPA). 2001. Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. EPA/823/B-01-022, October 2001.

EPA. 2004. Administrative Order on Consent for Removal Action between NW Natural and the U.S. Environmental Protection Agency. April 28, 2004.

TABLES

Table 2-1
Activity Hazard Analysis

Activity	Hazard	Control
Drilling activities including soil sample collection on land, subsurface core collection and processing and van Veen grab activities on a vessel	Falling overboard	Avoid working near the edge of the vessel, if possible. Stay away from edge of barge deck. Wear PFD during sample collection.
	Cuts, amputations	Use locking pins to secure the grab sampler prior to deployment, and keep fingers clear of the open jaws at all times. When coring, never hold the core barrel with the fingers inside the core. Use care when using circular saw during core processing.
	Back or muscle strain	Use appropriate lifting technique when handling heavy equipment and lifting heavy sample containers. Enlist help if necessary.
	Ear Protection	Wear ear plugs or ear muffs when operating loud machinery or cutting cores open with a power saw.
	Skin or eye contact with potentially contaminated sediments or liquids	Wear modified Level D PPE, including eye protection.
	Slipping/tripping on slick or uneven deck and on uneven surfaces on the riverbank	Wear steel-toed boots with gripping tread. Be aware of obstacles and wet patches on deck and select a path to avoid them. Keep ropes and lines coiled and stowed to eliminate trip hazards. Maintain 3 point contact on vessel while underway.
	Injury from equipment falling or swinging	Wear a hard hat and steel-toed boots at all times; be in the appropriate position on deck when equipment is in operation.
	Electric Shock	Use ground fault-indicator extension cord, and seal plug connections with electrical tape.
	Fire	Avoid fueling operations near hot engines. Mop up any spilled flammable liquids and dispose of absorbent. No smoking or flame sources on the vessel. Evacuate the vessel according to procedures outlined in the training session given by the captain.
	Rotating or percussive drilling equipment	Stay clear of area around borehole while drilling activities are underway. Do not wear loose fitting clothing or exposed long hair.

Activity	Hazard	Control
	Injury from winch line snapping	Ensure that winch line is not frayed
Handling, packaging, and shipping samples	Skin or eye contact with potentially contaminated liquids	Wear modified Level D PPE, including eye protection
	Back or muscle strain	Use appropriate lifting technique when handling heavy equipment and lifting heavy sample containers. Enlist help if necessary.
	Inhalation of or eye contact with airborne mists or vapors	Wear safety glasses. Perform decontamination activities outdoors or in a well-ventilated area. Stay upwind when spray-rinsing equipment.
Decontaminating equipment	Inhalation of, or eye contact with, airborne mists or vapors	Wear safety glasses. Perform decontamination activities outdoors or in a well-ventilated area. Stay upwind when spray-rinsing equipment.
	Skin contact with potentially contaminated materials	Wear modified Level D PPE.
	Ingestion of contaminated materials	Decontaminate clothing and skin prior to eating, drinking, smoking, or other hand-to-mouth activities. Follow the decontamination procedure for personal decontamination.

Table 2-2
Air Monitoring Action Levels

Instrument*	Job Tasks / Functions	Measurement	Monitoring Schedule[3]	Actions[1]
FID and/or PID (10.6*eV lamp) - Measures Total Organic Vapors	Conduct continuous air monitoring for volatile organic compounds during activities where contaminated media are present. Make sure that a background reading is taken before the start up of activities and periodically thereafter.	0 to 1 ppm above background in breathing zone	Continuous (logging periodically every 15-30 minutes)	Continue work
		Greater than 1 to 10 ppm above background	Continuous (logging periodically every 15 minutes)	Stop work if sustained readings for longer than 2 minutes.[2] Institute engineering controls. If concentrations decrease to below 1 ppm above background, continue work. If concentrations above 1 ppm persist, upgrade to Level C protection. Monitor for benzene and vinyl chloride using colorimetric detector tubes. Continue working with respiratory protection if colorimetric detector tubes indicate less than 1 ppm for benzene and/or vinyl chloride. Leave the work area if colorimetric tubes indicate > 1 ppm in the employee's breathing zone; contact PM for further guidance.
		Greater than 10 ppm above background in breathing zone	Continuous (logging periodically every 15-30 minutes)	Stop work required.[2] Leave work area, contact PM for guidance
Hydrogen Cyanide Monitor	Conduct air monitoring for HCN during activities where contaminated media are present. Monitor in the workers' breathing zone.	Detectable up to 4 ppm hydrogen cyanide	Continuous (logging periodically every 15 minutes)	Continue work
		Greater than 4 ppm hydrogen cyanide		Stop work required.[2] Leave work area, contact PM for guidance

Notes:

*	Instruments must be calibrated according to manufacturer's recommendations.
ppm	parts per million
1	For VOCs, sustained reading for greater than 2 minutes in excess of the action level will trigger a protective measure.
2	Contact with the PM must be made prior to continuance of work. A hazard review must be conducted before proceeding with work.
3	Monitoring frequency is at beginning of each task and continuously thereafter (logging periodically every 15 minutes), or when detectable soil contamination is encountered (as indicated by strong, sustained odor, visual evidence of product or petroleum discolored soils).
4	Contact the PM for respiratory protection fit testing and air purifying cartridge change-out requirements.

Table 2-3
Emergency Response Contacts*

Emergency Phone Numbers		
Ambulance	**911**	
Fire	**911**	
Police	**911**	
Poison Control	(800) 222-1212	
Legacy Good Samaritan Hospital and Medical Center	(503) 413-7711	
Project Manager	Ryan Barth	Office: (206) 287-9130 Cell: (503) 719-3605
Field Coordinator	Joy Dunay	Office: (206) 287-9130 Cell: (206) 909-0776
Site Safety and Health Officer	Tim Stone	Office: (503) 670-1108 Cell: (503) 475-9150
U.S. Coast Guard Willamette River Station General information	 (503) 240-9311 (503) 247-4018	
National Response Center	(800) 424-8802	
Oregon Emergency Response System	(800) 452-0311	
USEPA Region 10, Sean Sheldrake	(206) 553-1220	

Notes:
* In the event of any emergency, the PM, FC, SSHO, or any field personnel may contact emergency responders listed in this table.

FIGURES

LEGEND:

- Property Boundary
- Evacuation Route
- Emergency Assembly Area
- Upland Processing Area

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Scale in Feet

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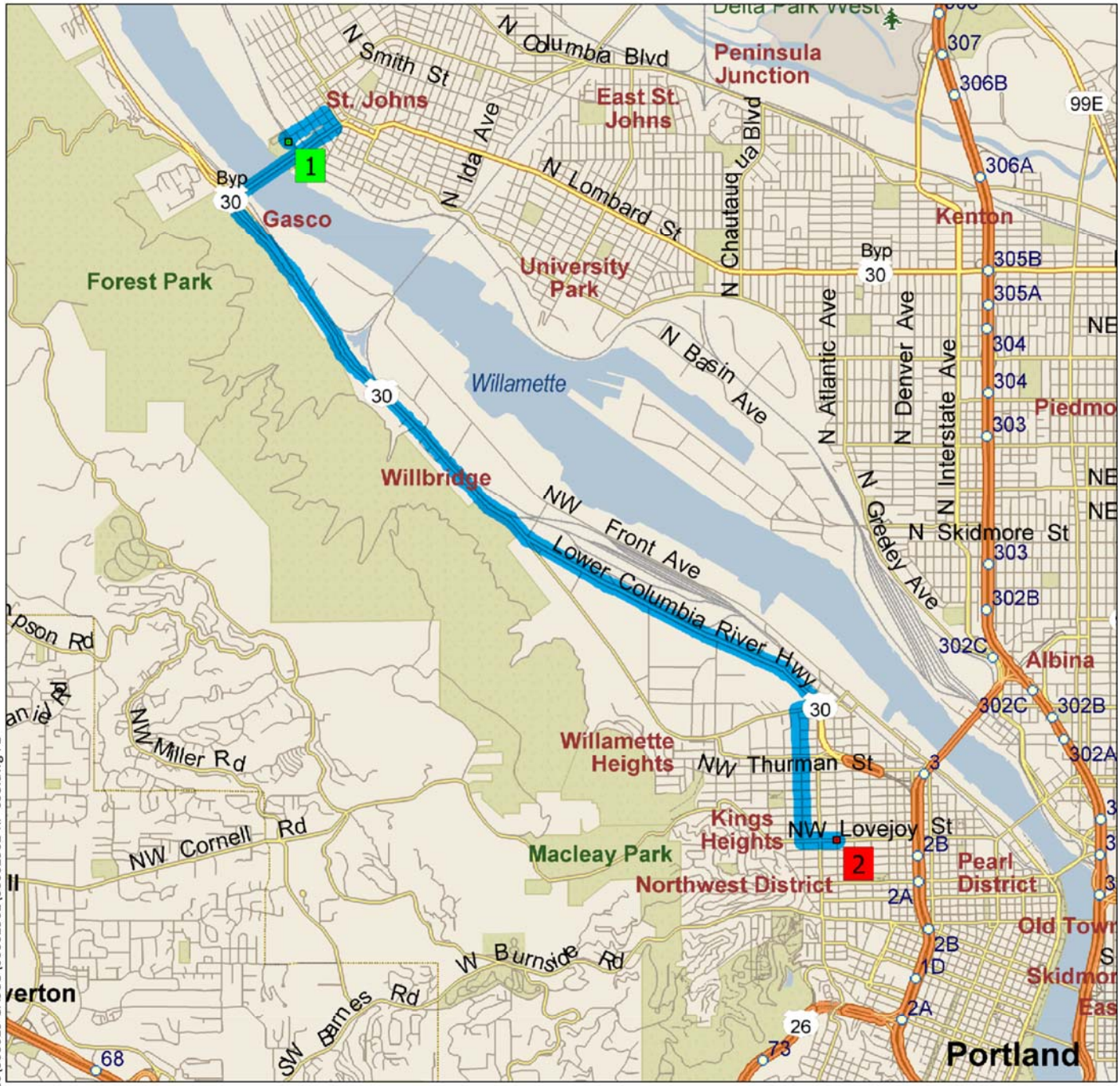
ANCHOR QEA

Figure 2-1
Emergency Evacuation Route Map and Emergency Assembly Area
Anchor QEA Health and Safety Plan
Gasco Sediments Cleanup Action



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1 **ON-WATER SITE ADDRESS**
Cathedral Park

2 **HOSPITAL ADDRESS**
Legacy Good Samaritan Hospital
and Medical Center
1015 NW 22nd Ave.
Portland, OR 97210

SOURCE: Map from Microsoft Streets & Trips, 2010.

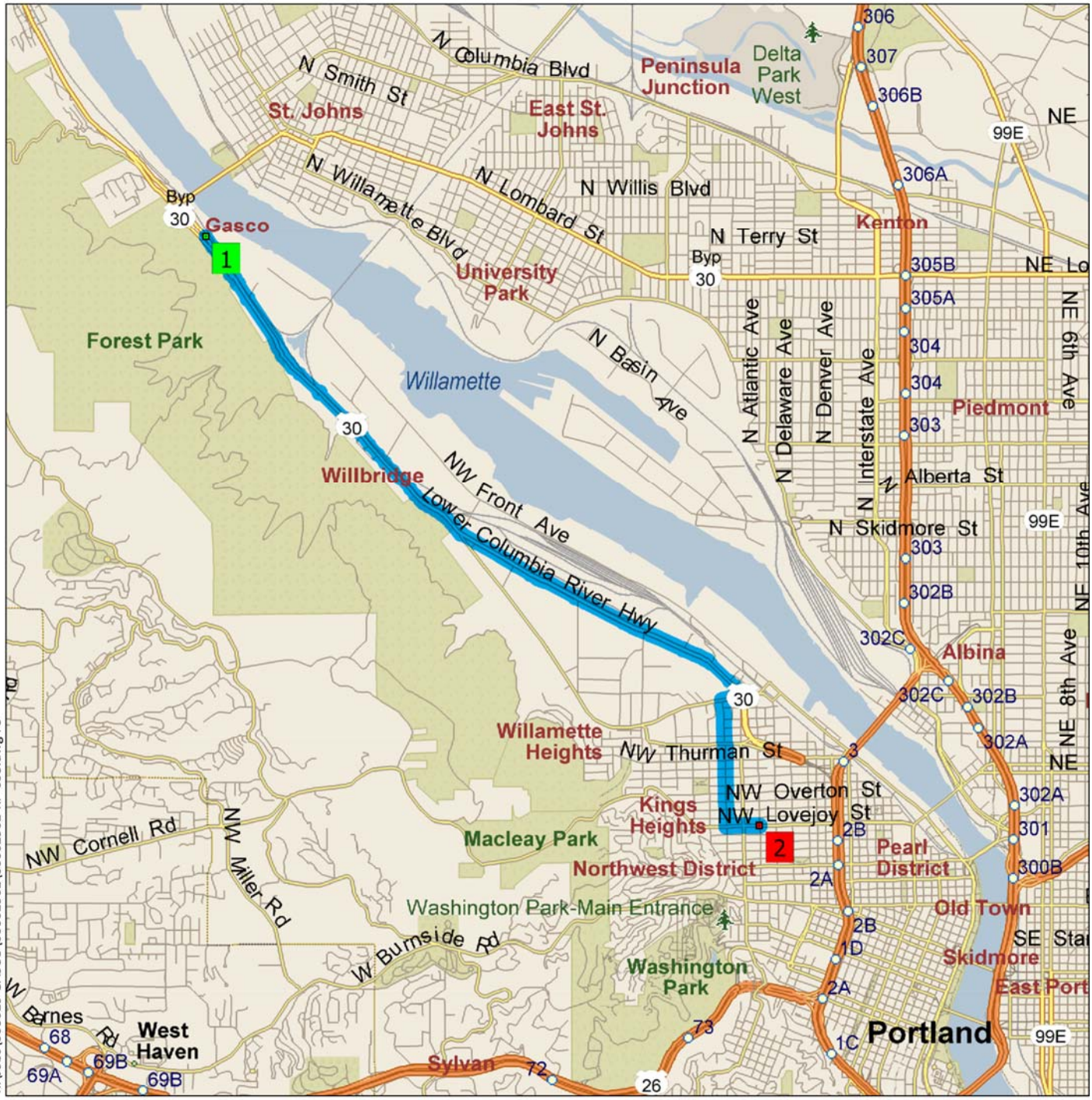
DIRECTIONS

- Depart near Untied Junction
- Turn right (East) onto North Baltimore Ave. (go 0.3 mile)
- Turn right (Southeast) onto North Syracuse Street (go 174 yards)
- Turn right (Southwest) onto US-30 (St. Johns Bridge) (go 1.3 miles)
- Bear right (South) onto US-30 (Lower Columbia River Highway) (go 4.0 miles)
- Turn right toward NW Nicolai Street (go 131 feet)
- Turn right at NW Nicolai Street (go 0.1 mile)
- Turn left at NW 24th Ave. (go 0.8 mile)
- Turn left at NE Lovejoy Street (go 0.2 mile)
- Turn left at the 2nd cross street onto NW 22nd Ave. (go 144 feet)
- Legacy Good Samaritan Hospital will be on the left

0 4600
Scale in Feet

Figure 2-2
Map to the Nearest Hospital, Upland Works Area
Anchor QEA Health and Safety Plan
Gasco Sediments Cleanup Action

ANCHOR QEA



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1 UPLAND SITE ADDRESS
7900 NW St. Helens Road
Portland, OR 97210

2 HOSPITAL ADDRESS
Legacy Good Samaritan Hospital
and Medical Center
1015 NW 22nd Ave.
Portland, OR 97210

DIRECTIONS

- Depart 7900 NW St. Helens Road towards NW Bridge Ave. (go 2.2 miles)
- Continue on US-30 E/NW Yeon Ave. (go 1.9 miles)
- Turn right toward NW Nicolai Street (go 131 feet)
- Turn right at NW Nicolai Street (go 0.1 mile)
- Turn left at NW 24th Ave. (go 0.8 mile)
- Turn left at NE Lovejoy Street (go 0.2 mile)
- Turn left at the 2nd cross street onto NW 22nd Ave. (go 144 feet)
- Legacy Good Samaritan Hospital will be on the left

0 4600
Scale in Feet

SOURCE: Map from Microsoft Streets & Trips, 2010.

Figure 2-3
Map to the Nearest Hospital, On-water Work Area
Anchor QEA Health and Safety Plan
Gasco Sediments Cleanup Action

ANCHOR QEA

ATTACHMENT 2-1
SAFETY RECORD FORMS

FIELD TEAM HEALTH AND SAFETY PLAN REVIEW

ANCHOR QEA, LLC

NW NATURAL GASCO SITE

I have read a copy of the HASP, which covers field activities that will be conducted to investigate specified areas on and adjacent to the NW Natural Gasco Site, Portland, Oregon. I understand the health and safety requirements of the project, which are detailed in this HASP.

Signature Date

Signature Date

Signature Date

Signature Date

Signature Date

ATTACHMENT 2-2
HEALTH AND SAFETY LOGS AND FORMS

DAILY AIR MONITORING RECORD

PROJECT NAME: _____ **DATE:** _____

PROJECT NUMBER: _____ **LOCATION:** _____

TEMPERATURE: _____

CONDITIONS: _____

_____

_____

_____

COC	Instrument	S/N	Calibration Date	Calibration Gas/Method	Calibration by
Organic vapors					
Particulates					
O_2					
Other:					
Other:					
Other:	Draeger				

Time	Location/Description	Organic Vapor (ppm)	O_2%	CG %LEL	Other	Other

Notes:

Completed by:

_____ _____ _____

Printed Name Signature Date

ANCHOR QEA

DATE: _____

PROJECT NAME: _____

PROJECT NO: _____

DAILY SAFETY BRIEFING

PERSON CONDUCTING MEETING: _____ **HEALTH & SAFETY OFFICER:** _____ **PROJECT MANAGER:** _____

TOPICS COVERED:

- ☐ Emergency Procedures and Evacuation Route
- ☐ Directions to Hospital
- ☐ HASP Review and Location
- ☐ Safety Equipment Location
- ☐ Proper Safety Equipment Use
- ☐ Employee Right-to-Know/MSDS Location
- ☐ Fire Extinguisher Location
- ☐ Eye Wash Station Location
- ☐ Buddy System
- ☐ Self and Coworker Monitoring
- ☐ Lines of Authority
- ☐ Communication
- ☐ Site Security
- ☐ Vessel Safety Protocols
- ☐ Work Zones
- ☐ Vehicle Safety and Driving/Road Conditions
- ☐ Equipment Safety and Operation
- ☐ Proper Use of PPE
- ☐ Decontamination Procedures
- ☐ Other:
- ☐ Lifting Techniques
- ☐ Slips, Trips, and Falls
- ☐ Hazard Exposure Routes
- ☐ Heat and Cold Stress
- ☐ Overhead and Underfoot Hazards
- ☐ Chemical Hazards
- ☐ Flammable Hazards
- ☐ Biological Hazards
- ☐ Eating/Drinking/Smoking

WEATHER CONDITIONS: _____

DAILY WORK SCOPE: _____

SITE-SPECIFIC HAZARDS: _____

SAFETY COMMENTS: _____

ATTENDEES

PRINTED NAME	SIGNATURE

ATTACHMENT 3
MFA HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

OVER WATER WORK

SILTRONIC CORPORATION
7200 NW FRONT AVE
PORTLAND, OREGON

Prepared for

SILTRONIC CORPORATION

July 2010

Project No 8128.01.21

MAUL
FOSTER
ALONGI

Prepared by
Maul Foster & Alongi, Inc.
2001 NW 19th Avenue, Suite 200
Portland, OR 97209

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HEALTH AND SAFETY PLAN

OVER WATER WORK
SILTRONIC CORPORATION
7200 NW FRONT AVE
PORTLAND, OREGON

The material and data in this health and safety plan were prepared under the supervision and direction of the undersigned.

MAUL FOSTER & ALONGI, INC.

_____

James Peale, RG
Project Manager

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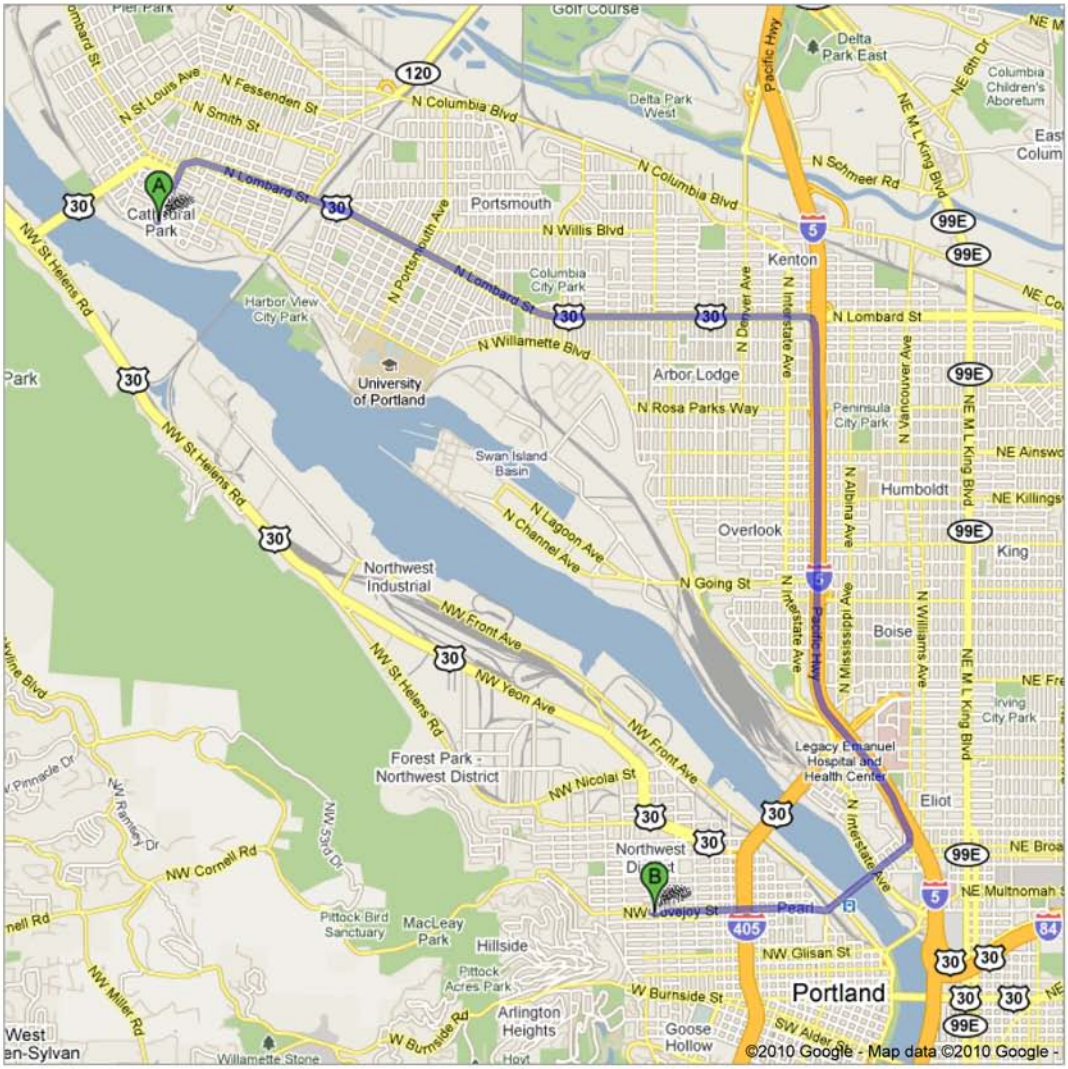
ATTACHMENT 3-1
MARINE AND BOAT SAFETY STANDARD OPERATING PROCEDURE

ATTACHMENT 3-2
MFA INCIDENT REPORT

ATTACHMENT 3-3
VEHICLE SAFETY STANDARD OPERATING PROCEDURE

Directions to Legacy Good Samaritan Hospital & Medical Center
1015 Northwest 22nd Avenue, Portland, OR 97210
- (503) 413-7711
8.6 mi – about **12 mins**
Driving directions from Cathedral Park (dock)



1 EMERGENCY RESPONSE

1.1 Emergency Meeting Locations

In the event of an emergency, all on-site personnel will meet at the Cathedral Park boat ramp (see map on first page of document for the location of Cathedral Park).

1.2 Nearest Hospital

Legacy Good Samaritan Hospital

1015 Northwest 22nd Avenue, Portland, Oregon

Phone: 503-229-7711

Distance: 5.1 miles

Travel Time: 12 minutes

1.3 Emergency Route to Hospital

See map on first page of document.

1.3.1 Driving Directions from dock barge at Cathedral Park (located at the north end of the St. Johns bridge).

1. Proceed from boat ramp to north end of Cathedral Park to intersection on N Edison Street and N Pittsburg Avenue
2. Turn left onto N Burlington Avenue
3. Turn left onto N Syracuse Street
4. Turn left onto US-30 Bypass (St. Johns Bridge)
5. Keep straight onto US-30 (Lower Columbia River Highway)
6. Bear right onto US-30
7. Bear right onto NW Wardway Street.

8. Turn right onto NW 23rd Street.
9. Turn left onto NW Northrup Street
10. Turn right onto NW 22nd Avenue

1.4 Emergency Phone Numbers

Ambulance, Police, Fire	**Dial 911**
James Peale Project Manager	Phone: (503) 501-5218 Cell: (503) 449-9576
Jim Maul Project Director	Phone: (360) 694-2691 Cell: (360) 903-8633
Scout Mauldin Health and Safety Coordinator	Phone: (503) 501-5223 Cell: (503) 209-0537
Justin Pounds Field Personnel	Phone: (503) 501-5221 Cell: (360) 772-2980
Kelly Titkemeier Field Personnel	Phone: (503) 501-5215 Cell: (971) 645-9731
Mike Murray Field Personnel	Phone: (503) 501-5226 Cell: (503) 310-0435
Siltronic ERT	Phone: (503) 219-4300 From a Plant phone: 611
Poison Control Center	(800) 222-1222
U.S. Coast Guard **Marine Emergencies** **Routine Inquiries**	 (503) 240-9301 (503) 240-9365
Multnomah County Sheriff **Willamette River Patrol**	(503) 243-7952
USEPA Region 10	(206) 553-1200
National Response Center (NRC)	(800) 424-8802
Oregon Emergency Response System (OERS)	(800) 452-0311

In the event of an emergency, the Project Director, Project Manager, Health and Safety Coordinator, and all Field Personnel have the authority to contact the contact emergency personnel at the numbers listed in this table.

1.5 Alerting Authorities

In the event of a reportable spill or release, a member of the site work team (see Section 3.1) will notify the Oregon Emergency Response System (800-452-0311) and the National Response Center (800-424-8802) immediately after the safety of the site personnel has been addressed.

2 PROJECT INFORMATION

Date: February 17, 2010

Project: Siltronic Corporation

Site: Siltronic Corporation and Willamette River (the Site)

Location: 7200 Northwest Front Avenue, Portland, Oregon

Project Manager: James Peale

Prepared By: Justin Pounds

3 KEY PROJECT PERSONNEL

3.1 Site Work Team

Name	Responsibility
Jim Maul	Project Director
James Peale	Project Manager
Scout Mauldin	Field Personnel
Justin Pounds	Field Personnel
Kelly Titkemeier	Field Personnel
Mike Murray	Field Personnel
Scout Mauldin	Health and Safety Coordinator

3.2 Roles and Responsibilities of Site Work Team

The Project Manager (PM) is responsible for the overall direction of the project and reports to the Project Director. The PM maintains regular contact with the Health and Safety Coordinator (HSC) and Field Personnel, and is responsible for coordinating with Siltronic, regulatory agencies, subcontractors, and others as necessary.

The Health and Safety Coordinator serves as a point of contact for the PM and field staff regarding health and safety concerns. The HSC ensures proper training of field staff, directs the selection and proper use of PPE, and performs periodic health and safety inspections in the field.

The Field Personnel are responsible for performing field operations. Field Personnel report to the PM, and coordinate with the HSC regarding health and safety matters. Field Personnel are responsible for complying with this HASP.

3.3 Entry Briefing Date

First day of on-site work or as the scope of work changes.

3.4 Special Conditions (e.g., work schedule or limitations)

Any work performed at night must be performed with lights mounted on stands (or equivalent) and using the "buddy system."

Maul Foster & Alongi, Inc. (MFA) personnel are not allowed to perform site activities alone after dark.

3.5 Required Training

MFA employees as well as contractor employees assigned to perform field activities covered by this procedure must be currently approved for hazardous-waste fieldwork, including:

- Enrolled in a Medical surveillance program in compliance with Occupational Safety and Health Administration (OSHA) standards (29 Code of Federal Regulations [CFR] 1910.120(f)). MFA employees shall have medical examinations and consultations made available to them by MFA including:
  - A medical examination every 12 months unless the attending physician believes a longer interval (not greater than biennially) is appropriate.
  - A medical examination at more frequent times, if the examining physician determines that increased frequency of examinations are necessary.
  - A medical examination as soon as possible if there are symptoms or signs indicating a possible exposure to hazardous substances.
- Current medical clearance to conduct hazardous-waste fieldwork and to wear a respirator by a physician.
- Successful completion of a respirator fit test within the last 12 months for the make and model of the respirator assigned to that individual.
- Completion of training as required by Title 29 CFR 1910.120(e), including:
  - Forty hours of hazardous-waste worker basic instruction within the last 12 months, or
  - Eight hours of hazardous-waste worker refresher training within the last 12 months, subsequent to completion of 40 hours of basic hazardous-waste worker training.

Copies of all required training certificates, current medical surveillance certificates, and respirator fit test records must be compiled before Site entry. This information must also be provided to MFA by all subcontractors for their on-site personnel.

3.6 Special Training

The HSC is required to successfully complete the HAZWOPER supervisor training course. Additionally, at least one person who has received the HAZWOPER supervisor training will be on-site at all times.

4 PROJECT DESCRIPTION

MFA has prepared this Health and Safety Plan (HASP) for over water work and work along the banks of the river. The physical address of the Siltronic property is 7200 Northwest Front Avenue, Portland, Oregon. The property is located in section 13, township 1 north, range 1 west of the Willamette Meridian. The over water work will occur adjacent to the property in the Willamette River and along the banks of the river. For the purposes of this HASP, "Site" refers to over water work in the Willamette River and work along the banks of the river.

This HASP has been prepared to instruct MFA personnel for over water work. Any contractors or subcontractors involved in the scope of work for this HASP are responsible for developing their own HSPs to ensure that proper health and safety procedures are followed by their personnel.

Activities performed by MFA may include sediment sampling, oversight of drilling activities, management of investigation-derived waste, and in-river sampling on the Site.

The purpose of this plan is to provide information to minimize the potential for adverse exposures or injuries while performing work on the Site. A combination of personal protective equipment (PPE), engineering controls, and safe work practices will be used to minimize the risk of physical injuries and chemical exposures. All personnel are advised that this field project may result in exposure to chemical and physical hazards, and that this plan must be followed to minimize and/or eliminate these risks.

The procedures and requirements contained in this plan are intended for MFA personnel performing field activities. All MFA field personnel are responsible for understanding and adhering to this HASP, and should also be alert to any unsafe conditions or practices that may affect their safety. Each day before beginning fieldwork, a site safety officer (SSO) who is familiar with health and safety procedures and the Site will be designated by the on-site MFA personnel. All subcontractors have the primary responsibility for the safety of their own personnel on the Site. Any safety deficiencies should be immediately communicated to the SSO and to the health and safety coordinator (HSC). If personnel safety is threatened, the SSO, project manager, or MFA HSC must be contacted immediately.

All personnel who will be working on site are required to read and understand this HASP. All personnel entering the work area must sign the Personnel Acknowledgment Sheet (Section 12), certifying that they have read and understand this HASP and agree to abide by it.

NOTE: This HASP must be reevaluated and updated annually or when site conditions or scope of work changes.

4.1 Scope of Work

The MFA scope of work for this project includes the following activities:

- If requested, assist the client with management of investigative derived waste.

- In-river sampling including profiling of sediment using a direct-push rig on a barge, measuring groundwater elevations, and collecting reconnaissance groundwater samples.

Methods for sample collection are described in Anchor QEA's Field Sampling Plan, which is Attachment A to the Data Gaps Quality Assurance Project Plan.

4.2 Site Work Zones

All work zones will be clearly communicated to all on-site personnel prior to the commencement of any site work activities. Exact geometry of the work zones will be determined during set-up and will be dependent upon the dimensions of the barge and drill rig, available work space, and other considerations. Work zones will include the exclusion zone, the contaminant reduction zone, and the support zone, as described below:

- Exclusion Zone: The exclusion zone is where sample collection and processing will occur. This includes the area immediately surrounding the drill rig.

- Contaminant Reduction Zone: The contaminant reduction zone is the area surrounding the exclusion zone. Decontamination will occur in this zone.

- Support Zone: The support zone is the area surrounding the exclusion zone. The support zone provides a clean area for personnel to rest and eat, as well as a clean area for storage.

Only authorized field personnel having the appropriate training and wearing appropriate PPE will be allowed inside the exclusion and contaminant reduction zones.

5 FACILITY DESCRIPTION AND BACKGROUND

5.1 Type of Facility

Industrial facility with warehouses, offices and wafer fabrication facilities adjacent to a large river.

5.2 Access

Accessible. Access the river by the boat landing at Cathedral Park. .

5.3 Topography

Relatively flat; easy access; paved parking lots; and landscaped areas. The topography along the bank of the river may be steep in some areas.

5.4 Site Status

Active.

5.5 Site History

Ponds and a lagoon in the vicinity of the Site had been used for disposal of manufactured gas product waste from about 1940 through 1967. Manufactured gas production operations ceased in 1956, although liquid wastes remained in the ponds and lagoon until about 1965. In 1978, the City of Portland sold the property to Siltronic (as Wacker Siltronic Corporation) for the purpose of constructing a wafer fabrication plant. Siltronic has operated on the property since 1978 to present, manufacturing silicon wafers from silicon crystal ingots.

5.6 Special Conditions/Comments

Working over or adjacent to a waterway poses a potential safety hazards. Workers must wear a U.S. Coast Guard-approved life vest while over water, conducting sediment sampling, or working along the shore line of the river.

Vehicular traffic poses a potential safety hazard. If the work area is located in a travel corridor, use triangle reflectors, traffic cones, and/or traffic barriers immediately upon beginning work at a sampling location.

6 WASTE TYPE(S)/CHARACTERISTICS

6.1 Hazardous Substances

Are hazardous substances known to have been stored/spilled on site?

__X__ YES _____ NO

6.2 Special Considerations/Comments

Before any site work by MFA employees, a copy of this HASP must be read and the Acknowledgment page signed. Before any underground exploration begins, make sure the following calls are made: One Call Utility Check, (800) 424-5555; on site—contact a private utility-locating company.

7 HAZARD EVALUATION

The following subsections describe the potential physical and chemical hazards associated with implementing this project. The control measures that field personnel must use to eliminate or minimize these hazards, such as air monitoring, PPE, and decontamination procedures, are detailed in subsequent sections of this plan.

7.1 Physical Hazards

Potential physical hazards in site operations include:

- Vehicular traffic
- Equipment and machinery
- Fire/explosion
- Falling objects/loads
- Uneven walking surfaces
- Water/drowning
- Noise

7.2 Electrical/Mechanical/Vapor Systems

MFA employees will not be working on electrical or mechanical systems. The contractor will be responsible for administering lockout/tagout procedures, as applicable.

7.3 Activity/Traffic/Pedestrian Control

Immediately upon moving to a new location, restrict access to work area with vehicles, traffic cones or barriers, and barrier tape. Be alert for inattentive drivers and boaters at or near the job site. Wear high-visibility orange safety vests when near traffic areas. Keep all nonessential personnel out of the sampling areas.

7.4 Fires and Explosions

In the case of an emergency, fire safety is the responsibility of all persons on site. The following general precautions address site-wide operations:

- A fire extinguisher will be kept in the MFA field vehicle and on sediment sampling vessel.
- Smoking is not allowed on site by MFA personnel.
- Leaks and spills of flammable or combustible fluids must be cleaned up immediately.

See the air monitoring section for potential explosive-atmosphere precautions.

7.5 Uneven Walking Surfaces

Care should be used when boarding and exiting water craft. Boats may shift without notice. Operating in a water environment, surfaces are likely to be wet and slick. When possible, minimize movement around the boat in order to minimize walking hazards.

7.6 Noise

The effects of noise on humans include physiological effects (e.g., interference with communication by speech, job performance, safety, temporary and permanent hearing loss). The factors that affect the degree and extent of hearing loss are intensity or loudness of the noise, type of noise, period of exposure, and distance from the noise source. When working in close proximity to operating equipment or other loud noise sources, all MFA personnel will be required to use hearing protection.

7.7 Marine Safety

When conducting activities related to the use of water craft, employees will adhere to the requirements in the MFA SOP for marine and boat safety (Appendix 3-1). MFA employees should not operate a boat under work-related activities. A licensed boat operator must maintain control of the boat at all times. Any incidents must be reported as indicated in the MFA Accident/Loss Report form (Attachment 3-2).

7.8 Falling Overboard

It is anticipated that sampling will be conducted from a vessel. As with any work from a floating platform, there is a chance of falling overboard. A personal flotation device (PFD) for each crew person will be available in the boat at all times. PFDs will be worn and properly buckled and zipped as appropriate, by all personnel on or over water, regardless of work zone. If hydrostatic vests are used, they will be checked daily to ensure that the carbon dioxide cartridge is "green," indicating that it is ready for use.

7.9 Willamette River – Biological Hazard

During periods of increased precipitation, stormwater in certain parts of the Portland metro area enters sewers and combines with raw sewage. If enough precipitation occurs, the mixture overflows directly into the Willamette River, creating a biological hazard. Because of this, employees will avoid direct contact with the Willamette River.

7.10 MFA Vehicle Use

When operating vehicles on the Site, employees will adhere to the requirements in the MFA SOP for vehicle safety operations (Attachment 3-3). Any traffic incidents must be reported as indicated in the MFA Accident/Loss Report form (Attachment 3-2).

7.11 Chemical Hazard Evaluation

The following potentially hazardous chemicals are known or suspected to be on site. Concentrations that may be encountered during the field investigation are listed in Appendix D of the Project Area Identification Report.

Chemical of Concern	OSHA PEL	OSHA STEL	OSHA IDLH	Odor Threshold	LEL (%)	IP(eV)	Other Hazard
Gasoline	NA	NA	NA	0.06–0.08 ppm	1.4	?	C, E, F, P
Diesel (Naphthalene)	10 ppm	15 ppm	250 ppm	14.68-12.0 ppm	0.9	8.12	E, F, P
Benzene	1 ppm	5 ppm	500 ppm; C; P	12 ppm	1.2	9.24	F, C, P, R
Toluene	100 ppm	150 ppm	500 ppm	0.17–2.9 ppm	1.1	8.82	E, F, P, R
Ethylbenzene	100 ppm	125 ppm	800 ppm	NA	0.8	8.76	F, P
Xylenes	100 ppm	150 ppm	900 ppm	0.62–5.4 ppm	0.9	8.44–8.56	F, P
TCE	100 ppm	300 ppm	150 ppm; C	50 ppm	NA	9.45	P
1,2-DCE	200 ppm	NA	1000 ppm	17 ppm	5.6	9.65	P
Vinyl Chloride	1 ppm	5 ppm	C	NA	3.6	9.99	P
Cyanide	-	5 $mg/m^{3(TWA)}$	-	-	-	-	-
Hexane	500 ppm	NA	1100 ppm	-	10	10.18	F
Hydrogen Sulfide	20 ppm	NA	100 ppm	-	4	10.46	F
Naphthalene	10 ppm	15 ppm	250 ppm	-	0.9	8.12	-

Chemical of Concern	OSHA PEL	OSHA STEL	OSHA IDLH	Odor Threshold	LEL (%)	IP(eV)	Other Hazard
Coal Tar Pitch (including PAHs)	0.2 ppm	NA	80 mg/m^3	-	Varies	Varies	C

NOTES:

-- — none established.
C — carcinogen.
E — explosivity.
F — flammable.
IDLH — immediately dangerous to life and health.
IP (eV) — ionization potential (electron volts).
LEL — lower explosive limit.
mg/m^3 — milligrams per cubic meter.
? — unknown.
NA — not available.
OSHA — Occupational Safety and Health Administration.
P — poison.
PEL — permissible exposure level.
ppm — parts per million.
R — reactive.
SC — suspected carcinogen.
STEL — short-term exposure level.
TWA — time-weighted average.
% — percent.

8 SAFETY EQUIPMENT AND PROCEDURES

8.1 Safety Equipment

The following safety equipment may be used as needed on the Site:

- Photoionization detector (PID), flame ionization detector (FID), and Dräger tubes.
- Combustible gas indicator (CGI) capable of measuring oxygen, methane, and hydrogen sulfide.
- Dust meter capable of measuring to a minimum level of micrograms per cubic meter.
- Respirator—Half-face respirator with high-efficiency purified air (HEPA) and organic vapor (OV) cartridges. The selection, use, and maintenance of respiratory protective equipment shall meet the requirements of established MFA procedures, recognized consensus standards (i.e., American Industrial Hygiene Association [AIHA], American National Standards Institute [ANSI], and National Institute for Occupational Safety and Health [NIOSH]), and shall comply with the requirements set forth in 29 CFR 1910.134.
- Protective clothing—Tyvek or equivalent.
- Chemical protective gloves—nitrile.
- Decontamination equipment—soap and water.
- Steel-toed boots.
- Hearing protection.
- Safety glasses—safety glasses with side shields are required at all times during active Site work. Use splash shields if performing activities where the potential exists for liquids to contact face or eyes.
- Hard hat.
- U.S. Coast Guard-approved life vest
- Caution tape, traffic cones, or barriers.

- High-visibility vest or clothing for working in or adjacent to any roadway.
- First-aid kit—located in the MFA field vehicle.
- Fire extinguisher—located in the MFA field vehicle.
- Drinking water and Gatorade or equivalent.

Each level of protection will incorporate the following equipment:

Level D: Workers performing general site activities where contact with contaminated materials is not likely wear steel-toed leather or chemical-resistant work bo work clothes or coveralls, hard hat, safety glasses, ni gloves, and hearing protection, as needed.

Modified D: Same as Level D (when performing activities in wl inhalation of dust or volatile organic compou (VOCs) is not of concern), plus chemical-resistant, st toed boots and Tyvek coveralls (if contaminated so encountered); and coated Tyvek or rain gear (if lic contaminants are encountered).

Level C: Same as Modified Level D, plus half- or full-face purifying respirator with combination OV/HEPA fil (when performing activities in which inhalation of or VOCs are of concern).

Note: Project personnel are not permitted to deviate from the specified levels of protection without the prior approval of the SSO or the HSC.

8.2 Air Monitoring Equipment

Organic vapor analyzer (PID or FID), Dräger tubes (if necessary; see Section 9.1, toxicity action levels) and CGI (if necessary, based on presence of organic or flammable vapors.)

8.3 Communications

A mobile phone will be available to MFA personnel. Field personnel are not permitted to carry mobile phones or pagers into a potentially flammable environment; as such instruments are not intrinsically safe.

8.4 Decontamination Procedures

Decontamination procedures are outlined below.

8.4.1 Partial Decontamination Procedure

Partial decontamination procedures will be followed when exiting the exclusion zone and will apply to items used in the exclusion zone.

- Wash and rinse boots and outer gloves in buckets in the contamination-reduction zone.
- Inspect Tyvek suit for stains, rips, or tears. If suit is contaminated or damaged, deposit in a labeled container for disposable clothing or a full decontamination will be performed as described in Section 8.4.2.
- Remove outer gloves. Inspect and discard in a labeled container for disposable clothing if ripped or damaged.
- Remove respirator, if worn, and clean with pre-moistened alcohol wipes. Deposit used cartridges in a plastic bag at the frequency directed by the SSO.
- Remove and clean life vest, as needed
- Wash hands and face with soap and water.
- All contaminated materials resulting from decontamination procedures will be contained and disposed of appropriately.

8.4.2 Full Decontamination Procedures

Full decontamination procedures will be followed at the end of each work shift and will apply to items used.

- Wash and rinse boots and outer gloves in buckets in the contamination-reduction zone.
- Remove outer gloves and Tyvek suit and deposit in a labeled container for disposable clothing.
- Remove respirator and place used cartridges in a plastic bag at the frequency directed by the SSO.
- If end of day, wash and rinse respirator in a special "respirators only" decon bucket or similar container.

- Remove inner gloves and deposit in a container labeled for disposable clothing.
- Remove work boots without touching exposed surfaces, and put on street shoes. Place work boots in a plastic bag for later reuse.
- Remove and clean life vest, as needed
- Wash hands and face with soap and water.
- Shower as soon after the work shift as practicable.
- All contaminated materials resulting from decontamination procedures will be contained and disposed of appropriately.

8.4.3 Emergency decontamination

If evacuation becomes necessary, decontamination will be performed only to the extent that doing so will not endanger on-site personnel.

If the evacuation of an injured member of the site work team becomes necessary, removal of contaminated PPE will take place only to the extent that doing so will not cause further injury to the individual or endanger other personnel. If emergency transportation is warranted, emergency responders will be advised as to the nature of the contamination and will use a barrier such as plastic sheeting to prevent contact of the contaminant with emergency vehicles and equipment.

All contaminated materials resulting from decontamination procedures will be contained and disposed of appropriately.

8.5 Emergency Equipment

A fire extinguisher will be kept in the MFA field vehicle and on the boat. The extinguisher will be Type ABC, approved by the National Fire Prevention Association. The extinguisher will be inspected monthly and serviced yearly. A first-aid kit will be available in the MFA field vehicle and on the boat. An automated external defibrillator (AED) supplied by the drilling contractor will be accessible and stored in an unlocked location at the work site, along with procedures for its

use.[1] The location of the AED will be discussed initially and in daily briefings.

1 The AED should be used only by individuals who have received the appropriate training.

9 AIR MONITORING

Personnel exposure monitoring should be performed as specified in this section to protect field personnel from hazardous concentrations of vapors. Monitoring must be performed by individuals familiar with the calibration, use, and care of the required instruments.

During Site activities, air monitoring shall be conducted at least every half hour[2] in the worker's breathing zone, which is a 1-foot-diameter sphere surrounding the worker's head. Respirators must be worn when meter readings in the breathing zone (sustained for two minutes) equal or exceed the action levels described below for upgrade to Level C PPE.

9.1 Toxicity Action Levels

The toxicity action levels given below are set to comply with OSHA Permissible Exposure Levels and American Conference of Governmental Industrial Hygienists Threshold Limit Values, and NIOSH recommendations for the chemicals that may be encountered on the Site. These action levels are also adjusted for the relative response of common PID or FID instruments to motor-fuel vapors.

The alarm on this instrument should be set to sound at the action level. If the instrument must be unattended, the detector inlet should be located as close to the worker's breathing zone as practicable.

Workers must be evacuated from the area when vapor concentrations exceeding respiratory equipment protection factors are encountered.

During site activities that generate airborne dust, MFA employees will remain upwind and outside of residual dust plumes. Dust monitoring will be undertaken at the discretion of the SSO. Engineering controls will be required of the contractor if the action level shown on the table below is exceeded. MFA workers must be evacuated until dust levels fall below the action level.

2 MFA recognizes that continuous air monitoring provides better protection. However, continuous monitoring during over-water activities presents logistical difficulties such as rigging and powering the monitoring equipment, as well as the continuous exposure of moisture-sensitive equipment to moisture on days when rain, fog, and/or spray are present. Therefore, air monitoring will be conducted as frequently as possible, with the time between readings not to exceed half an hour.

Air Monitoring Procedures and Toxicity Action Levels

Instrument	Action Level	Initial Action	Followup Action
FID or PID[a]	Detection of **1 ppm** (above ambient) or greater in breathing zone **sustained for two minutes**	Dräger tube test for **benzene**. If **1 ppm benzene** detected with Dräger tube, upgrade to level C.	Ventilate area, always work upwind.
Dräger tube test (benzene)	Over **1 ppm benzene sustained** in breathing zone	After upgrade to Level C, continue to monitor breathing zone with Dräger tube. If **10 ppm or greater benzene**, leave exclusion zone. Return only if levels decrease to below 10 ppm.	Ventilate area, always work upwind.
FID or PID[a]	Detection of 10 ppm (above ambient) in breathing zone **and determined not to be benzene**	Upgrade to Level C and continue to monitor breathing zone with Dräger tube. **If 50 ppm, leave exclusion zone**. Return only if levels decrease to below 50 ppm.	Ventilate area, always work upwind.
CGI[b]	At or above 10 percent of LEL	Cease activities; turn off all potential sources of ignition. Evacuate.	Determine source of flammable vapors.

[a]Some PIDs do not work in high (e.g., >90%) humidity or rainy weather. Under these atmospheric conditions, only PIDs certified for use in high humidity will be used.

[b]See Section 9.2 for complete explosion hazard action levels.

Respirator/Respirator Cartridge Information

Respirator Manufacturer	**North (or equivalent)**
Respirator Cartridge Selected for Use	HEPA/OV
Respirator Cartridge Change Schedule	**Determine using contaminant types and levels, per North Web site http://www.northsafety.com**

Note: Project personnel are not permitted to deviate from the specified levels of protection without the prior approval of the SSO or MFA HSC.

9.2 Explosion Hazard Action Levels

A CGI should be used when working in a potentially explosive atmosphere, based on the presence of flammable vapors. The explosivity action level in the table above (≥ 10% LEL) are set to minimize risk due to flammable or explosive atmospheres. Measurements should be taken at all locations where flammable vapors may cause an

explosive condition. American Petroleum Institute procedures shall be followed for measurements in tanks or piping.

The CGI alarm must be set to sound at the action level and calibrated to a methane standard. When measurements with a CGI indicate the presence of combustible gas levels equal to or exceeding the explosivity action level in the work area, the following action must be taken:

1. Extinguish all possible ignition sources in the work area and shut down all powered equipment.
2. Move personnel at least 100 feet away from the work area.
3. Contact the MFA HSC.
4. At the instruction of the MFA HSC and after waiting 15 minutes for organic vapors to dissipate, the SSO may use the CGI to, cautiously and with prudence, approach the worksite to determine the extent and concentration of organic emissions. The SSO shall not enter (or allow any personnel to enter) any area where CGI readings exceed the explosivity action level, nor shall the SSO make any approach if there is a possibility of fire or explosion.
5. Personnel may reenter the work area only by clearance from the SSO after the cause of the emission has been determined and the source abated.

9.3 Instrument Calibrations

All instruments shall be calibrated both immediately before the day's fieldwork begins and after work ceases for the day. Calibration and monitoring records shall be kept in the project file and provided to the HSC. Records shall include:

- Worker's name
- Date
- Time
- Location
- Temperature and humidity
- Calibration gas identity and concentration
- Exposure data (time, location, and concentration)

10 HEALTH AND SAFETY EQUIPMENT CHECKLIST

REQUIRED SAFETY EQUIPMENT:

Equipment	Requirements
Hard Hat	Required on all job sites.
Steel-Toed Boots	Required on all job sites.
Safety Glasses w/side shields	Required on all job sites.
Hearing Protection	Use when appropriate.
PID or FID	PID calibrated to 100 ppm isobutylene.
CGI	To be used when working in a potentially explosive atmosphere, based on the presence of high concentrations of vapors. Methane standard to be used for calibration.
Respirator	Half-face respirator with cartridges appropriate for contaminants of concern.
Protective Clothing	Tyvek suit when appropriate.
Chemical Protective Gloves	Scorpio, Solvex, or similar gloves.
Decontamination Equipment	Bring soap and water to wash hands and face if no facilities are available.
Caution Tape, Traffic Cones, or Barriers	Use when working near traffic.
Emergency Eyewash	Located in the MFA field vehicle.
First-Aid Kit	Located in the MFA field vehicle.
Fire Extinguisher	Located in the MFA field vehicle.
Drinking Water	Located in the MFA field vehicle.

11 GENERAL SAFE WORK PRACTICES

Field operations for this project shall be conducted in accordance with the minimum safety practices described below, which are required for MFA employees.

11.1 Safety Practices for Field Personnel

1. Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of materials is prohibited in any area where the possibility of contamination exists.
2. Field personnel must thoroughly wash hands when leaving a contaminated or suspected contaminated area before eating, drinking, or any other activities.
3. Contaminated protective equipment shall not be removed from the work area until it has been properly decontaminated or containerized on site.
4. Avoid activities that may cause dust. Removal of materials from protective clothing or equipment by blowing, shaking, or any means that may disperse materials into the air is prohibited.
5. Field personnel must use the "buddy system" when wearing any respiratory protective devices. Communications between members must be maintained at all times. Emergency communications shall be prearranged in case unexpected situations arise. Visual contact must be maintained between pairs on site, and team members should stay close enough to assist one another in the event of an emergency.
6. Personnel should be cautioned to inform one another of subjective symptoms of chemical exposure such as headache, dizziness, nausea, and irritation of the respiratory tract.
7. No excessive facial hair that interferes with the seal of the respirator to the face will be allowed on personnel required to wear respiratory protective equipment.
8. The selection, use, and maintenance of respiratory protective equipment shall meet the requirements of established MFA procedures and recognized consensus standards (AIHA, ANSI, NIOSH), and shall comply with the requirements set forth in 29 CFR 1910.134.
9. At sites with known or suspected contamination, appropriate work areas for field personnel support, contaminant reduction, and exclusion will be designated and maintained.
10. All MFA field vehicles shall contain a first-aid kit and a multipurpose, portable fire extinguisher.

11. All field personnel will, whenever practicable, remain upwind of drilling rigs, open excavations, boreholes, etc.

12. Subsurface work shall not be performed at any location until the area has been confirmed by a utility-locator firm to be free of underground utilities or other obstructions.

13. Field personnel are specifically prohibited from entering excavations, trenches, or other confined spaces deeper than 4 feet. Unattended boreholes must be properly covered or otherwise protected.

14. MFA field personnel are to be briefed thoroughly on the anticipated hazards, equipment requirements, safety practices, emergency procedures, and communications methods, both initially and in daily briefings. Below is an outline of topics to be covered in safety briefings:

    - Hazard Exposure Routes
    - Chemical Hazards
    - Physical Hazards
    - Biological Hazards (via direct contact with the Willamette River)
    - Mitigation Procedures
    - Vessel Safety
    - Safety Communication
    - Roles and Responsibilities
    - Location of first aid kit(s), fire extinguisher(s), and AED
    - Over water safety and PFD usage

15. MFA field personnel will conduct emergency response rehearsals for the hazards outlined above.

12 ACKNOWLEDGMENT

MFA cannot guarantee the health or safety of any person entering this Site. Because of the potentially hazardous nature of visits to active sites, it is not possible to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury and illness at this Site. The health and safety guidelines in this plan were prepared specifically for this Site and should not be used on any other site without prior evaluation by trained health and safety personnel.

All MFA personnel are to read, understand, and agree to comply with the specific practices and guidelines as described in this HASP (including attachments for specific activities and the General Work Practices described below) regarding field safety and health hazards.

This HASP has been developed for the exclusive use of MFA personnel. MFA makes this plan available for review by contracted or subcontracted personnel for information only. This plan does not cover the activities performed by employees of any other employer on the Site. All contract or subcontracted personnel are responsible for generating and using their own plan, which must have requirements at least as stringent as those listed in this HASP.

I have read and I understand this HASP and all attachments, and agree to comply with the requirements described herein:

Name	Title	Date

ATTACHMENT 3-1

MARINE AND BOAT SAFETY STANDARD OPERATING PROCEDURE

MARINE AND BOAT SAFETY

PURPOSE

This operating procedure (OP) establishes guidelines for the safe operation of watercraft during Maul Foster & Alongi Inc.'s (MFA) field activities such as sediment sampling, biological sampling, and bathymetry mapping. The U.S. Coast Guard (USCG) and individual states have additional specific requirements. This OP is intended to apply to the operation of Class A and Class 1 boats.

DEFINITIONS

Class A—a boat less than 16 feet long. Class A has the greatest number of boats. They can all be car-topped or trailered. Due to their lightness and small size, many can become unstable if weight in them is excessive or carelessly loaded. Too much weight makes these boats sluggish, reduces their freeboard (the height of their sides above water), and can swamp (flood) them.

Class 1—a motorized boat from 16 feet to less than 26 feet in length. Though heavier and more powerful than Class A craft, most are still trailerable.

Type III Flotation Aid—generally the most comfortable, they have at least 15.5 pounds of buoyancy in the adult size.

Type IV Throwable Devices—include the horseshoe, rung, and cushion. They have at least 16.5 pounds of buoyancy.

BOARDING SMALL BOATS

Be sure that the boat is secure. With one hand on the boat, quickly lower yourself straight down into the center of the boat. A life preserver should be worn. If others are boarding, have them step along the fore-and-aft centerline of the boat while you hold the boat in place along the pier. Avoid carrying anything aboard. Step down into the boat and load the items off the pier, or have someone hand them to you one by one.

LOADING OF BOATS

Amount and location of weight (persons and gear: the movable ballast) are critical for capsize protection. In a small utility boat, keep weight toward the middle, both fore and aft and side to

side. If you see waves approaching, take them on the bow. Overloading a small boat inhibits its ability to rise to oncoming waves. Less freeboard means less clearance above the water's surface to prevent swamping. All craft must be operated within the boat manufacturers' weight limits.

OPERATED CLASS A AND CLASS 1 BOATS

- All persons on the boat will wear a USCG-approved Type III personal flotation vest. The type II vests (typically orange chest type) are not recommended because they are difficult to work in. In addition, throwable Type IV devices will be readily available for use.

- At least one B-1 Type USCG-approved, hand-held, portable fire extinguisher will be on the boat, readily available for use.

- Visual distress-signal flares and a battery-operated light will be in good working order and readily available on the boat.

- A sound-producing distress signal, either bell, whistle, or horn, will be in good working order and readily available on the boat.

- A first-aid kit will be available on the boat.

- All boat fuel (gasoline) will be contained in engine manufacturer's approved containers that supply fuel to the engine via neoprene fuel lines. No fuel transfers between containers are to be conducted aboard the boat.

- A secondary means of propulsion will be available on the boat (oars or paddle).

- A boat hook, anchors, and proper mooring lines will be available on the boat.

SAFE BOATING OPERATIONS

- All boats will be properly registered for use in waterways of local, state, and federal jurisdictions.

- All boat trailers and towing vehicles will be properly licensed and in good working order.

- The boat will be operated only by experienced personnel. The USCG Auxiliary and other organizations regularly sponsor boating-safety courses. In addition to basic boating safety, the courses cover navigation regulations and emergency procedures. The training is recommended, even for experienced boat operators.

- The boat will be operated in a safe manner and all waterway regulations will be obeyed.

- No smoking or alcoholic beverages are permitted on the boat.
- No recreational equipment for fishing, hunting, water skiing, or scuba diving will be allowed on the boat unless specifically authorized as part of the work-related equipment.

BOATING ACCIDENTS

USCG regulations, as well as state regulations, require accident reports if significant injuries or property damage occurs. It is normally best to stay with the boat in case of an accident and use signal flares or a distress horn to summon help. Hypothermia (cold stress) is a risk for those involved in boating accidents due to the rapid conduction of body heat by cold water. Wet or dry suits are recommended for cold weather/cold water (less than 45°F) operations.

ATTACHMENT 3-2

MFA INCIDENT REPORT

ACCIDENT/LOSS REPORT

******THIS REPORT MUST BE COMPLETED IN FULL AND SUBMITTED TO THE MFA MANAGING DIRECTOR******

Date of Accident:_____ Company:_____

Time Occurred:_____ Project Number:_____

Where Occurred:_____ Name and Location of Project:_____

PART I—PROPERTY DAMAGE/LOSS

Equipment Involved:_____

Names of Persons Involved:_____

Describe Incident/Damage:_____

_____

Estimated Cost of Damage:_____

***Copy of Police Report, if filed, must also be submitted.**

DRAW A DIAGRAM OF INCIDENT ON THE BACK OF THIS REPORT

PART II—PERSONAL INJURY *(fill out only if personal injury occurred)*

Name of employee injured:_____ Age:_____

Address:_____ Occupation:_____

What was employee doing when injured:_____

Exact location where injury occurred (station number or prominent landmark):_____

_____

Was place of accident or exposure on job site?:_____

Describe injury:_____

_____

How did injury occur?:_____

_____

Did employee see a doctor or go to the hospital?_____ If yes, give name, address, and phone number of Doctor and/or hospital:_____

_____

Employee Name (print):_____

Employee Signature: _____

Date of this report: _____

ATTACHMENT 3-3

VEHICLE SAFETY STANDARD OPERATING PROCEDURE

VEHICLE SAFETY

This operating procedure applies to Maul Foster & Alongi, Inc. (MFA)-owned vehicles, vehicles leased or rented for MFA business, and personal vehicles when used on MFA business. In order to drive a vehicle on behalf of the company, you must have a valid driver's license as well as a driving record that is satisfactory to MFA and its insurance carriers.

Additional policies relating to vehicle use are provided in Part 2, Section 3 of the MFA Policies and Procedures Manual.

COMPANY-OWNED AND COMPANY-RENTED VEHICLES

Company vehicles are to be driven by authorized employees only, except in case of testing by a mechanic. An employee must be familiarized with the vehicle before it is driven. To avoid accidents because an accessory cannot be located during operation (e.g., windshield wipers), it is recommended that the driver locate the horn, windshield-wiper switch, lights, defroster, gauges, hood and gas fill door releases, and seat and mirror adjustments before the vehicle is started. Once the vehicle is started, fluid levels, wiper blades, and lights should be checked. The spare tire should be located, along with instructions and tools for changing a flat tire.

HAZARDOUS SUBSTANCES

Hazardous substances or potentially hazardous substances may not be transported in privately-owned vehicles. Hazardous substances include, but are not limited to, environmental-media samples, air-monitoring meters (photoionization detectors, four-gas meters) and associated calibration gases, investigation-derived waste, decontamination chemicals, fuel, and fuel products.

DRIVER SAFETY GUIDELINES

The use of a vehicle for company business while under the influence of intoxicants or other drugs that could impair driving ability is forbidden and is sufficient cause for disciplinary action, up to and including termination of employment.

Cell-phone use while driving is a major cause of accidents. Drivers should complete calls while the vehicle is parked. While driving, attention to the road and safety must always take precedence over conducting business over the phone.

No driver shall operate a vehicle on company business when his/her ability to do so safely has been impaired by illness, fatigue, injury, or prescription medication.

All drivers and passengers operating or riding in a company vehicle must wear seat belts, even if air bags are available.

No unauthorized personnel are allowed to ride in company vehicles.

Headlights shall be used starting two hours before sunset until two hours after sunrise, during inclement weather, and at any time when the area 500 feet ahead of the vehicle cannot be clearly seen.

Allot enough time for travel to avoid the need to hurry.

Be well rested and alert.

Notify someone of your destination and anticipated time of arrival.

DEFENSIVE-DRIVING GUIDELINES

Drivers are required to maintain a safe following distance at all times. Drivers should keep at least a two-second interval between their vehicle and the vehicle immediately ahead. During slippery road conditions, the following distance should be increased.

Drivers must yield the right of way at all traffic control signals and signs requiring them to do so. Drivers should also be prepared to yield for safety's sake at any time. Pedestrians and bicycles in the roadway always have the right of way.

Drivers must honor posted speed limits. In adverse driving conditions, reduce speed to a safe operating speed that is consistent with the conditions of the road, weather, lighting, and volume of traffic.

Radar detectors are strictly prohibited in company vehicles. Drivers are to drive at the speed of traffic but are never to exceed the posted speed limit.

Turn signals must be used before every turn or lane change.

When passing or changing lanes, view the entire vehicle in your rearview mirror before pulling into that lane.

Be alert to other vehicles, pedestrians, and bicyclists when approaching intersections. Never speed through an intersection on a caution light. When the traffic light turns green, look both ways for oncoming traffic before proceeding.

When waiting to make left turns, keep your wheels facing straight ahead. If rear-ended, you will not be pushed into the path of oncoming traffic.

When stopping behind another vehicle, leave enough space so you can see the rear wheels of the car in front. This allows room to go around the vehicle, if necessary, and may prevent you from being pushed into the car in front of you if you are rear-ended.

Avoid backing where possible, but when necessary, keep the distance traveled to a minimum and be particularly careful. Check behind your vehicle before backing. Back the vehicle toward the driver's side. Do not back around a corner or into an area of no visibility.

ACCIDENT PROCEDURES

All accidents, in either company vehicles, rented vehicles, or personal vehicles (while on company business), must follow these accident procedures.

In an attempt to minimize the results of an accident, the driver involved in the accident must prevent further damages or injuries and obtain all pertinent information and report it accurately. Call for medical aid, if necessary.

Record names and addresses of driver, witnesses, and occupants of the other vehicles and any medical personnel who may arrive at the scene. Complete the form located in the Vehicle Accident Packet. An employee who is involved in an accident when on MFA business must report it by completing an MFA Accident/Loss Report and submit it to the health and safety coordinator as soon as possible. An Accident/Loss Report form is attached.

Pertinent information to obtain includes: driver's license number of other drivers; insurance company names and policy numbers of other vehicles; make, model, year, and license plate number of other vehicles; date and time of accident; and overall road and weather conditions. Provide the other party with your name, address, driver's license number, and insurance information. Do not discuss the accident with anyone at the scene except the police. Do not accept any responsibility for the accident. Do not argue with anyone.

All accidents, regardless of severity, must be reported to the police and also to the Managing Director or your Group Manager. Accidents are to be reported immediately (from the scene, during the same day, or as soon as practicable if immediate or same-day reporting is not possible). If the driver cannot get to a phone, he/she should write a note giving the location to a reliable-appearing motorist and ask him or her to notify the police. MFA may conduct a review of each accident to determine its cause and how it could have been prevented.

Accidents involving personal injury to an MFA employee must be reported to the Managing Director or your Group Manager so that a workers' compensation claim can be promptly filed and MFA's short-term-disability carrier can be notified, if applicable. Failing to stop after an accident and/or failure to report an accident may result in disciplinary action, up to and including termination of employment.

TRAFFIC VIOLATIONS

Driving motor vehicles is a serious responsibility and must be done safely and in accordance with all traffic laws. Vehicle accidents are costly to our company, but more importantly, they may result in injury to you or others. It is the driver's responsibility to operate the vehicle in a safe manner and to drive defensively to prevent injuries and property damage. MFA endorses all applicable state motor-vehicle regulations relating to driver responsibility and expects each driver to drive in a safe and courteous manner pursuant to the preceding safety rules. The attitude you take when behind the wheel is the single most important factor in driving safely. Traffic and/or parking citations will not be reimbursed by MFA.

ATTACHMENT

ACCIDENT/LOSS REPORT

******THIS REPORT MUST BE COMPLETED IN FULL AND SUBMITTED TO THE MFA MANAGING DIRECTOR******

Date of Accident:_____ Company:_____

Time Occurred:_____ Project Number:_____

Where Occurred:_____ Name and Location of Project:_____

PART I—PROPERTY DAMAGE/LOSS

Equipment Involved:_____

Names of Persons Involved:_____

Describe Incident/Damage:_____

_____

Estimated Cost of Damage:_____

***Copy of Police Report, if filed, must also be submitted.**

DRAW A DIAGRAM OF INCIDENT ON THE BACK OF THIS REPORT

PART II—PERSONAL INJURY *(fill out only if personal injury occurred)*

Name of employee injured:_____ Age:_____

Address:_____ Occupation:_____

What was employee doing when injured:_____

Exact location where injury occurred (station number or prominent landmark):_____

_____

Was place of accident or exposure on job site?:_____

Describe injury:_____

_____

How did injury occur?:_____

_____

Did employee see a doctor or go to the hospital?_____ If yes, give name, address, and phone number of Doctor and/or hospital:_____

_____

Employee Name (print):_____

Employee Signature: _____

Date of this report: _____

ATTACHMENT 4
LABORATORY CERTIFICATIONS AND ACCREDITATIONS

Oregon

Environmental Laboratory Accreditation Program

Public Health Laboratory
3150 NW 229th Ave, Suite 100
Hillsboro, OR, OR 97124
(503) 693-4122
FAX (503) 693-5602

NELAP Recognized

Department of Agriculture, Laboratory Division
Department of Environmental Quality, Laboratory Division
Department of Human Services, Public Health Laboratory

ORELAP Fields of Accreditation

ORELAPID: WA100006
EPACode: WA00037

Certificate:
WA100006-004

Analytical Resources Inc.

4611 S. 134th Place
Tukwila, WA, 98168

Issue Date: 5/12/2009 ***Expiration Date:*** 5/11/2010
As of 05/12/2009 this list supercedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with ORELAP.

MATRIX: Drinking Water

Reference	Code	Description
EPA 200.8 5.5	10014809	Metals by ICP-MS

Analyte Code	Analyte
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1030	Cadmium
1040	Chromium
1050	Cobalt
1055	Copper
1070	Iron
1075	Lead
1085	Magnesium
1090	Manganese
1100	Molybdenum
1105	Nickel
1140	Selenium
1150	Silver
1165	Thallium
1170	Thorium
3035	Uranium
1185	Vanadium
1190	Zinc

NELAP-Recognized

EPA 200.9 3	10015608	Metals by Graphite Atomic Absorption

Analyte Code	Analyte
1005	Antimony
1010	Arsenic
1030	Cadmium
1075	Lead
1140	Selenium
1150	Silver
1165	Thallium

EPA 524.2 4.1	10088809	Volatile Organic Compounds GC/MS Capillary Column

Analyte Code	Analyte
5105	1,1,1,2-Tetrachloroethane
5160	1,1,1-Trichloroethane

ORELAPID: WA100006
EPACode: WA00037

Certificate:
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5110	1,1,2,2-Tetrachloroethane
5165	1,1,2-Trichloroethane
4630	1,1-Dichloroethane
4640	1,1-Dichloroethylene
4670	1,1-Dichloropropene
5150	1,2,3-Trichlorobenzene
5155	1,2,4-Trichlorobenzene
4610	1,2-Dichlorobenzene
4635	1,2-Dichloroethane
4655	1,2-Dichloropropane
5215	1,3,5-Trimethylbenzene
4615	1,3-Dichlorobenzene
4660	1,3-Dichloropropane
4620	1,4-Dichlorobenzene
4665	2,2-Dichloropropane
4500	2-Chloroethyl vinyl ether
4535	2-Chlorotoluene
4995	4-Methyl-2-pentanone (MIBK)
4375	Benzene
4385	Bromobenzene
4390	Bromochloromethane
4395	Bromodichloromethane
4400	Bromoform
4950	Bromomethane (Methyl bromide)
4455	Carbon tetrachloride
4475	Chlorobenzene
4485	Chloroethane
4505	Chloroform
105	Chloromethane
4645	cis-1,2-Dichloroethylene
4680	cis-1,3-Dichloropropene
4595	Dibromomethane
4625	Dichlorodifluoromethane
4650	Dichloromethane (DCM, Methylene chloride)
4765	Ethylbenzene
4835	Hexachlorobutadiene
4900	Isopropylbenzene
5240	m+p-xylene
5005	Naphthalene
4435	n-Butylbenzene
5090	n-Propylbenzene
5250	o-Xylene
4440	sec-Butylbenzene
5100	Styrene
4445	tert-Butylbenzene
5115	Tetrachloroethylene (Perchloroethylene)
5140	Toluene
4700	trans-1,2-Dicloroethylene
4685	trans-1,3-Dichloropropylene
5170	Trichloroethene (Trichloroethylene)
5175	Trichlorofluoromethane

ACCREDITING AUTHORITY
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ORELAP Fields of Accreditation

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5235	Vinyl chloride

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MATRIX: Non-Potable Water

Reference	Code	Description
EPA 120.1	10006403	Conductance - Specific @ 25 C
Analyte Code	***Analyte***	
1610	Conductivity	
EPA 1311	10118806	Toxicity Characteristic Leaching Procedure
Analyte Code	***Analyte***	
125	Extraction/Preparation	
EPA 1312	10119003	Synthetic Precipitation Leaching Procedure
Analyte Code	***Analyte***	
125	Extraction/Preparation	
EPA 150.1	10008409	pH - Electrometric Measurement
Analyte Code	***Analyte***	
1900	pH	
EPA 160.1	10009208	Total Dissolved Solids, dried @ 180 C
Analyte Code	***Analyte***	
1955	Residue-filterable (TDS)	
EPA 160.2	10009606	Total Suspended Solids, 0.2um dried @105C
Analyte Code	***Analyte***	
1960	Residue-nonfilterable (TSS)	
EPA 160.3	10010001	Total Solids, dried @ 103-105 C
Analyte Code	***Analyte***	
1950	Residue-total (TS)	
EPA 160.4	10010409	Total Volatile Solids, ignition @ 550 C
Analyte Code	***Analyte***	
1970	Residue-volatile	
EPA 160.5	10010807	Settleable solids
Analyte Code	***Analyte***	
1965	Residue-settleable	
EPA 1664A (HEM)	10127807	N-Hexane Extractable Material (Oil and Grease) by Extrac
Analyte Code	***Analyte***	
109	Hexane Extractable Material	
EPA 180.1 2	10011800	Turbidity - Nephelometric
Analyte Code	***Analyte***	
2055	Turbidity	
EPA 200.7 5	10014003	ICP - metals
Analyte Code	***Analyte***	
1000	Aluminum	
1005	Antimony	
1010	Arsenic	
1015	Barium	
1020	Beryllium	
1025	Boron	
1030	Cadmium	
1035	Calcium	
1040	Chromium	
1050	Cobalt	
1055	Copper	
1070	Iron	
1075	Lead	
1085	Magnesium	

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Analytical Resources Inc.

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1090	Manganese
1100	Molybdenum
1105	Nickel
1125	Potassium
1140	Selenium
1145	Silicon
1150	Silver
1155	Sodium
1160	Strontium
1165	Thallium
1175	Tin
1180	Titanium
1185	Vanadium
1190	Zinc

EPA 200.8 5.5 10014809 Metals by ICP-MS

Analyte Code	***Analyte***
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1030	Cadmium
1035	Calcium
1040	Chromium
1050	Cobalt
1055	Copper
1070	Iron
1075	Lead
1085	Magnesium
1090	Manganese
1100	Molybdenum
1105	Nickel
1125	Potassium
1140	Selenium
1150	Silver
1155	Sodium
1165	Thallium
1170	Thorium
3035	Uranium
1185	Vanadium
1190	Zinc

NELAP-Recognized

EPA 200.9 3 10015608 Metals by Graphite Atomic Absorption

Analyte Code	***Analyte***
1005	Antimony
1010	Arsenic
1030	Cadmium
1075	Lead
1140	Selenium
1150	Silver
1165	Thallium

ORELAPID: WA100006
EPACode: WA00037

Analytical Resources Inc.

4611 S. 134th Place
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EPA 204.2 10017808 Antimony by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1005	Antimony

EPA 206.2 10018607 Arsenic by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1010	Arsenic

EPA 213.2 10024007 Cadmium by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1030	Cadmium

EPA 239.2 10034205 Lead by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1075	Lead

EPA 245.1 CLP-M IMLO 4.1 10271008 Mercury by Cold Vapor Atomic Absorption

Analyte Code	Analyte
1095	Mercury

EPA 270.2 10045406 Selenium by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1140	Selenium

EPA 272.2 10046807 Silver by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1150	Silver

EPA 279.2 10048803 Thallium by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1165	Thallium

EPA 300.0 10053006 Ion chromatography - anions

Analyte Code	Analyte
1540	Bromide

EPA 300.0 2.1 10053200 Methods for the Determination of Inorganic Substances in

Analyte Code	Analyte
1540	Bromide
1575	Chloride
1730	Fluoride
1810	Nitrate as N
1840	Nitrite as N
1870	Orthophosphate as P
2000	Sulfate

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EPA 3005A 1 10133207 Acid Digestion of waters for Total Recoverable or Dissolv

Analyte Code	Analyte
125	Extraction/Preparation

EPA 3010A 1 10133605 Acid Digestion of Aqueous samples and Extracts for Total

Analyte Code	Analyte
125	Extraction/Preparation

EPA 3020A 1 10134404 Acid Digestion of Aqueous samples and Extracts for Total

Analyte Code	Analyte
125	Extraction/Preparation

EPA 305.1 10054203 Acidity using H2O2 procedure

Analyte Code	Analyte
1500	Acidity, as CaCO3

EPA 310.1 10054805 Alkalinity as CaCO3

Analyte Code	Analyte
1505	Alkalinity as CaCO3

ORELAP Fields of Accreditation

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EPA 335.4 10061402 Methods for the Determination of Inorganic Substances in

Analyte Code	Analyte
1635	Cyanide

EPA 340.2 10062201 Fluoride - Ion selective electrode

Analyte Code	Analyte
1730	Fluoride

EPA 350.3 10064401 Ammonia Nitrogen - Ion Selective Electrode

Analyte Code	Analyte
1515	Ammonia as N

EPA 3510C 3 10138202 Separatory Funnel Liquid-liquid extraction

Analyte Code	Analyte
125	Extraction/Preparation

EPA 3520C 3 10139001 Continuous Liquid-liquid extraction

Analyte Code	Analyte
125	Extraction/Preparation

EPA 353.2 2 10067604 Nitrate/Nitrite Nitrogen - Automated, Cadmium

Analyte Code	Analyte
1820	Nitrate+nitrite
1840	Nitrite as N

EPA 3550C 10142004 Ultrasonic Extraction

Analyte Code	Analyte
125	Extraction/Preparation

EPA 3580A 1 10143007 Waste Dilution

Analyte Code	Analyte
125	Extraction/Preparation

EPA 360.2 10069406 Dissolved Oxygen - Winkler

Analyte Code	Analyte
1880	Oxygen, dissolved

EPA 3640A 1 10147203 Gel Preparation Cleanup

Analyte Code	Analyte
125	Extraction/Preparation

EPA 365.2 10070403 Phosphorous - Colorimetric, single reagent

Analyte Code	Analyte
1870	Orthophosphate as P

EPA 3660B 2 10148400 Sulfur cleanup

Analyte Code	Analyte
125	Extraction/Preparation

EPA 3665A 1 10148808 Sulfuric Acid / permanganate Cleanup

Analyte Code	Analyte
125	Extraction/Preparation

EPA 375.2 2 10073004 Sulfate - Colorimetric, Automated, Methylthymol.

Analyte Code	Analyte
2000	Sulfate

EPA 376.2 10074609 Sulfide - Colorimetric, Methylene Blue.

Analyte Code	Analyte
2005	Sulfide

EPA 405.1 10075602 Biochemical Oxygen Demand (5 days @ 20 C).

Analyte Code	Analyte
1530	Biochemical oxygen demand

EPA 410.4 2 10077404 Chemical Oxygen Demand - Colorimetric, Automated.

Analyte Code	Analyte

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Analytical Resources Inc.

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1565	Chemical oxygen demand		
EPA 415.1		10078407	Organic carbon - Combustion or Oxidation
Analyte Code	***Analyte***		
2040	Total Organic Carbon		
EPA 420.1		10079400	Phenolics - Spectrophotometric, manual.
Analyte Code	***Analyte***		
1905	Total Phenolics		
EPA 5000		10152600	Sample Preparation for Volatile Organics
Analyte Code	***Analyte***		
125	Extraction/Preparation		
EPA 5030B 2		10153409	Purge and trap for aqueous samples
Analyte Code	***Analyte***		
125	Extraction/Preparation		
EPA 6010C		10155803	ICP - AES
Analyte Code	***Analyte***		
1000	Aluminum		
1005	Antimony		
1010	Arsenic		
1015	Barium		
1020	Beryllium		
1025	Boron		
1030	Cadmium		
1035	Calcium		
1040	Chromium		
1050	Cobalt		
1055	Copper		
1070	Iron		
1075	Lead		
1085	Magnesium		
1090	Manganese		
1100	Molybdenum		
1105	Nickel		
1125	Potassium		
1140	Selenium		
1145	Silicon		
1150	Silver		
1155	Sodium		
1160	Strontium		
1165	Thallium		
1175	Tin		
1180	Titanium		
1185	Vanadium		
1190	Zinc		
EPA 6020A		10156408	Inductively Coupled Plasma-Mass Spectrometry
Analyte Code	***Analyte***		
1000	Aluminum		
1005	Antimony		
1010	Arsenic		
1015	Barium		
1020	Beryllium		
1030	Cadmium		

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1035	Calcium		
1040	Chromium		
1050	Cobalt		
1055	Copper		
1070	Iron		
1075	Lead		
1085	Magnesium		
1090	Manganese		
1100	Molybdenum		
1105	Nickel		
1125	Potassium		
1140	Selenium		
1150	Silver		
1155	Sodium		
1165	Thallium		
1170	Thorium		
3035	Uranium		
1185	Vanadium		
1190	Zinc		
EPA 7010		10157809	Metals by Graphite Furnace Atomic Absorption
Analyte Code	***Analyte***		
1005	Antimony		
1010	Arsenic		
1030	Cadmium		
1075	Lead		
1140	Selenium		
1150	Silver		
1165	Thallium		
EPA 7041		10158404	Antimony by Graphite Furnace Atomic Absorption
Analyte Code	***Analyte***		
1005	Antimony		
EPA 7060A		10158802	Arsenic by Graphite Furnace Atomic Absorption
Analyte Code	***Analyte***		
1010	Arsenic		
EPA 7131A 1		10161203	Cadmium by Graphite Furnace Atomic Absorption
Analyte Code	***Analyte***		
1030	Cadmium		
EPA 7196A 1		10162400	Chromium Hexavalent colorimetric
Analyte Code	***Analyte***		
1045	Chromium VI		
EPA 7421		10164600	Lead by Graphite Furnace Atomic Absorption
Analyte Code	***Analyte***		
1075	Lead		
EPA 7470A 1		10165807	Mercury in Liquid Waste by Cold Vapor Atomic Absorptio
Analyte Code	***Analyte***		
1095	Mercury		
EPA 7740		10168602	Selenium by Graphite Furnace Atomic Absorption
Analyte Code	***Analyte***		
1140	Selenium		
EPA 7761		10169809	Silver by Graphite Furnace Atomic Absorption
Analyte Code	***Analyte***		

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1150	Silver		

EPA 7841 10170602 Thallium by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1165	Thallium

EPA 8021B 2 10174808 Aromatic and Halogenated Volatiles by GC with PID and/

Analyte Code	Analyte
4375	Benzene
4765	Ethylbenzene
5240	m+p-xylene
5000	Methyl tert-butyl ether (MTBE)
5250	o-Xylene
5140	Toluene

EPA 8080A 10305803 Organochlorine Pesticides and Polychlorinated Biphenyls

Analyte Code	Analyte
8580	2,4'-DDD
8585	2,4'-DDE
8590	2,4'-DDT
7355	4,4'-DDD
7360	4,4'-DDE
7365	4,4'-DDT
7025	Aldrin
7110	alpha-BHC (alpha-Hexachlorocyclohexane)
7240	alpha-Chlordane
7115	beta-BHC (beta-Hexachlorocyclohexane)
7250	Chlordane (tech.)
7925	cis-Nonachlor
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7535	Endrin ketone
7120	gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)
7245	gamma-Chlordane
7685	Heptachlor
7690	Heptachlor epoxide
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
7810	Methoxychlor
7870	Mirex
3890	Oxychlordane
8250	Toxaphene (Chlorinated camphene)
7910	trans Nanochlor

EPA 8081B 10178800 Organochlorine Pesticides by GC/ECD

Analyte Code	Analyte
8580	2,4'-DDD
8585	2,4'-DDE
8590	2,4'-DDT
7355	4,4'-DDD

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7360	4,4'-DDE
7365	4,4'-DDT
7025	Aldrin
7110	alpha-BHC (alpha-Hexachlorocyclohexane)
7240	alpha-Chlordane
7115	beta-BHC (beta-Hexachlorocyclohexane)
7250	Chlordane (tech.)
7925	cis-Nonachlor
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7535	Endrin ketone
7120	gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)
7245	gamma-Chlordane
7685	Heptachlor
7690	Heptachlor epoxide
7810	Methoxychlor
7870	Mirex
3890	Oxychlordane
8250	Toxaphene (Chlorinated camphene)
7910	trans Nanochlor

EPA 8082A 10179201 Polychlorinated Biphenyls (PCBs) by GC/ECD

Analyte Code	***Analyte***
8880	Aroclor-1016 (PCB-1016)
8885	Aroclor-1221 (PCB-1221)
8890	Aroclor-1232 (PCB-1232)
8895	Aroclor-1242 (PCB-1242)
8900	Aroclor-1248 (PCB-1248)
8905	Aroclor-1254 (PCB-1254)
8910	Aroclor-1260 (PCB-1260)
184	Aroclor-1262 (PCB 1262)
103	Aroclor-1268 (PCB-1268)

EPA 8151A 10183207 Chlorinated Herbicides by GC/ECD

Analyte Code	***Analyte***
8655	2,4,5-T
8545	2,4-D
8560	2,4-DB
8555	Dalapon
8595	Dicamba
8605	Dichloroprop (Dichlorprop)
8620	Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)
7775	MCPA
7780	MCPP
8650	Silvex (2,4,5-TP)

EPA 8260C 10307003 Volatile Organics: GC/MS (capillary column)

Analyte Code	***Analyte***
5105	1,1,1,2-Tetrachloroethane

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EPACode: WA00037

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5160	1,1,1-Trichloroethane
5110	1,1,2,2-Tetrachloroethane
5195	1,1,2-Trichloro-1,2,2-trifluoroethane
5165	1,1,2-Trichloroethane
4630	1,1-Dichloroethane
4640	1,1-Dichloroethylene
4670	1,1-Dichloropropene
5180	1,2,3-Trichloropropane
5155	1,2,4-Trichlorobenzene
5210	1,2,4-Trimethylbenzene
4570	1,2-Dibromo-3-chloropropane (DBCP)
4585	1,2-Dibromoethane (EDB, Ethylene dibromide)
4610	1,2-Dichlorobenzene
4635	1,2-Dichloroethane
4655	1,2-Dichloropropane
5215	1,3,5-Trimethylbenzene
4615	1,3-Dichlorobenzene
4660	1,3-Dichloropropane
4620	1,4-Dichlorobenzene
4915	1,4-Isopropyltoluene
4665	2,2-Dichloropropane
4410	2-Butanone (Methyl ethyl ketone, MEK)
4535	2-Chlorotoluene
4860	2-Hexanone
4540	4-Chlorotoluene
4315	Acetone
4325	Acrolein (Propenal)
4340	Acrylonitrile
4375	Benzene
4385	Bromobenzene
4390	Bromochloromethane
4395	Bromodichloromethane
255	Bromoethane (Ethyl Bromide)
4400	Bromoform
4950	Bromomethane (Methyl bromide)
4450	Carbon disulfide
4455	Carbon tetrachloride
4475	Chlorobenzene
4485	Chloroethane
4505	Chloroform
4960	Chloromethane (Methyl chloride)
4645	cis-1,2-Dichloroethylene
4575	Dibromochloromethane
4595	Dibromomethane
4625	Dichlorodifluoromethane
4650	Dichloromethane (DCM, Methylene chloride)
4765	Ethylbenzene
4870	Iodomethane (Methyl iodide)
4900	Isopropylbenzene
5240	m+p-xylene
5000	Methyl tert-butyl ether (MTBE)

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Analytical Resources Inc.

4611 S. 134th Place
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Certificate:
WA100006-004

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5005	Naphthalene
4435	n-Butylbenzene
5090	n-Propylbenzene
5250	o-Xylene
4440	sec-Butylbenzene
5100	Styrene
4445	tert-Butylbenzene
5115	Tetrachloroethylene (Perchloroethylene)
4700	trans-1,2-Dicloroethylene
4685	trans-1,3-Dichloropropylene
4605	trans-1,4-Dichloro-2-butene
5170	Trichloroethene (Trichloroethylene)
5175	Trichlorofluoromethane
5225	Vinyl acetate
5235	Vinyl chloride

EPA 8270D 10186002 Semivolatile Organic compounds by GC/MS

Analyte Code	***Analyte***
6715	1,2,4,5-Tetrachlorobenzene
5155	1,2,4-Trichlorobenzene
4610	1,2-Dichlorobenzene
4615	1,3-Dichlorobenzene
4620	1,4-Dichlorobenzene
6380	1-Methylnaphthalene
183	2,2'-Oxybis(1-chloropropane)
6835	2,4,5-Trichlorophenol
6840	2,4,6-Trichlorophenol
6000	2,4-Dichlorophenol
6130	2,4-Dimethylphenol
5795	2-Chloronaphthalene
5800	2-Chlorophenol
6385	2-Methylnaphthalene
6400	2-Methylphenol (o-Cresol)
6460	2-Nitroaniline
6490	2-Nitrophenol
5945	3,3'-Dichlorobenzidine
6140	4,6-Dinitro-2-methylphenol
5660	4-Bromophenyl phenyl ether
5700	4-Chloro-3-methylphenol
5745	4-Chloroaniline
5825	4-Chlorophenyl phenylether
6410	4-Methylphenol (p-Cresol)
6470	4-Nitroaniline
6500	4-Nitrophenol
5500	Acenaphthene
5505	Acenaphthylene
7005	Alachlor
5545	Aniline
5555	Anthracene
7075	Azinphos-methyl (Guthion)
123	Azobenzene
5595	Benzidine

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5575	Benzo[a]anthracene
5580	Benzo[a]pyrene
5585	Benzo[b]fluoranthene
5590	Benzo[g,h,i]perylene
5600	Benzo[k]fluoranthene
5610	Benzoic acid
5630	Benzyl alcohol
5760	bis(2-Chloroethoxy)methane
5765	bis(2-Chloroethyl)ether
6255	bis(2-Ethylhexyl)phthalate (DEHP)
7125	Bolstar (Sulprofos)
5670	Butyl benzyl phthalate
257	Butylated Hydroxy Toluene (BHT)
259	Butyldiphenyl Phosphate
5680	Carbazole
7255	Chlorfenvinphos
7300	Chlorpyrifos
5855	Chrysene
7315	Coumaphos
7330	Crotoxyphos
7385	Demeton-s
7410	Diazinon
5895	Dibenz[a,h]anthracene
5905	Dibenzofuran
260	Dibutylphenyl Phospahate
7465	Dicrotophos
6070	Diethyl phthalate
7475	Dimethoate
6135	Dimethyl phthalate
5925	Di-n-butyl phthalate
6200	Di-n-octyl phthalate
8625	Disulfoton
7550	EPN
7565	Ethion
7570	Ethoprop
7600	Fensulfothion
7605	Fenthion
6265	Fluoranthene
6270	Fluorene
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
6285	Hexachlorocyclopentadiene
4840	Hexachloroethane
6315	Indeno[1,2,3-cd]pyrene
6320	Isophorone
7770	Malathion
7785	Merphos
7825	Methyl parathion (Parathion, methyl)
7850	Mevinphos
7880	Monocrotophos
7905	Naled

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5005	Naphthalene
5015	Nitrobenzene
6530	n-Nitrosodimethylamine
6545	n-Nitroso-di-n-propylamine
6535	n-Nitrosodiphenylamine
7950	Parathion
6605	Pentachlorophenol
6615	Phenanthrene
6625	Phenol
7985	Phorate
6665	Pyrene
8110	Ronnel
6685	Safrole
8155	Sulfotepp
8200	Tetrachlorvinphos (Stirophos, Gardona)
8245	Tokuthion (Prothiophos)
8275	Trichloronate

EPA 9010C 10243002 Total and Amenable Cyanide by Distillation and UV-Vis

Analyte Code	***Analyte***
1510	Amenable cyanide
1645	Total cyanide

EPA 9014 10193803 Titrimetric and Manual Spectrophotometric Determinativ

Analyte Code	***Analyte***
1635	Cyanide

EPA 9036 10196404 Sulfate (Colorimetric, Automated, Methylthymol Blue, AA

Analyte Code	***Analyte***
2000	Sulfate

EPA 9040C 10244403 pH Electrometric Measurement

Analyte Code	***Analyte***
1900	pH

EPA 9050A 1 10198808 Specific Conductance

Analyte Code	***Analyte***
1610	Conductivity

EPA 9056A 10199607 Determination of Inorganic Anions by Ion Chromatograph

Analyte Code	***Analyte***
1540	Bromide
1575	Chloride
1730	Fluoride
1810	Nitrate as N
1840	Nitrite as N
1870	Orthophosphate as P
2000	Sulfate

EPA 9060A 10244801 Total Organic Carbon

Analyte Code	***Analyte***
2040	Total Organic Carbon

EPA 9065 10200405 Phenolics (Spectrophotometric, Manual 4-AAP with Distill

Analyte Code	***Analyte***
1905	Total Phenolics

EPA 9214 10206403 Potentiometric Determination of Fluoride in Aqueous Sa

Analyte Code	***Analyte***
1730	Fluoride

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EPA RSK-175 (GC-FID) 697 Volatiles in Water by Headspace GC/FID

Analyte Code	Analyte
213	Ethane
214	Ethene
212	Methane

NWTPH-Dx 90018409 Oregon DEQ TPH Diesel Range

Analyte Code	Analyte
9369	Diesel range organics (DRO)

NWTPH-Gx 90018603 Oregon DEQ TPH Gasoline Range Organics by GC/FID-PI

Analyte Code	Analyte
9408	Gasoline range organics (GRO)

NWTPH-HCID 90013200 Oregon DEQ Total Petroleum Hydrocarbon ID

Analyte Code	Analyte
2050	Total Petroleum Hydrocarbons (TPH)

SM 2120 B-93 online 20039207 Color by Visual Comparison Method

Analyte Code	Analyte
1605	Color

SM 2130 B-94 online 20042802 Turbidity by Nephelometric Method

Analyte Code	Analyte
2055	Turbidity

SM 2310 B-97 online 20044604 Acidity by Titration Method

Analyte Code	Analyte
1500	Acidity, as CaCO3

SM 2320 B-97 online 20045607 Alkalinity by Titration Method

Analyte Code	Analyte
1505	Alkalinity as CaCO3

SM 2340 B-97 online 20046600 Hardness by calculation

Analyte Code	Analyte
1750	Hardness

SM 2510 B-97 online 20048606 Conductivity by Probe

Analyte Code	Analyte
1610	Conductivity

SM 2520 B 20th ED 760 Salinity by Electrical Conductivity

Analyte Code	Analyte
1975	Salinity

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SM 2540 B-97 online 20049405 Total Solids Dried at 103 - 105C

Analyte Code	Analyte
1950	Residue-total (TS)

SM 2540 C-97 online 20050402 Total Dissolved Solids Dried at 180C

Analyte Code	Analyte
1955	Residue-filterable (TDS)

SM 2540 D-97 online 20051201 Total Suspended Solids Dried at 103 - 105C

Analyte Code	Analyte
1960	Residue-nonfilterable (TSS)

SM 2540 E 20th ED 753 Total Volatile Solids

Analyte Code	Analyte
1725	Total, fixed, and volatile residue

SM 2540 F-97 online 20052204 Solids by Fixed and Volatile Solids Ignited at 550C

Analyte Code	Analyte
1965	Residue-settleable

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SM 3120 B-93 online 20061205 Plasma Emission by Inductively Coupled Plasma Method

Analyte Code	Analyte
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1025	Boron
1030	Cadmium
1035	Calcium
1040	Chromium
1050	Cobalt
1055	Copper
1070	Iron
1075	Lead
1085	Magnesium
1090	Manganese
1100	Molybdenum
1105	Nickel
1125	Potassium
1140	Selenium
1150	Silver
1155	Sodium
1160	Strontium
1165	Thallium
1175	Tin
1180	Titanium
1185	Vanadium
1190	Zinc

SM 3125 B-97 online 20061807 Metals by Inductively Coupled Plasma/Mass Spectrometry

Analyte Code	Analyte
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1030	Cadmium
1035	Calcium
1040	Chromium
1050	Cobalt
1055	Copper
1070	Iron
1075	Lead
1085	Magnesium
1090	Manganese
1100	Molybdenum
1105	Nickel
1125	Potassium
1140	Selenium
1150	Silver
1155	Sodium

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1165	Thallium
1170	Thorium
3035	Uranium
1185	Vanadium
1190	Zinc

SM 4110 B-97 online 20077003 Ion Chromatography by Ion Chromatography with Chemic

Analyte Code	Analyte
1540	Bromide
1575	Chloride
1730	Fluoride
1810	Nitrate as N
1840	Nitrite as N
1870	Orthophosphate as P
2000	Sulfate

SM 4500-CN⁻ G-97 online 20097205 Cyanide by Cyanides Amenable to Chlorination after Dist

Analyte Code	Analyte
1510	Amenable cyanide

SM 4500-F⁻ C-97 online 20102403 Fluoride by Ion-Selective Electrode Method

Analyte Code	Analyte
1730	Fluoride

SM 4500-H+ B-96 online 20105208 pH Value by Electrometric Method

Analyte Code	Analyte
1900	pH

SM 4500-O C-93 online 20120803 Oxygen by Azide Modification

Analyte Code	Analyte
1880	Oxygen, dissolved

SM 4500-P B-97 online 20123404 Phosphorus by Sample Preparation

Analyte Code	Analyte
1910	Phosphorus, total

SM 4500-S2⁻ D-97 online 20125808 Sulfide by Methylene Blue Method

Analyte Code	Analyte
2005	Sulfide

SM 5210 B-97 online 20135200 BOD by 5-Day BOD Test

Analyte Code	Analyte
1530	Biochemical oxygen demand

SM 5220 D-97 online 20136805 COD by Closed Reflux, Colorimetric Method

Analyte Code	Analyte
1565	Chemical oxygen demand

SM 5310 B-96 online 20137808 TOC by High-Temperature Combustion Method

Analyte Code	Analyte
2040	Total Organic Carbon

SM 5530 D 20th ED 758 Phenols Direct Photometric

Analyte Code	Analyte
106	Phenolics

SM 6630 B-93 online 20153406 Organochlorine Pesticides by Liquid-Liquid Extraction G

Analyte Code	Analyte
8580	2,4'-DDD
8585	2,4'-DDE
8590	2,4'-DDT
7025	Aldrin
7110	alpha-BHC (alpha-Hexachlorocyclohexane)

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7240	alpha-Chlordane
8880	Aroclor-1016 (PCB-1016)
7115	beta-BHC (beta-Hexachlorocyclohexane)
7250	Chlordane (tech.)
7925	cis-Nonachlor
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7535	Endrin ketone
7120	gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)
7245	gamma-Chlordane
7870	Mirex
3890	Oxychlordane
8250	Toxaphene (Chlorinated camphene)
7910	trans Nanochlor

WA EPH 101 Extractable Petroleum Hydrocarbons

Analyte Code	***Analyte***
222	EPH Aliphatic >C10-C12
223	EPH Aliphatic >C12-C16
224	EPH Aliphatic >C16-C21
225	EPH Aliphatic >C21-C34
221	EPH Aliphatic C8-C10
217	EPH Aromatic >C10-C12
218	EPH Aromatic >C12-C16
219	EPH Aromatic >C16-C21
220	EPH Aromatic >C21-C34
216	EPH Aromatic C8-C10

WA VPH 102 Volatile Petroleum Hydrocarbons (VPH) by GC/PID Purge

Analyte Code	***Analyte***
229	VPH Aliphatic >C10-C12
227	VPH Aliphatic >C6-C8
228	VPH Aliphatic >C8-C10
226	VPH Aliphatic C5-C6
231	VPH Aromatic >C10-C12
232	VPH Aromatic >C12-C13
230	VPH Aromatic >C8-C10

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MATRIX: Solids

Reference		Code	Description
EPA 1311		10118806	Toxicity Characteristic Leaching Procedure
Analyte Code	***Analyte***		
125	Extraction/Preparation		
EPA 1312		10119003	Synthetic Precipitation Leaching Procedure
Analyte Code	***Analyte***		
125	Extraction/Preparation		
EPA 150.1		10008409	pH - Electrometric Measurement
Analyte Code	***Analyte***		
1900	pH		
EPA 160.3		10010001	Total Solids, dried @ 103-105 C.
Analyte Code	***Analyte***		
1950	Residue-total (TS)		
EPA 160.4		10010409	Total Volatile Solids, ignition @ 550 C.
Analyte Code	***Analyte***		
1970	Residue-volatile		
EPA 1664A (HEM)		10127807	N-Hexane Extractable Material (Oil and Grease) by Extrac
Analyte Code	***Analyte***		
109	Hexane Extractable Material		
EPA 200.7 5		10014003	ICP - metals
Analyte Code	***Analyte***		
1000	Aluminum		
1005	Antimony		
1010	Arsenic		
1015	Barium		
1020	Beryllium		
1025	Boron		
1030	Cadmium		
1035	Calcium		
1040	Chromium		
1050	Cobalt		
1055	Copper		
1070	Iron		
1075	Lead		
1085	Magnesium		
1090	Manganese		
1100	Molybdenum		
1105	Nickel		
1125	Potassium		
1140	Selenium		
1145	Silicon		
1150	Silver		
1155	Sodium		
1160	Strontium		
1165	Thallium		
1175	Tin		
1180	Titanium		
1185	Vanadium		
1190	Zinc		

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EPA 200.9 3 10015608 Metals by Graphite Atomic Absorption

Analyte Code	Analyte
1005	Antimony
1010	Arsenic
1030	Cadmium
1075	Lead
1140	Selenium
1150	Silver
1165	Thallium

EPA 204.2 10017808 Antimony by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1005	Antimony

EPA 206.2 10018607 Arsenic by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1010	Arsenic

EPA 213.2 10024007 Cadmium by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1030	Cadmium

EPA 239.2 10034205 Lead by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1075	Lead

EPA 245.5 10037602 Mercury in Sediment by Cold Vapor Atomic Absorption

Analyte Code	Analyte
1095	Mercury

EPA 270.2 10045406 Selenium by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1140	Selenium

EPA 272.2 10046807 Silver by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1150	Silver

EPA 279.2 10048803 Thallium by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1165	Thallium

EPA 300.0 2.1 10053200 Methods for the Determination of Inorganic Substances in

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Analyte Code	Analyte
1540	Bromide
1575	Chloride
1730	Fluoride
1810	Nitrate as N
1840	Nitrite as N
1870	Orthophosphate as P
2000	Sulfate

EPA 3050B 2 10135601 Acid Digestion of Sediments, Sludges, and soils

Analyte Code	Analyte
125	Extraction/Preparation

EPA 325.2 10057202 Chloride - Colorimetric, automated Ferricyanide,II

Analyte Code	Analyte
1575	Chloride

EPA 335.4 10061402 Methods for the Determination of Inorganic Substances in

Analyte Code	Analyte
1635	Cyanide

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EPA 350.1 2 10063602 Ammonia Nitrogen - Colorimetric, Auto Phenate

Analyte Code	Analyte
1515	Ammonia as N

EPA 351.4 10066203 Kjeldahl Nitrogen - Ion Selective Electrode

Analyte Code	Analyte
1795	Kjeldahl nitrogen - total

EPA 353.2 2 10067604 Nitrate/Nitrite Nitrogen - Automated, Cadmium

Analyte Code	Analyte
1820	Nitrate+nitrite

EPA 3540C 3 10140202 Soxhlet Extraction

Analyte Code	Analyte
125	Extraction/Preparation

EPA 3550C 10142004 Ultrasonic Extraction

Analyte Code	Analyte
125	Extraction/Preparation

EPA 3580A 1 10143007 Waste Dilution

Analyte Code	Analyte
125	Extraction/Preparation

EPA 3640A 1 10147203 Gel Preparation Cleanup

Analyte Code	Analyte
125	Extraction/Preparation

EPA 365.2 10070403 Phosphorous - Colorimetric, single reagent

Analyte Code	Analyte
1870	Orthophosphate as P

EPA 3660B 2 10148400 Sulfur cleanup

Analyte Code	Analyte
125	Extraction/Preparation

EPA 3665A 1 10148808 Sulfuric Acid / permanganate Cleanup

Analyte Code	Analyte
125	Extraction/Preparation

EPA 376.1 10074201 Sulfide - Titrimetric, Iodine.

Analyte Code	Analyte
2005	Sulfide

EPA 376.2 10074609 Sulfide - Colorimetric, Methylene Blue.

Analyte Code	Analyte
2005	Sulfide

EPA 420.1 10079400 Phenolics - Spectrophotometric, manual.

Analyte Code	Analyte
1905	Total Phenolics

EPA 5000 10152600 Sample Preparation for Volatile Organics

Analyte Code	Analyte
125	Extraction/Preparation

EPA 5035 10154004 Closed-System Purge-and-Trap and Extraction for Volatil

Analyte Code	Analyte
125	Extraction/Preparation

EPA 6010C 10155803 ICP - AES

Analyte Code	Analyte
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium

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1020	Beryllium
1025	Boron
1030	Cadmium
1035	Calcium
1040	Chromium
1050	Cobalt
1055	Copper
1070	Iron
1075	Lead
1085	Magnesium
1090	Manganese
1100	Molybdenum
1105	Nickel
1125	Potassium
1140	Selenium
1145	Silicon
1150	Silver
1155	Sodium
1160	Strontium
1165	Thallium
1175	Tin
1180	Titanium
1185	Vanadium
1190	Zinc

EPA 7010 10157809 Metals by Graphite Furnace Atomic Absorption

Analyte Code	***Analyte***
1005	Antimony
1010	Arsenic
1030	Cadmium
1075	Lead
1140	Selenium
1150	Silver
1165	Thallium

EPA 7041 10158404 Antimony by Graphite Furnace Atomic Absorption

Analyte Code	***Analyte***
1005	Antimony

EPA 7060A 10158802 Arsenic by Graphite Furnace Atomic Absorption

Analyte Code	***Analyte***
1010	Arsenic

EPA 7131A 1 10161203 Cadmium by Graphite Furnace Atomic Absorption

Analyte Code	***Analyte***
1030	Cadmium

EPA 7196A 1 10162400 Chromium Hexavalent colorimetric

Analyte Code	***Analyte***
1045	Chromium VI

EPA 7421 10164600 Lead by Graphite Furnace Atomic Absorption

Analyte Code	***Analyte***
1075	Lead

EPA 7471B 10166402 Mercury by Cold Vapor Atomic Absorption

Analyte Code	***Analyte***
1095	Mercury

ACCREDITING AUTHORITY nelap NELAP-Recognized

ORELAP Fields of Accreditation

ORELAPID: WA100006
EPACode: WA00037

Analytical Resources Inc.

4611 S. 134th Place
Tukwila, WA, 98168

Certificate:
WA100006-004

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EPA 7740 10168602 Selenium by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1140	Selenium

EPA 7761 10169809 Silver by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1150	Silver

EPA 7841 10170602 Thallium by Graphite Furnace Atomic Absorption

Analyte Code	Analyte
1165	Thallium

EPA 8021B 2 10174808 Aromatic and Halogenated Volatiles by GC with PID and/

Analyte Code	Analyte
4375	Benzene
4765	Ethylbenzene
5240	m+p-xylene
5000	Methyl tert-butyl ether (MTBE)
5250	o-Xylene
5140	Toluene

EPA 8080A 10305803 Organochlorine Pesticides and Polychlorinated Biphenyls

Analyte Code	Analyte
8580	2,4'-DDD
8585	2,4'-DDE
8590	2,4'-DDT
7355	4,4'-DDD
7360	4,4'-DDE
7365	4,4'-DDT
7025	Aldrin
7110	alpha-BHC (alpha-Hexachlorocyclohexane)
7240	alpha-Chlordane
7115	beta-BHC (beta-Hexachlorocyclohexane)
7250	Chlordane (tech.)
7925	cis-Nonachlor
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7535	Endrin ketone
7120	gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)
7685	Heptachlor
7690	Heptachlor epoxide
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
7810	Methoxychlor
7870	Mirex
3890	Oxychlordane
8250	Toxaphene (Chlorinated camphene)
7910	trans Nanochlor

EPA 8081B 10178800 Organochlorine Pesticides by GC/ECD

Analyte Code	Analyte

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8580	2,4'-DDD
8585	2,4'-DDE
8590	2,4'-DDT
7355	4,4'-DDD
7360	4,4'-DDE
7365	4,4'-DDT
7025	Aldrin
7110	alpha-BHC (alpha-Hexachlorocyclohexane)
7240	alpha-Chlordane
7115	beta-BHC (beta-Hexachlorocyclohexane)
7250	Chlordane (tech.)
7925	cis-Nonachlor
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7535	Endrin ketone
7120	gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)
7685	Heptachlor
7690	Heptachlor epoxide
6275	Hexachlorobenzene
7810	Methoxychlor
7870	Mirex
3890	Oxychlordane
8250	Toxaphene (Chlorinated camphene)
7910	trans Nanochlor

EPA 8082A 10179201 Polychlorinated Biphenyls (PCBs) by GC/ECD

Analyte Code	Analyte
8880	Aroclor-1016 (PCB-1016)
8885	Aroclor-1221 (PCB-1221)
8890	Aroclor-1232 (PCB-1232)
8895	Aroclor-1242 (PCB-1242)
8900	Aroclor-1248 (PCB-1248)
8905	Aroclor-1254 (PCB-1254)
8910	Aroclor-1260 (PCB-1260)
184	Aroclor-1262 (PCB 1262)
103	Aroclor-1268 (PCB-1268)

EPA 8151A 10183207 Chlorinated Herbicides by GC/ECD

Analyte Code	Analyte
8655	2,4,5-T
8545	2,4-D
8560	2,4-DB
8555	Dalapon
8595	Dicamba
8605	Dichloroprop (Dichlorprop)
8620	Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)
7775	MCPA
7780	MCPP

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8650	Silvex (2,4,5-TP)

EPA 8260C 10307003 Volatile Organics: GC/MS (capillary column)

Analyte Code	Analyte
5105	1,1,1,2-Tetrachloroethane
5160	1,1,1-Trichloroethane
5110	1,1,2,2-Tetrachloroethane
5195	1,1,2-Trichloro-1,2,2-trifluoroethane
5165	1,1,2-Trichloroethane
4630	1,1-Dichloroethane
4640	1,1-Dichloroethylene
4670	1,1-Dichloropropene
5180	1,2,3-Trichloropropane
5155	1,2,4-Trichlorobenzene
5210	1,2,4-Trimethylbenzene
4570	1,2-Dibromo-3-chloropropane (DBCP)
4585	1,2-Dibromoethane (EDB, Ethylene dibromide)
4610	1,2-Dichlorobenzene
4635	1,2-Dichloroethane
4655	1,2-Dichloropropane
5215	1,3,5-Trimethylbenzene
4615	1,3-Dichlorobenzene
4660	1,3-Dichloropropane
4620	1,4-Dichlorobenzene
4665	2,2-Dichloropropane
4410	2-Butanone (Methyl ethyl ketone, MEK)
4500	2-Chloroethyl vinyl ether
4535	2-Chlorotoluene
4860	2-Hexanone
4540	4-Chlorotoluene
4315	Acetone
4325	Acrolein (Propenal)
4375	Benzene
4385	Bromobenzene
4390	Bromochloromethane
4395	Bromodichloromethane
255	Bromoethane (Ethyl Bromide)
4400	Bromoform
4950	Bromomethane (Methyl bromide)
4450	Carbon disulfide
4455	Carbon tetrachloride
4475	Chlorobenzene
4485	Chloroethane
4505	Chloroform
4960	Chloromethane (Methyl chloride)
4645	cis-1,2-Dichloroethylene
4575	Dibromochloromethane
4595	Dibromomethane
4625	Dichlorodifluoromethane
4650	Dichloromethane (DCM, Methylene chloride)
4765	Ethylbenzene
4870	Iodomethane (Methyl iodide)

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4900	Isopropylbenzene
5240	m+p-xylene
5000	Methyl tert-butyl ether (MTBE)
5005	Naphthalene
4435	n-Butylbenzene
5090	n-Propylbenzene
5250	o-Xylene
4910	p-Isopropyltoluene
4440	sec-Butylbenzene
5100	Styrene
4445	tert-Butylbenzene
5115	Tetrachloroethylene (Perchloroethylene)
4700	trans-1,2-Dicloroethylene
4685	trans-1,3-Dichloropropylene
4605	trans-1,4-Dichloro-2-butene
5170	Trichloroethene (Trichloroethylene)
5175	Trichlorofluoromethane
5225	Vinyl acetate
5235	Vinyl chloride

EPA 8270D 10186002 Semivolatile Organic compounds by GC/MS

Analyte Code	***Analyte***
6715	1,2,4,5-Tetrachlorobenzene
5155	1,2,4-Trichlorobenzene
4610	1,2-Dichlorobenzene
4615	1,3-Dichlorobenzene
4620	1,4-Dichlorobenzene
6380	1-Methylnaphthalene
183	2,2'-Oxybis(1-chloropropane)
6730	2,3,4,5-Tetrachlorophenol
6835	2,4,5-Trichlorophenol
6840	2,4,6-Trichlorophenol
6000	2,4-Dichlorophenol
6130	2,4-Dimethylphenol
5795	2-Chloronaphthalene
5800	2-Chlorophenol
6385	2-Methylnaphthalene
6400	2-Methylphenol (o-Cresol)
6460	2-Nitroaniline
6490	2-Nitrophenol
5945	3,3'-Dichlorobenzidine
146	3-Chlorophenol
6825	4,5,6-Trichloroguaiacol
6140	4,6-Dinitro-2-methylphenol
5660	4-Bromophenyl phenyl ether
5700	4-Chloro-3-methylphenol
5745	4-Chloroaniline
5825	4-Chlorophenyl phenylether
5870	4-Isopropyltoluene
6410	4-Methylphenol (p-Cresol)
6470	4-Nitroaniline
6500	4-Nitrophenol

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5500	Acenaphthene
5505	Acenaphthylene
7005	Alachlor
5545	Aniline
5555	Anthracene
7075	Azinphos-methyl (Guthion)
123	Azobenzene
5595	Benzidine
5575	Benzo[a]anthracene
5580	Benzo[a]pyrene
5585	Benzo[b]fluoranthene
5605	Benzo[e]pyrene
5590	Benzo[g,h,i]perylene
5600	Benzo[k]fluoranthene
5610	Benzoic acid
5630	Benzyl alcohol
5760	bis(2-Chloroethoxy)methane
5765	bis(2-Chloroethyl)ether
6255	bis(2-Ethylhexyl)phthalate (DEHP)
7125	Bolstar (Sulprofos)
5670	Butyl benzyl phthalate
257	Butylated Hydroxy Toluene (BHT)
259	Butyldiphenyl Phosphate
5680	Carbazole
7255	Chlorfenvinphos
7300	Chlorpyrifos
5855	Chrysene
7315	Coumaphos
7330	Crotoxyphos
7385	Demeton-s
7410	Diazinon
5895	Dibenz[a,h]anthracene
5905	Dibenzofuran
260	Dibutylphenyl Phospahate
7465	Dicrotophos
6070	Diethyl phthalate
7475	Dimethoate
6135	Dimethyl phthalate
5925	Di-n-butyl phthalate
6200	Di-n-octyl phthalate
8625	Disulfoton
7550	EPN
7565	Ethion
7570	Ethoprop
7600	Fensulfothion
7605	Fenthion
6265	Fluoranthene
6270	Fluorene
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
6285	Hexachlorocyclopentadiene

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4840	Hexachloroethane
6315	Indeno[1,2,3-cd]pyrene
6320	Isophorone
7735	Kelthane (Diclofol)
7770	Malathion
7825	Methyl parathion (Parathion, methyl)
7850	Mevinphos
7880	Monocrotophos
7905	Naled
5005	Naphthalene
6300	n-Hexadecane
5015	Nitrobenzene
6530	n-Nitrosodimethylamine
6545	n-Nitroso-di-n-propylamine
6535	n-Nitrosodiphenylamine
7950	Parathion
6605	Pentachlorophenol
6615	Phenanthrene
6625	Phenol
7985	Phorate
6665	Pyrene
8110	Ronnel
8155	Sulfotepp
8200	Tetrachlorvinphos (Stirophos, Gardona)
8245	Tokuthion (Prothiophos)
261	Tributyl Phosphate
8275	Trichloronate

EPA 9010C 10243002 Total and Amenable Cyanide by Distillation and UV-Vis

Analyte Code	Analyte
1510	Amenable cyanide
1645	Total cyanide

EPA 9014 10193803 Titrimetric and Manual Spectrophotometric Determinativ

Analyte Code	Analyte
1635	Cyanide

EPA 9030B 2 10195605 Acid-Soluble and Acid-Insoluble sulfides: Distillation

Analyte Code	Analyte
2005	Sulfide

EPA 9045D 10244607 Soil and Waste pH

Analyte Code	Analyte
1900	pH

EPA 9056A 10199607 Determination of Inorganic Anions by Ion Chromatograph

Analyte Code	Analyte
1540	Bromide
1575	Chloride
1730	Fluoride
1810	Nitrate as N
1840	Nitrite as N
1870	Orthophosphate as P
2000	Sulfate

EPA 9065 10200405 Phenolics (Spectrophotometric, Manual 4-AAP with Distill

Analyte Code	Analyte

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1905	Total Phenolics		
EPA 9071B 2		10201602	Oil and Grease Extraction Method for sludge and sedime
Analyte Code	***Analyte***		
1860	Oil & Grease		
EPA 9080		10203200	Cation-Exchange Capacity of Soils (Ammonium Acetate)
Analyte Code	***Analyte***		
1560	Cation exchange capacity		
EPA 9081		10203404	Cation-Exchange Capacity of Soils (Sodium Acetate)
Analyte Code	***Analyte***		
1560	Cation exchange capacity		
EPA 9214		10206403	Potentiometric Determination of Fluoride in Aqueous Sa
Analyte Code	***Analyte***		
1730	Fluoride		
EPA 9251		10207406	Chloride (Colorimetric, Automated Ferricyanide AAII)
Analyte Code	***Analyte***		
1575	Chloride		
NWTPH-HCID		90013200	Oregon DEQ Total Petroleum Hydrocarbon ID
Analyte Code	***Analyte***		
2050	Total Petroleum Hydrocarbons (TPH)		
SM 2540 B-97 online		20049405	Total Solids Dried at 103 - 105C
Analyte Code	***Analyte***		
1950	Residue-total (TS)		
SM 4110 B-97 online		20077003	Ion Chromatography by Ion Chromatography with Chemic
Analyte Code	***Analyte***		
1540	Bromide		
1575	Chloride		
1730	Fluoride		
1810	Nitrate as N		
1840	Nitrite as N		
1870	Orthophosphate as P		
2000	Sulfate		
SM 4500-F⁻ C-97 online		20102403	Fluoride by Ion-Selective Electrode Method
Analyte Code	***Analyte***		
1730	Fluoride		
SM 4500-NH3 D-97 online		20109404	Ammonia by Ammonia-Selective Electrode Method .
Analyte Code	***Analyte***		
1515	Ammonia as N		
SM 4500-S2⁻ D-97 online		20125808	Sulfide by Methylene Blue Method
Analyte Code	***Analyte***		
2005	Sulfide		
WA EPH		101	Extractable Petroleum Hydrocarbons
Analyte Code	***Analyte***		
222	EPH Aliphatic >C10-C12		
223	EPH Aliphatic >C12-C16		
224	EPH Aliphatic >C16-C21		
225	EPH Aliphatic >C21-C34		
221	EPH Aliphatic C8-C10		
217	EPH Aromatic >C10-C12		
218	EPH Aromatic >C12-C16		
219	EPH Aromatic >C16-C21		
220	EPH Aromatic >C21-C34		

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216	EPH Aromatic C8-C10		
WA VPH		102	Volatile Petroleum Hydrocarbons (VPH) by GC/PID Purge
Analyte Code	***Analyte***		
229	VPH Aliphatic >C10-C12		
227	VPH Aliphatic >C6-C8		
228	VPH Aliphatic >C8-C10		
226	VPH Aliphatic C5-C6		
231	VPH Aromatic >C10-C12		
232	VPH Aromatic >C12-C13		
230	VPH Aromatic >C8-C10		

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MATRIX: Biological Tissue

Reference	Code	Description
EPA 200.7 5	10014003	ICP - metals

Analyte Code	Analyte
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1025	Boron
1030	Cadmium
1035	Calcium
1040	Chromium
1050	Cobalt
1055	Copper
1070	Iron
1075	Lead
1085	Magnesium
1090	Manganese
1100	Molybdenum
1105	Nickel
1125	Potassium
1140	Selenium
1145	Silicon
1150	Silver
1155	Sodium
1160	Strontium
1165	Thallium
1175	Tin
1180	Titanium
1185	Vanadium
1190	Zinc

EPA 245.5	10037602	Mercury in Sediment by Cold Vapor Atomic Absorption

Analyte Code	Analyte
1095	Mercury

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EPA 3540C 3	10140202	Soxhlet Extraction

Analyte Code	Analyte
125	Extraction/Preparation

EPA 3550C	10142004	Ultrasonic Extraction

Analyte Code	Analyte
125	Extraction/Preparation

EPA 3580A 1	10143007	Waste Dilution

Analyte Code	Analyte
125	Extraction/Preparation

EPA 3640A 1	10147203	Gel Preparation Cleanup

Analyte Code	Analyte
125	Extraction/Preparation

EPA 3660B 2	10148400	Sulfur cleanup

Analyte Code	Analyte
125	Extraction/Preparation

ORELAP Fields of Accreditation

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EPA 5000 10152600 Sample Preparation for Volatile Organics

Analyte Code	Analyte
125	Extraction/Preparation

EPA 5035 10154004 Closed-System Purge-and-Trap and Extraction for Volatil

Analyte Code	Analyte
125	Extraction/Preparation

EPA 6010B 2 10155609 ICP - AES

Analyte Code	Analyte
1000	Aluminum
1005	Antimony
1010	Arsenic
1015	Barium
1020	Beryllium
1025	Boron
1030	Cadmium
1035	Calcium
1040	Chromium
1050	Cobalt
1055	Copper
1070	Iron
1075	Lead
1085	Magnesium
1090	Manganese
1100	Molybdenum
1105	Nickel
1125	Potassium
1140	Selenium
1145	Silicon
1150	Silver
1155	Sodium
1160	Strontium
1165	Thallium
1175	Tin
1180	Titanium
1185	Vanadium
1190	Zinc

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EPA 7471B 10166402 Mercury by Cold Vapor Atomic Absorption

Analyte Code	Analyte
1095	Mercury

EPA 8080A 10305803 Organochlorine Pesticides and Polychlorinated Biphenyls

Analyte Code	Analyte
8580	2,4'-DDD
8585	2,4'-DDE
8590	2,4'-DDT
7355	4,4'-DDD
7360	4,4'-DDE
7365	4,4'-DDT
7025	Aldrin
7110	alpha-BHC (alpha-Hexachlorocyclohexane)
7240	alpha-Chlordane
7115	beta-BHC (beta-Hexachlorocyclohexane)

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7250	Chlordane (tech.)
7925	cis-Nonachlor
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7535	Endrin ketone
7120	gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)
7685	Heptachlor
7690	Heptachlor epoxide
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
7810	Methoxychlor
7870	Mirex
3890	Oxychlordane
8250	Toxaphene (Chlorinated camphene)
7910	trans Nanochlor

EPA 8081B 10178800 Organochlorine Pesticides by GC/ECD

Analyte Code	***Analyte***
8580	2,4'-DDD
8585	2,4'-DDE
8590	2,4'-DDT
7355	4,4'-DDD
7360	4,4'-DDE
7365	4,4'-DDT
7025	Aldrin
7110	alpha-BHC (alpha-Hexachlorocyclohexane)
7240	alpha-Chlordane
7115	beta-BHC (beta-Hexachlorocyclohexane)
7250	Chlordane (tech.)
7925	cis-Nonachlor
7105	delta-BHC
7470	Dieldrin
7510	Endosulfan I
7515	Endosulfan II
7520	Endosulfan sulfate
7540	Endrin
7530	Endrin aldehyde
7535	Endrin ketone
7120	gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)
7685	Heptachlor
7690	Heptachlor epoxide
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
7810	Methoxychlor
7870	Mirex
3890	Oxychlordane
8250	Toxaphene (Chlorinated camphene)

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7910	trans Nanochlor

EPA 8082A 10179201 Polychlorinated Biphenyls (PCBs) by GC/ECD

Analyte Code	Analyte
8880	Aroclor-1016 (PCB-1016)
8885	Aroclor-1221 (PCB-1221)
8890	Aroclor-1232 (PCB-1232)
8895	Aroclor-1242 (PCB-1242)
8900	Aroclor-1248 (PCB-1248)
8905	Aroclor-1254 (PCB-1254)
8910	Aroclor-1260 (PCB-1260)
184	Aroclor-1262 (PCB 1262)
103	Aroclor-1268 (PCB-1268)

EPA 8260C 10307003 Volatile Organics: GC/MS (capillary column)

Analyte Code	Analyte
5105	1,1,1,2-Tetrachloroethane
5160	1,1,1-Trichloroethane
5110	1,1,2,2-Tetrachloroethane
5195	1,1,2-Trichloro-1,2,2-trifluoroethane
5165	1,1,2-Trichloroethane
4630	1,1-Dichloroethane
4640	1,1-Dichloroethylene
4670	1,1-Dichloropropene
5180	1,2,3-Trichloropropane
5155	1,2,4-Trichlorobenzene
5210	1,2,4-Trimethylbenzene
4570	1,2-Dibromo-3-chloropropane (DBCP)
4585	1,2-Dibromoethane (EDB, Ethylene dibromide)
4610	1,2-Dichlorobenzene
4635	1,2-Dichloroethane
4655	1,2-Dichloropropane
5215	1,3,5-Trimethylbenzene
4615	1,3-Dichlorobenzene
4660	1,3-Dichloropropane
4620	1,4-Dichlorobenzene
4665	2,2-Dichloropropane
4410	2-Butanone (Methyl ethyl ketone, MEK)
4535	2-Chlorotoluene
4860	2-Hexanone
4540	4-Chlorotoluene
4315	Acetone
4325	Acrolein (Propenal)
4375	Benzene
4385	Bromobenzene
4390	Bromochloromethane
4395	Bromodichloromethane
255	Bromoethane (Ethyl Bromide)
4400	Bromoform
4950	Bromomethane (Methyl bromide)
4450	Carbon disulfide
4455	Carbon tetrachloride
4475	Chlorobenzene

ACCREDITING AUTHORITY
elap
NELAP-Recognized

Analytical Resources Inc.

4611 S. 134th Place
Tukwila, WA, 98168

Certificate:
WA100006-004

Issue Date: 5/12/2009 ***Expiration Date:*** 5/11/2010
As of 05/12/2009 this list supercedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with ORELAP.

4485	Chloroethane
4505	Chloroform
4960	Chloromethane (Methyl chloride)
4645	cis-1,2-Dichloroethylene
4575	Dibromochloromethane
4595	Dibromomethane
4625	Dichlorodifluoromethane
4650	Dichloromethane (DCM, Methylene chloride)
4765	Ethylbenzene
4870	Iodomethane (Methyl iodide)
4900	Isopropylbenzene
5240	m+p-xylene
5000	Methyl tert-butyl ether (MTBE)
5005	Naphthalene
4435	n-Butylbenzene
5090	n-Propylbenzene
5250	o-Xylene
4910	p-Isopropyltoluene
4440	sec-Butylbenzene
5100	Styrene
4445	tert-Butylbenzene
5115	Tetrachloroethylene (Perchloroethylene)
4700	trans-1,2-Dicloroethylene
4685	trans-1,3-Dichloropropylene
4605	trans-1,4-Dichloro-2-butene
5170	Trichloroethene (Trichloroethylene)
5175	Trichlorofluoromethane
5225	Vinyl acetate
5235	Vinyl chloride

EPA 8270D 10186002 Semivolatile Organic compounds by GC/MS

Analyte Code	***Analyte***
6715	1,2,4,5-Tetrachlorobenzene
5155	1,2,4-Trichlorobenzene
4610	1,2-Dichlorobenzene
4615	1,3-Dichlorobenzene
4620	1,4-Dichlorobenzene
6380	1-Methylnaphthalene
183	2,2'-Oxybis(1-chloropropane)
6835	2,4,5-Trichlorophenol
6840	2,4,6-Trichlorophenol
6000	2,4-Dichlorophenol
6130	2,4-Dimethylphenol
5795	2-Chloronaphthalene
5800	2-Chlorophenol
6385	2-Methylnaphthalene
6400	2-Methylphenol (o-Cresol)
6460	2-Nitroaniline
6490	2-Nitrophenol
5945	3,3'-Dichlorobenzidine
6140	4,6-Dinitro-2-methylphenol
5660	4-Bromophenyl phenyl ether

ACCREDITING AUTHORITY nelap
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Analytical Resources Inc.

4611 S. 134th Place
Tukwila, WA, 98168

Certificate:
WA100006-004

Issue Date: 5/12/2009 ***Expiration Date:*** 5/11/2010
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Customers: Please verify the current accreditation standing with ORELAP.

5700	4-Chloro-3-methylphenol
5745	4-Chloroaniline
5825	4-Chlorophenyl phenylether
6410	4-Methylphenol (p-Cresol)
6470	4-Nitroaniline
6500	4-Nitrophenol
5500	Acenaphthene
5505	Acenaphthylene
7005	Alachlor
5545	Aniline
5555	Anthracene
7075	Azinphos-methyl (Guthion)
123	Azobenzene
5595	Benzidine
5575	Benzo[a]anthracene
5580	Benzo[a]pyrene
5585	Benzo[b]fluoranthene
5590	Benzo[g,h,i]perylene
5600	Benzo[k]fluoranthene
5610	Benzoic acid
5630	Benzyl alcohol
5640	Biphenyl
5760	bis(2-Chloroethoxy)methane
5765	bis(2-Chloroethyl)ether
6255	bis(2-Ethylhexyl)phthalate (DEHP)
7125	Bolstar (Sulprofos)
5670	Butyl benzyl phthalate
259	Butyldiphenyl Phosphate
5680	Carbazole
7255	Chlorfenvinphos
7300	Chlorpyrifos
5855	Chrysene
7315	Coumaphos
7330	Crotoxyphos
7385	Demeton-s
7410	Diazinon
5895	Dibenz[a,h]anthracene
5905	Dibenzofuran
7465	Dicrotophos
6070	Diethyl phthalate
7475	Dimethoate
6135	Dimethyl phthalate
5925	Di-n-butyl phthalate
6200	Di-n-octyl phthalate
8625	Disulfoton
7550	EPN
7565	Ethion
7570	Ethoprop
7600	Fensulfothion
7605	Fenthion
6265	Fluoranthene

NELAP-Recognized

ORELAPID: WA100006
EPACode: WA00037

Analytical Resources Inc.

4611 S. 134th Place
Tukwila, WA, 98168

Certificate:
WA100006-004

Issue Date: 5/12/2009 ***Expiration Date:*** 5/11/2010
As of 05/12/2009 this list supercedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with ORELAP.

6270	Fluorene
6275	Hexachlorobenzene
4835	Hexachlorobutadiene
6285	Hexachlorocyclopentadiene
4840	Hexachloroethane
6315	Indeno[1,2,3-cd]pyrene
6320	Isophorone
7770	Malathion
7825	Methyl parathion (Parathion, methyl)
7850	Mevinphos
7880	Monocrotophos
7905	Naled
5005	Naphthalene
5015	Nitrobenzene
6530	n-Nitrosodimethylamine
6545	n-Nitroso-di-n-propylamine
6535	n-Nitrosodiphenylamine
7950	Parathion
6605	Pentachlorophenol
6615	Phenanthrene
6625	Phenol
7985	Phorate
6665	Pyrene
8110	Ronnel
8155	Sulfotepp
8200	Tetrachlorvinphos (Stirophos, Gardona)
8245	Tokuthion (Prothiophos)
8275	Trichloronate

NELAP-Recognized

The State of Washington Department of Ecology

This is to certify that

Northwestern Aquatic Sciences
Newport, OR

has complied with provisions set forth in Chapter 173-50 WAC and is hereby recognized by the Department of Ecology as an ACCREDITED LABORATORY for the analytical parameters listed on the accompanying Scope of Accreditation. This certificate is effective October 1, 2009, and shall expire September 30, 2010.

Witnessed under my hand on September 23, 2009.

for Stewart M. Lombard
Lab Accreditation Unit Supervisor

Laboratory ID
C1238

Scope of Accreditation

Northwestern Aquatic Sciences

Newport, OR

is accredited by the State of Washington Department of Ecology to perform analyses for the parameters listed below using the analytical methods indicated. This Scope of Accreditation may apply to any of the following matrix types: non-potable water, drinking water, solid and chemical materials, and air and emissions. Accreditation for all parameters is final unless indicated otherwise in a note. Accreditation is for the latest version of a method unless otherwise specified in a note. EPA refers to the U.S. Environmental Protection Agency. SM refers to American Public Health Association's publication, Standard Methods for the Examination of Water and Wastewater, 18th, 19th or 20th Edition, unless otherwise noted. ASTM stands for the American Society for Testing and Materials. PSEP stands for Puget Sound Estuary Program. Other references are detailed in the notes section.

Matrix Type/Parameter Name	Reference	Method Number	Notes
Non-potable Water			
Ampelisca abdita	ASTM	E 1367	
Ampelisca abdita	EPA	100.4	4
Ampelisca abdita	PSEP	1995	
Atherinops affinis (West Coast)	EPA	1006.0	6,8
Bioaccumulation, Bedded Sediments	EPA	600/R-93/183	7
Bioaccumulation, Benthic Invert	ASTM	E 1688	
Bioconcentration, Fish, Mollusks	ASTM	E 1022	
Ceriodaphnia dubia	EPA	1002.0	2,8
Ceriodaphnia dubia	EPA	2002.0	1,8
Chironomus tentans	EPA	100.5	5
Chironomus tentans	ASTM	E 1706	
Chironomus tentans	EPA	100.2	5
Corbicula fluminea	ASTM	E 1688	
Crassostrea gigas	PSEP	1995	
Crassostrea gigas (West Coast)	EPA	1005.0	6,8
Cyprinodon variegatus	EPA	2004.0	1,8
Cyprinodon variegatus	EPA	1004.0	3,8
Dangerous Waste Static Salmonid	WDOE	80-12 Part A	
Daphnia magna	EPA	2021.0	1,8

Matrix Type/Parameter Name	Reference	Method Number	Notes
Daphnia pulex	EPA	2021.0	1,8
Dendraster excentricus	ASTM	E 1563	
Dendraster excentricus	PSEP	1995	
Dendraster excentricus (WC)	EPA	600/R-95/136	6,8
Dendraster excentricus (West Coast)	EPA	1008.0	6,8
Eohaustorius estuarius	ASTM	E 1367	
Eohaustorius estuarius	PSEP	1995	
Eohaustorius estuarius	EPA	100.4	4
Hyalella azteca	EPA	100.4	5
Hyalella azteca	EPA	100.1	5
Hyalella azteca	ASTM	E 1706	
Leptocheirus plumulosus	ASTM	E 1367	
Leptocheirus plumulosus	EPA	100.4	4
Lumbriculus variegatus	EPA	100.3	5
Lumbriculus variegatus	ASTM	E 1688	
Macoma spp.	ASTM	E 1688	
Menidia beryllina	EPA	1006.0	3,8
Menidia spp.	EPA	2006.0	1,8
Mysidopsis bahia	EPA	1007.0	3,8
Mysidopsis bahia	EPA	2007.0	1,8
Mytilus spp.	PSEP	1995	
Mytilus spp. (West Coast)	EPA	1005.0	6,8
Neanthes arenaceodentata	PSEP	1995	
Nereis/Neanthes spp.	ASTM	E 1688	
Oncorhynchus mykiss	EPA	2019.0	1,8
Pimephales promelas	EPA	2000.0	1,8
Pimephales promelas, Chronic	EPA	1000.0	2,8
Rhepoxynius abronius	EPA	100.4	4
Rhepoxynius abronius	PSEP	1995	
Rhepoxynius abronius	ASTM	E 1367	

Matrix Type/Parameter Name	Reference	Method Number	Notes
Salvelinus fontinalis	EPA	2019.0	1,8
Strongylocentrotus purpuratus	ASTM	E 1563	
Strongylocentrotus purpuratus (WC)	EPA	1008.0	6,8
Strongylocentrotus purpuratus (WC)	EPA	600/R-95/136	6,8
Strongylocentrotus spp.	PSEP	1995	

Accredited Parameter Note Detail

(1) USEPA. "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms." EPA-821-R-02-012. Fifth Edition. Oct 2002. (2) USEPA. "Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms." EPA-821-R-02-013. Fourth Edition. Oct 2002. (3) USEPA. "Short-term Methods for Measuring the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms." EPA-821-R-02-014. Fourth Edition. Oct 2002. (4) USEPA. "Methods for Assessing the Toxicity of Sediment-associated Contaminants with Estuarine and Marine Amphipods." EPA 600/R/R-94/025. June 1994. (5) USEPA. "Methods for Measuriing the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates." EPA 600/R-99/064. Second Edition. March 2000. (6) USEPA. "Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms," EPA 600/R-95/136. Third Edition. Aug 1995. (7) USEPA. "Bedded Sediment Bioaccumulation Tests." EPA/600/R-93/183. Sept 1993. (8) Meets requirements of "Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria," Washington Dept. of Ecology, Pub. No. WQ-R-80, Rev. Dec 2008.

Authentication Signature

9/24/09
Date

for Stewart M. Lombard, Lab Accreditation Unit Supervisor

The State of Washington
Department of Ecology

This is to certify that

Specialty Analytical
Clackamas, OR

has complied with provisions set forth in Chapter 173-50 WAC and is hereby recognized by the Department of Ecology as an ACCREDITED LABORATORY for the analytical parameters listed on the accompanying Scope of Accreditation. This certificate is effective October 5, 2009, and shall expire October 4, 2010.

Witnessed under my hand on October 26, 2009.

Stewart M. Lombard
Lab Accreditation Unit Supervisor

Laboratory ID
C1783

WASHINGTON STATE DEPARTMENT OF ECOLOGY

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM

SCOPE OF ACCREDITATION

Specialty Analytical

Clackamas, OR

is accredited for the analytes listed below using the methods indicated. Full accreditation is granted unless stated otherwise in a note. Accreditation for U.S. Environmental Protection Agency (EPA) "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" (SW-846) is for the latest version of the method. SM refers to "Standard Methods for the Examination of Water and Wastewater," 18th through 21st Editions and the Online Edition, unless otherwise indicated. ASTM is the American Society for Testing and Materials. Other references are described in notes.

Matrix/Analyte	Method	Notes
Non-Potable Water		
Alkalinity as CaCO3	SM 2320 B	
Ammonia as N	EPA 350.1	
Ammonia as N	SM 18 4500-NH3 H	
Biochemical oxygen demand	SM 5210 B	
Chemical oxygen demand	EPA 410.4	
Chloride	EPA 300.0	
Chloride	SM 4500-Cl- B	1
Conductivity	EPA 120.1	
Fluoride	EPA 300.0	
Hardness (calc.)	SM 2340 B	
Kjeldahl nitrogen - total	EPA 351.2	
Nitrate	EPA 353.2	
Nitrate-nitrite	EPA 353.2	
Oil & Grease	EPA 1664	
Orthophosphate as P	EPA 365.1	
Residue-filterable (TDS)	SM 2540 C	
Residue-nonfilterable (TSS)	SM 2540 D	
Residue-total	SM 2540 B	
Residue-volatile	EPA 160.4	
Sulfate	EPA 300.0	
Sulfide	SM 4500-S2 F	
Tannin & Lignin	SM 5550	
Total cyanide	EPA 335.4	

Matrix/Analyte	Method	Notes
Total organic carbon	SM 5310 B	
Total phenolics	EPA 420.1	
Turbidity	EPA 180.1	
Aluminum	EPA 200.7	
Aluminum	EPA 200.8	
Antimony	EPA 200.7	
Antimony	EPA 200.8	
Arsenic	EPA 200.7	
Arsenic	EPA 200.8	
Barium	EPA 200.7	
Barium	EPA 200.8	
Beryllium	EPA 200.7	
Beryllium	EPA 200.8	
Cadmium	EPA 200.7	
Cadmium	EPA 200.8	
Calcium	EPA 200.7	
Chromium	EPA 200.7	
Chromium	EPA 200.8	
Cobalt	EPA 200.7	
Cobalt	EPA 200.8	
Copper	EPA 200.7	
Copper	EPA 200.8	
Gold	EPA 200.7	
Iron	EPA 200.7	
Iron	EPA 200.8	
Lead	EPA 200.7	
Lead	EPA 200.8	
Magnesium	EPA 200.7	
Manganese	EPA 200.7	
Manganese	EPA 200.8	
Mercury	EPA 200.8	
Mercury	EPA 245.2	
Molybdenum	EPA 200.7	
Molybdenum	EPA 200.8	
Nickel	EPA 200.7	
Nickel	EPA 200.8	
Potassium	EPA 200.7	

Matrix/Analyte	Method	Notes
Selenium	EPA 200.7	
Selenium	EPA 200.8	
Silica as SiO2	EPA 200.7	
Silver	EPA 200.7	
Silver	EPA 200.8	1
Sodium	EPA 200.7	
Strontium	EPA 200.7	
Thallium	EPA 200.7	
Thallium	EPA 200.8	
Tin	EPA 200.7	
Titanium	EPA 200.7	
Vanadium	EPA 200.7	
Vanadium	EPA 200.8	
Zinc	EPA 200.7	
Zinc	EPA 200.8	1
Organochlorine Pesticides	EPA 608	
PMI Volatile Organics	EPA 1671	
Polychlorinated Biphenyls	EPA 608	
BNA Extr (Semivolatile) Organics	EPA 625	
PMI Volatile Organics	EPA 1666	
Volatile Organic Compounds	EPA 624	
Solid and Chemical Materials		
Amenable cyanide	EPA 9012	
Chromium VI	EPA 7196	
Nitrite	EPA 9056	
pH (non-aqueous)	EPA 9045	
Total chlorine	EPA 9076	
Total cyanide	EPA 9012	
Aluminum	EPA 6010	
Aluminum	EPA 6020	1
Antimony	EPA 6010	
Antimony	EPA 6020	
Arsenic	EPA 6010	
Arsenic	EPA 6020	
Barium	EPA 6010	
Barium	EPA 6020	
Beryllium	EPA 6010	

Matrix/Analyte	Method	Notes
Beryllium	EPA 6020	
Cadmium	EPA 6010	
Cadmium	EPA 6020	
Calcium	EPA 6010	
Calcium	EPA 6020	
Chromium	EPA 6010	
Chromium	EPA 6020	
Cobalt	EPA 6010	
Cobalt	EPA 6020	
Copper	EPA 6010	
Copper	EPA 6020	3
Iron	EPA 6010	
Iron	EPA 6020	
Lead	EPA 6010	
Lead	EPA 6020	
Magnesium	EPA 6010	
Magnesium	EPA 6020	
Manganese	EPA 6010	
Manganese	EPA 6020	
Mercury	EPA 6020 Mod	1
Mercury, Liquid Waste	EPA 7470	1
Mercury, Solid Waste	EPA 7471	1
Molybdenum	EPA 6010	
Molybdenum	EPA 6020	
Nickel	EPA 6010	
Nickel	EPA 6020	
Potassium	EPA 6010	
Potassium	EPA 6020	
Selenium	EPA 6010	
Selenium	EPA 6020	
Silica as SiO2	EPA 6010	
Silica as SiO2	EPA 6020	
Silver	EPA 6010	
Silver	EPA 6020	
Sodium	EPA 6010	
Sodium	EPA 6020	
Strontium	EPA 6010	

Matrix/Analyte	Method	Notes
Thallium	EPA 6010	
Thallium	EPA 6020	1
Tin	EPA 6010 Mod	
Titanium	EPA 6010 Mod	
Vanadium	EPA 6010	
Vanadium	EPA 6020	
Zinc	EPA 6010	
Zinc	EPA 6020	
Alcohols	EPA 8015 Mod-Alc	
BTEX	EPA 8021 Mod BTEX	
Chlorinated Herbicides	EPA 8151	
Organochlorine Pesticides	EPA 8081	
Polychlorinated Biphenyls	EPA 8082	
Total Pet Hydrocarbons - Diesel	WDOE NWTPH-Dx	
Total Pet Hydrocarbons - Gasoline	WDOE NWTPH-Gx	
BNA Extr (Semivolatile) Organics	EPA 8270	
Organophosphorus Pesticides	EPA 8270 Mod	1
Petroleum Hydrocarbons, Extractable	WA EPH	1
Polycyclic Aromatic HC	EPA 8270 SIM	
Volatile Organic Compounds	EPA 8260	

Accredited Parameter Note Detail

(1) Provisional accreditation pending submittal of additional, acceptable Proficiency Testing (PT) results (WAC 173-50-110).

Authentication Signature

January 4, 2009
Date

Stewart M. Lombard, Lab Accreditation Unit Supervisor

ATTACHMENT 5
LABORATORY QA PLANS

Analytical Resources Inc. Quality Assurance Plan

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Quality Assurance Plan

Analytical Resources, Inc.
4611 S. 134th Place, Suite 100
Tukwila, WA 98168-3240

Revision 013-000
8/17/09

Uncontrolled Copy

A web page is configured to inform you if this is the most recent version of ARI's LQAP. Click on the link or type the URL into your web browser. No web access? Phone 206-695-6200

http://arilabs.com/cgi-bin/rcheck.cgi?f=LQAP&r=R13000

This Quality Assurance Plan is approved and authorized for release by:

Mark Weidner
Laboratory Director

David Mitchell
Quality Assurance Manager

Analytical Resources, Incorporated
Analytical Chemists and Consultants

Quality Assurance Plan

Analytical Resources Inc.

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SECTION 1: INTRODUCTION

Quality Assurance Policy and Objectives

Analytical Resources, Inc. (ARI) is dedicated to providing accurate and reliable data in a timely and cost effective manner. The management of ARI is committed to analytical excellence and will provide the facilities and a professional environment to achieve this goal. The quality assurance program detailed in this document sets forth the policies and procedures that are followed by ARI to ensure that all reported results are both legally defensible and of the highest quality.

To ensure that data quality goals are achieved, the following characteristics must be considered:

Precision, Bias and Accuracy

For all analyses, there is a degree of uncertainty or error in the measurement process. This measurement error is generally one of two types: random error (precision) or systematic error (bias). Precision is a measure of agreement between replicate measurements. Bias is considered to be the difference between the expected value and the true value for a measurement or series of measurements. Accuracy is a determination of how closely a measurement is to the expected value. Both precision and bias are considered when determining the accuracy of measurements. Precision, bias and accuracy are evaluated through the use of method guidelines, and project and laboratory control limits.

Representativeness

Representativeness is an indicator of how closely one sample aliquot resembles another aliquot from the same bulk source or sample site. Sample representativeness is more easily obtained for particulate-free water samples than for solid samples or viscous liquids. Representativeness is an important consideration in achieving other data quality objectives.

Completeness

Completeness is an indicator of the number of valid (useable) data points compared with the overall number of data points obtained. Valid data are normally obtained when sample collection and analysis is performed in accordance with specified methods and procedures. Completeness is often expressed as a percentage: the higher the number of valid data points, the higher the overall completeness percentage. Conversely, fewer valid data points will result in an overall lower percentage of completeness. Project specifications will dictate the required level of completeness.

Comparability

Comparability is an indicator of how confidently one data set can be compared with another, as well as the consistency between data sets. Stable analytical conditions and adherence to standard procedures, combined with high levels of accuracy; help ensure that results obtained over a period of time will be comparable.

Timeliness

To ensure that the most accurate results possible are obtained, samples must be processed within specified time periods. Analytical holding times have been established to allow sufficient time for sample processing without compromising sample integrity. It is important that, while meeting timeliness requirements, other data quality objectives are still considered and met.

Documentation

Complete and accurate documentation is essential for verifying the integrity of analytical results. Achievement of other quality objectives cannot be used to substantiate data quality without full documentation of the analytical process. Documentation must be concise and readily available for subsequent review.

The quality assurance program at ARI has been developed to ensure that the specified data quality objectives are met for all reported results and the highest degree of completeness possible is achieved.

1.2 Ethics Policy on Data Quality and Confidentiality

To ensure that data quality or confidentiality is not compromised, ARI has established the following policy on corporate ethics. These steps must be taken when the quality or confidentiality of data is suspected or known to be compromised. This policy applies to all ARI employees at every organizational level.

General

ARI's corporate commitment to integrity and honesty in the workplace is clearly stated in the ARI Employee's Handbook, under "Standards of Conduct". The Standards of Conduct statement is attached as Appendix O. The ARI commitment to excellence in data quality extends to and includes all aspects of data production, review and reporting.

Any attempt by management or any employee to compromise this commitment presents a case for serious disciplinary action. Any indications or allegations of waste, fraud or abuse will be rigorously investigated by ARI management, with the penalties for verified cases to be employment termination, and if appropriate, prosecution. In addition to these steps, any such

charges related to data generated for the federal government will also be reported to the Inspector General of the appropriate department.

Circumstances

All ARI employees will immediately report to management any information concerning the misrepresentation or possible misrepresentation of analytical data (or any associated components).

Misrepresentation of data includes (but is not limited to) the following:

Altering an instrument, computer or clock to falsify time or output
Altering the content of a logbook or data sheet in order to misrepresent data
Falsifying analyst identity
Changing documents with correction fluid with the intent of falsifying information
Preparing or submitting counterfeit data packages or reports
Unauthorized release (either written or verbal) of confidential data
Illegal calibration techniques (peak shaving, fraudulent integrator parameters)
Any attempt to misrepresent data or events as they actually occur in the course of data production or reporting

Responsibilities

It is the responsibility of all ARI employees to report any situation which may be adverse to data quality or confidentiality, or which may impact the final data quality. All ARI employees have the obligation to discuss known or suspected violations of this policy with laboratory management, who in turn are obliged to inform the ARI Laboratory Manager. If a satisfactory resolution is not obtained or is not possible at laboratory level, all ARI employees have the right and responsibility to discuss the matter directly with the ARI Laboratory Manager.

It is the responsibility of the ARI Laboratory Manager to promptly investigate any reports of known or suspected violations. The ARI Laboratory Manager has the authority and responsibility to resolve all known or potential violations of the policy.

It is the responsibility of ARI management to provide all of its employees with the facilities, equipment, and training to achieve the quality goals stated in the policy. It is the responsibility of ARI to provide our clients with data of known and documented quality.

Documentation

To reaffirm an awareness of and commitment to the highest standards of data quality, excellence, and integrity, all employees are required to sign the following "Commitment to Excellence in Data Quality" statement:

"As an ARI employee, I have the right and responsibility to report any situation which may be adverse to quality or which may impact the final quality or integrity of data produced for our clients."

"I will report immediately to management any information concerning the misrepresentation or possible misrepresentation of analytical data (or any of its associated components). Examples of this include (but are not limited to): alteration of an instrument computer or clock, alteration of the contents of logbooks and/or data sheets in order to misrepresent data, misrepresentation of analyst identity, intentional falsification of documents with correction fluid ("white-out"), preparation and submittal of counterfeit data packages, use of illegal calibration techniques (peak shaving, use of fraudulent integrator parameters, etc.), or any attempt to misrepresent data or events as they actually occur in the course of an analysis."

"I will likewise alert management of any situation or activity which may be adverse to the confidentiality of clients' data."

"I will not knowingly participate in any such activity, nor fail to report such activities of which I may become aware. I understand that any voluntary participation on my part in such activities may result in the termination of my employment, and possible legal prosecution."

"Where circumstances permit, I will report any actual or suspected violations of this policy to my lab or section supervisor. If a satisfactory resolution is not obtained or is not possible at that level, I have the right and obligation to discuss the matter directly with the ARI Laboratory Manager."

Confidentiality

All information related to client projects, such as client work plans, documentation and analytical data will be considered confidential. This information will be released only to the

client or an authorized representative. Should an outside agency request information related to a client project, the client will be contacted for approval prior to releasing any information.

Some programs or contractual agreements (such as the USEPA Contract Laboratory Program) may have specific requirements for protecting a client's confidentiality Project Managers will be responsible for strict control of access to any such confidential information or documentation. All data generated from the analysis of confidential samples will also be considered confidential.

SECTION 2.0: QA MANAGEMENT AND RESPONSIBILITIES

The principal tenet of the Quality Assurance Program at Analytical Resources Inc. (ARI) is that every employee knows she/he is a vital component of the program, and holds a responsibility to produce high-quality, defensible data in a timely manner. While production of quality data is a global philosophy, held by the entire laboratory, each section is responsible for ensuring that the data produced within that section meets the required quality objectives.

2.1 Overall Structure

The Board of Directors shall direct ARI's QA Policy and shall determine the Philosophy of the QA Program. It shall be the responsibility of the Laboratory Director to translate this policy into practical procedures with respect to the business plan developed for ARI, and direct the Laboratory Manager and Section Managers regarding the incorporation of these procedures into daily laboratory activities.

The Laboratory Manager is responsible for coordination of laboratory activities to result in an integrated approach to quality data production. The Laboratory Manager will coordinate Client Services, Laboratory Section Management, Computer Services, and Data Services to ensure that project requirements and data quality objectives are met.

The Laboratory Section Managers and Supervisors shall hold the final authority in decisions concerning implementation of QA policy, with the contributions of the Laboratory Director, Laboratory Manager, QA Manager and Project Managers. Section Managers and Section Supervisors shall instruct employees in the proper employment of QA policies.

Each Section Supervisor will ensure that analyses are completed within required holding times, that data is submitted within required submission times, and all analyses are performed according to the current Standard Operating Procedures (SOPs). They will ensure that any client modifications or QA issues are well documented for each sample set and that all required documents are complete when submitted with each data set.

The analytical staff shall execute all methods following QA policies, and will write SOPs reflecting the methods exactly as performed. These SOPs will be reviewed for compliance by Section Managers and the Laboratory Director, and once approved will be submitted to the Quality Assurance Program Manager (QAPM).

The QAPM will be responsible for controlling Company SOPs and other internal documents, overseeing the scheduling and completion of detection limit studies. The QAPM will coordinate the production of control charts and distribution of control limit data to all laboratory sections. The QAPM will administer the blind QA proficiency tests and performance samples as described in the QA Program. The QAPM will verify that QA policies and procedures are followed through out ARI.

Data reviewers will be responsible for ensuring that all samples have been analyzed by the approved and requested methods, that data calculations are performed correctly, and that analyses meet the Data Quality Objectives of the client. They shall also be responsible for ensuring that the documentation from each laboratory section is intact and complete.

Computer Services is responsible for ensuring that the Laboratory Information Management System (LIMS) correctly reflects the preparations and analyses performed and that the LIMS is updated with the current SOP, MDL, RL and QL data as submitted from the QAPM. Computer Services personnel are also responsible for ensuring that all electronic deliverables for clients are formatted correctly as requested by the Project Managers and that this data matches the hardcopy deliverables submitted.

Client Services (Project Management, Sample Receiving), shall be responsible for ensuring that the laboratories understand and can meet project specific analytical requirements and DQO.

2.2 Hierarchical Responsibilities

Technical Director

> *It shall be the responsibility of the Laboratory Director to translate QA policy into practical procedures with respect to ARI's business plan, and to direct the Laboratory Manager and Section Managers in the implementation of these procedures in daily laboratory activities.*

The Director shall interpret overall QA Policy, and determine the broad practicality of policies based on methodologies, technological advances, and the current environmental market. It shall be the interpretation of these policies that will, in turn, direct the growth ARI, the addition or withdrawal of methods to ARI's repertoire, and ARI's marketing focus.

At a minimum of once a year the Technical Director shall include on the agenda of the Board of Directors meeting a discussion of ARI′s QA Policy. This discussion will include the reputation of ARI for producing quality analyses, the affect of QA policies on turn-around time, competitive edge and cost-of-analysis, needs for stricter or more flexible policies, and the response of employees to the QA policies in place at that time.

At a minimum of once every six months the Director shall attend management meetings, which include on the agenda the subject 'QA Program'. This format will allow for the dissemination of information on any QA issues addressed in the laboratory or by the Board of Directors. Management shall also use these meetings to discuss requirements of clients that are not met by ARI′s present QA Program, and the appropriate response to these requirements.

The Technical Director may be required to act as a technical advisor at any impromptu meetings called by management to address QA issues that cannot be immediately resolved within a laboratory section.

It shall also be the Director's authority and responsibility to hold final review approval for all SOPs of ARI. Once an SOP has been updated and reviewed by the laboratory section, it shall go through the Section and Laboratory Managers for approval, and then to the Laboratory Director for final approval before the SOP is released.

Laboratory Manager

> *The Laboratory Manager is responsible for coordination of laboratory activities to result in an integrated approach to quality data production. It shall be the Laboratory Manager's responsibility to coordinate Client Services, Laboratory Management, Computer Services, and Data Services to ensure that QA Program requirements and data quality objectives are met.*

The Laboratory Manager is required to attend all management meetings, at which the QA Program will be an agenda item. Management shall use these meetings to discuss requirements of clients that are not met by ARI′s present QA Program, the appropriate response to these requirements, and dissemination of information on any QA issues addressed in the laboratory or by the Board of Directors.

It is the responsibility of the Laboratory Manager, along with the QA Manager, Laboratory Director, Section Managers and Client Services, to determine in which QA Proficiency

Programs the Laboratory will participate, and those accreditations that ARI will pursue. It is the responsibility of the Laboratory Manager, with the Section Managers, to ensure that all laboratory sections perform the tasks required by the QA Manager to pursue each accreditation or to complete a scheduled audit.

The Laboratory Manager has the authority to direct Client Services to discontinue the bidding/contracting process for a new project, refuse samples, or to re-schedule projects based on Data Quality Objectives or current workload. The Laboratory Manager also shall evaluate staffing and equipment needs based on information from the Section Managers and Client Services and may elect to meet new project requirements by increasing staffing levels or purchasing additional equipment.

The Laboratory Manager serves as a senior-level technical reference for all laboratory activities, and as such will be brought in to advise on out-of-control events and trends, corrective actions, and/or other QA issues that require his/her expertise.

Laboratory Section Managers

> *The Section Managers shall hold the final authority in decisions concerning implementation of QA policy, with the contributions of the Laboratory Director, Laboratory Manager, QAPM and Project Managers. Section Managers are responsible for correcting out of control events within their respective laboratories. Section Managers and supervisors shall instruct employees in the proper employment of QA Policies.*

Laboratory Sections Managers shall have the final authority in decisions concerning QA policy. It is their expertise that will determine the final acceptable format of each method SOP, as they are the best resource to integrate methods into ARI′s philosophy.

Laboratory Section Managers are responsible for completing or delegating updates of laboratory procedures and quality assurance manual sections as scheduled by the QA Manager.

The Section Managers are best able to determine capacity of the Laboratory Sections. To ensure that analyses are completed within required hold times, the Section Managers will give Supervisors the authority to balance employee workloads and modify employee work schedules. It is the Section Manager's responsibility to take reports from supervisors and work

with the Laboratory Manager to increase staffing levels or reject samples as needed. It is the Section Manager's responsibility to work with the Laboratory Manager and the section supervisor and analysts to ensure that sample capacity does not affect the quality of data generated from that laboratory section.

It is the responsibility of the Laboratory Section Managers, along with the QA Manager, Laboratory Director, Laboratory Manager and Client Services, to determine in which QA Proficiency Programs the Laboratory will participate, and which accreditation processes ARI will pursue. It is the responsibility of the Section Managers, with the Section Supervisors, to ensure that all laboratory sections perform the tasks required by the QA Manager to pursue each accreditation or to complete a scheduled audit.

The Section Manager will be responsible for reviewing training records of analysts produced by the Section Supervisor. Training shall be the responsibility of the Section Supervisor, but it is the responsibility of the Section Manager to oversee this training.

It is the Section Managers' responsibility to work with the Section Supervisor and Project Manager to assure that Project Requirements are achievable and valid for the given methods. At times, ARI′s clients have requests or requirements for methods that are 1) not the method of choice in the laboratory, 2) not presently performed by the laboratory, or 3) unachievable by the instrumentation used in the laboratory. It is the responsibility of the Section Supervisor, Section Manager and Project Manager to work with the client to resolve these issues before samples are accepted.

Clients may also request modifications to the methods that must be approved by the Section Supervisor, the Section Manager and the QAPM. These modifications must be thoroughly documented and all pertinent information on modifications must be conveyed to the analysts, sample preparation sections, sample receiving, and computer services, as needed for implementation.

The Section Manager is responsible for resolution of out-of-control events that have not or cannot be resolved by the analysts or Section Supervisor.

The Section Manager has the authority to re-classify analysts or require additional training of analysts based on their performance.

The Section Manager has the responsibility of balancing client requests and requirements with the QA policies of ARI. It is the Section Manager's task to evaluate a client's Data Quality Objectives (submitted through Client Services), and with the Project Managers, Laboratory Supervisors and Quality Assurance Manager to determine the feasibility of laboratory performance. Feasibility will be based on the quality objectives requested, current QA Manual, present workload (in-house and scheduled/pending), the technology in place, and staffing levels available. Current workload in-house will be evaluated using reports from Computer Services, and scheduled/pending workload will be evaluated using written and verbal input from Client Services.

Section Supervisors

> *It is the responsibility of each section Supervisor to ensure that analyses are completed following the most current version of ARI´s SOP, within required holding and turn around times, and assure that analyses meet the Data Quality Objectives of each project. They will ensure that any client modifications or QA issues are well documented for each sample set, and that all documentation is complete when submitted with each data set.*

To ensure that analyses are completed within required hold times, the Supervisors have the authority to balance employee workloads and modify employee work schedules. The Section Supervisors, with the input of the Section Manager, have the authority to request overtime from employees should the workload warrant the additional effort, or to modify employee schedules to extend the operating hours of the laboratory section.

The Section Supervisors shall oversee the day-to-day section operations, using LIMS printouts and verbal or written workload estimates and requests from Project Managers to adjust section efforts as needed. It is also the Section Supervisors' responsibility to inform management (Section Manager, Data Review, and Project Managers), when capacities are limited, so that the appropriate adjustments can be made to reduce workloads or increase laboratory capacities. At no time should sample capacity be allowed to affect the quality of data generated from any laboratory section.

It is the Section Supervisor's responsibility to assure that employees have the proper training for their positions. This training will include training in the methods, use of the LIMS system if applicable, training in correct documentation procedures, and all information necessary for

adherence to the ARI QA Program. The Supervisor shall either perform the training personally, or designate the trainer for given methods or procedures. It is the Supervisor's responsibility to test each employee for each method or procedure, and to thoroughly document each employee's advances and current capabilities. The Supervisor shall have the authority to require further training or supervision for any employee, and shall be the authority to approve each employee for working without supervision. There will be a training record for each employee. These will be kept in the laboratory section; copies will be submitted to the QA Manager for record keeping.

It is the Supervisor's responsibility to work with the Section Manager and Project Manager to ensure that Project Requirements are achievable and valid for the given methods. At times clients have requests and/or requirements for methods that are 1) not the method of choice in the laboratory, 2) not presently part of the method as performed by the laboratory, or 3) unachievable by the instruments used in the laboratory. It is the responsibility of the Supervisor, Section Manager and Project Manager to work with the client to resolve these issues before samples are accepted.

It is the responsibility of the Section Supervisor to ensure that each analyst reads and understands all requirements submitted with each sample set, including those for any special analyte, calibration, or data deliverable. It is the Section Supervisor’s responsibility to clarify any issues, with the input of the Section Manager and the Project Manager for the client.

Clients also at times will request modifications to methods, which must be approved by the Supervisor and Section Manager. These modifications must be thoroughly documented and all pertinent information on modifications must be conveyed to the analysts, sample preparation sections, sample receiving, and computer services as needed for implementation.

It is the Supervisor's responsibility to ensure that each employee understands the requirements of all projects they work with. This may necessitate section meetings or project-specific cross-section teams to work with Project Managers for large, specialty projects to ensure that everyone has the same understanding of project requirements.

The Supervisor is responsible for resolution of out-of-control events that have not or cannot be resolved by the analysts, and for ensuring that the analysts complete all documentation. If the

Supervisor and laboratory section analysts cannot resolve the issues in a timely manner, the Supervisor's will request the assistance of laboratory management to bring the section into compliance. The Supervisor will also inform Project Management and his/her Section Manager of possible delays, and inform Data Review of possible time constraints they may face in preparation of data submissions from the lab section.

The Section Supervisors shall have the authority, usually in consultation with Laboratory or Project Management to use professional judgment in requiring samples be re-prepared, and shall determine which analysts have the authority to require re-preparation of samples.

It is the responsibility of the Section Supervisor to inform the QAPM, Section Manager and the Computer Services section of any changes in methodologies that will require revision of SOPs, MDLs, Control Limits or the LIMS programming. This includes changes in spiking compounds, spiking levels, preparation methods and analytical methods.

Analysts

> *The analytical staff shall execute all methods following QA Policies, and will write SOPs reflecting the methods exactly as performed. These SOPs will be reviewed for compliance by Section Managers, the Laboratory Manager, and the Laboratory Director, and once approved will be submitted to the QA Manager.*

The analysts are responsible for following the current SOPs (with project-specific modifications if required) in preparing and analyzing client samples and quality control samples to meet the project specific Data Quality Objectives. It is the analyst's responsibility to ensure that he/she understands all requirements of a project before proceeding with sample preparation or analysis.

Analysts are responsible for working with the Supervisor to ensure that all sample preparations and analyses are performed within required holding times and required turn-around times, and that all documentation is completed in a timely fashion. It is each analyst's responsibility to bring any recurrent or anticipated problems to the attention of laboratory management.

It is each analyst's responsibility to correct his/her own errors, to document corrective actions thoroughly, to perform peer review, and to ensure that fellow employees within the section follow documentation procedures.

The Section Supervisor may give lead analysts responsibility for training and evaluation of new staff members. This training will include instruction in the methods, use of the LIMS system if applicable, correct documentation procedures, and all information necessary for adherence to the ARI QA Program. Analysts will be responsible for maintaining all instruments and equipment in optimum operating condition and documenting this maintenance as required by the QA Program.

It is the responsibility of each analyst to request the assistance of Supervisors or Managers in resolving out-of-control situations that cannot be corrected in a timely manner, and to perform the documentation of all corrective action activities.

Quality Assurance Program Manager (QAPM)

> *The QAPM will be responsible for controlling Company SOPs and other internal documents. The QAPM will oversee the scheduling and completion of detection limit studies and control charts. The QAPM will administer the training program, analyst's proficiency documentation and performance evaluation analyses as described in the QA Program. The QAPM will verify that QA policies and procedures are followed at all levels in the Company. The QAPM will produce a "Quality Assurance report to Management" each calendar year.*

The QAPM is responsible for the oversight of the QA Program as defined by the Board of Directors and interpreted by the Laboratory Director and Laboratory Managers.

Part of this oversight will be monitoring of the QA Program through submission of performance evaluation samples, blind QA samples and double-blind QA samples. It is the responsibility of the QAPM, along with the Laboratory Manager, Laboratory Director, Section Managers and Client Services, to determine in which QA Proficiency Programs the Laboratory will participate. The QAPM will be responsible for submitting these samples to the laboratory for analysis, overseeing submission of the results to the appropriate agencies, and for control of documented proficiency results.

The QAPM will be responsible for scheduling laboratory section SOP and procedural reviews and revisions, and section updates of the Quality Assurance Manual. It is the responsibility of the QAPM to work with each Section Manager to attempt to stagger these review schedules across the year within each laboratory section. The QAPM will also be responsible for

maintaining document control of all SOPs, bench sheets, logbooks, and other forms used within the laboratory.

All laboratory sections, on an annual basis, will perform detection limit studies for each method used within each section. It is the responsibility of the QAPM to schedule, review, compile, and distribute the results of these studies.

The QAPM is responsible for evaluation of the laboratories' adherence to defined protocols through periodic audits of completed projects and of the laboratory facilities. Following the audit schedule (Appendix K), the QA Manager will perform the scheduled audit and prepare an evaluation that will be submitted to the Board of Directors in the Annual QA Report to Management.

The QAPM will be responsible for evaluation of outside accreditation requested by Client Services. The QA Manager will deliberate with the Laboratory Managers and Laboratory Director on the feasibility of pursuing accreditation based on the scope of the accreditation, the effort required to pursue accreditation and the scope of work that might become available once the accreditation is obtained. If a decision is made to pursue an accreditation, it is the responsibility of the QAPM to coordinate laboratory efforts towards the accreditation.

The QAPM will produce an annual "Quality Assurance Report to Management" to be distributed to ARI management personnel as described in Section 13 of this LQAP.

The QAPM will serve as a resource for quality-related issues for all Laboratory Sections, and will serve management in an advisory capacity.

The QAPM will have documented training in elementary statistics and Quality Systems theory.

Data Reviewers

> *Data reviewers will be responsible for ensuring that all samples have been analyzed by the approved and requested methods, that data calculations are performed correctly, and that analyses meet the Data Quality Objectives of the client. They shall also be responsible for ensuring that the documentation from each laboratory section is intact and complete.*

Data reviewers shall ensure that all samples are analyzed according to approved methods by reviewing the data released by each laboratory section. The data will be evaluated for compliance with all Data Quality Objectives as defined in the method SOP or in the project-

specific quality assurance plan, including instrument tuning and calibration, holding time, spiking level, and spiking recovery criteria. Data reviewers will also verify 100% of manual calculations, spot check computer calculations, check electronic data for correct sample matching, and do a 100% check on any manually entered data. Analytical parameters, which have concentration interdependence, will be evaluated in relationship to each other.

Final reports generated will be evaluated to ensure that laboratories are using the current detection limit/reporting limit values and the current control limits. Data will be checked to ensure that all QA issues are addressed and fully documented. Reviewers are responsible for working with Laboratory Supervisors, Laboratory Managers and Project Managers when out-of-control events are incompletely documented, or if data is found to not meet Data Quality Objectives of a project without documentation.

It is the responsibility of data reviewers, the QAPM and section supervisors to work with Computer Services to ensure that the LIMS is updated to the current limits and methods used within the laboratory.

Computer Services

> *Computer Services is responsible for ensuring that the LIMS correctly reflects the preparations and analyses performed and that the LIMS is updated to include the current SOP, MDL, RL and QL data, as submitted by the QA Manager. Computer Services personnel are also responsible for ensuring that all electronic deliverables for clients are formatted correctly as requested by the Project Managers and that electronic data matches the hardcopy deliverables submitted.*

It is the responsibility of the Computer Services Manager to update, or to designate the task of updating, the LIMS as determined by Laboratory Management, including adjustment to current MDL/RL data, additions of analytes to methods, changes in method designations or changes in calculations for methodologies.

Computer Services will be responsible for generating the work list scripts required to allow analysts to enter data into the LIMS, and for generating the report scripts that produce final hardcopy or electronic reports for clients.

Computer Services Management and personnel are also responsible for generation and review of electronic data deliverables (EDD), as requested by clients through Project

Management. Computer Services personnel will review the EDD for compliance with the Software Quality Assurance SOP before it is released to the client.

Computer Services will be responsible for informing laboratory Section Managers and Project Managers of any discrepancies found between the EDD and the hardcopy, and for following up on corrections to hardcopy and EDD as required.

Client Services

> *Client Services (CS) (Project Managers, Sample Receiving, and Sales Management) personnel are the primary interface between ARI's clients and the laboratory sections. CS staff shall be responsible, with the assistance of the Section Managers and Supervisors, for ensuring that the laboratories understand and can meet the Data Quality Goals and Requirements of each Project before committing laboratory services to the project. CS will monitor the quality of sample processing after they are received.*

Client Services Management and Project Managers shall ensure that the laboratories can meet the data quality objectives for a project. The Project Managers are responsible for knowing the capabilities of the laboratory, in order to develop project proposals or accept samples without consultation with laboratory management. It is the responsibility of Client Services to consult with the Laboratory Manager and Section Managers, or supervisors designated by Management, when data quality goals are not included in standard Company policies. Clients may, at times, request modifications to methods that must be approved by the Supervisor and Section Manager. These modifications must be thoroughly documented and all pertinent information on modifications must be conveyed to the analysts, sample preparation sections, sample receiving, and computer services as needed for verification of feasibility. Laboratory Management may determine that a project should not be pursued based on the specific Data Quality Objectives and on current or projected laboratory capacity.

Project Managers shall be responsible for ensuring that project requirements and analytical requests are submitted correctly to all laboratory sections. Once samples have been logged into the laboratory, it is the responsibility of the Project Managers to ensure that all information is available to the laboratories concerning the Data Quality Objectives and deliverables requirements. It is also the responsibility of the Project Managers to convey changes in client

requirements to the laboratories and ensure that all paperwork reflects the changes if necessary.

It is the responsibility of Project Managers and Client Services Management to assure that specific EDD formats are submitted to Computer Services and approved as feasible before contracting with a client to provide the EDD.

It is the responsibility of Project Managers to notify clients of out-of-control events, “problem” samples, or anticipated turn-around time delays, as conveyed to them by Laboratory Management. It is also the responsibility of Project Management to work with Laboratory Management in setting priorities during times of heavy sample workloads.

Project Managers shall be responsible for coordinating data submissions and compiling hardcopy data for final submission to the client. This involves conducting a fourth level data review, from which any data which is found to contain errors that were not found earlier in the review process is returned to the Data Reviewer for correction and/or corrective action. The Project Manager will be responsible for compiling all analyst notes into a project narrative. This will include discussion of any sample receipt discrepancies, sample preparation and analysis difficulties or non-compliance, and any corrective actions that may have been required during processing. It will also discuss quality control analyses and results if applicable to the sample set.

Project Managers shall work with Laboratory Management in determination of the direction of growth for ARI, as the Project Managers are best able to define the analytical needs of clients based on new technologies and new environmental regulations.

SECTION 3: PERSONNEL QUALIFICATIONS AND TRAINING

The production of quality analytical data is dependent upon a laboratory staff with qualifications and training necessary to perform assigned tasks. All personnel employed by ARI will receive adequate training and instruction specific to their responsibilities. Prior to assigning a staff member full responsibility for performing a laboratory procedure, her/his skills will be evaluated and verified acceptable. It is the obligation of ARI′s supervisors and managers to ensure that personnel are qualified to successfully perform all assigned duties.

ARI′s training program is described in SOP 1017S (*Training and Demonstration of Proficiency*). The procedures described in this SOP assure that all ARI employees are proficient at the tasks required to produce quality analytical data. The SOP also provides for periodic review of each employees training and proficiency status, which may indicate any need for additional or remedial training. All training and review procedures are documented as described in the SOP.

Basic elements of ARI′s training program are:

1. All employees are required to read and document their knowledge of non-technical documents that describe general policies in place at ARI. These documents include ARI′s *Employee Manual* and ARI′s *Chemical Hygiene Plan*.
2. All technical employees are required to read and document their knowledge of ARI′s *Laboratory Quality Assurance Plan* and quality assurance policies.
3. All new employees must attend a Quality Assurance Orientation during which ARI′s general and specific requirements for the production of quality analytical data are emphasized.
4. All new technical employees will attend a laboratory specific technical orientation conducted by their laboratory supervisor or manager that provides specific information about laboratory operation.
5. All employees will complete an ‘on the job’ training program designated by their supervisor. The training program will be laboratory, SOP and employee specific. The training is

incremental with each step documented in an employee Training File. While an analyst is in the training period, her/his supervisor or trainer must approve all analytical work.

6. Upon completion of the training program a technical employee must complete an Initial Demonstration of Capability (IDOC) as described in ARI SOP 1017S. An analyst is considered proficient and may perform analytical procedures without supervision only after they have completed training and a successful IDOC.

7. The proficiency of each employee performing a given laboratory SOP will be continually monitored and documented as described SOP 1017S. An employee must continually generate data that meets all of ARI's published acceptance criteria for a given SOP to be considered proficient. Unacceptable results or insufficient number of analyses performed in a calendar quarter will result in revocation of proficiency. This will result in a remedial training program.

8. Each analyst is responsible for maintaining a training record as described in SOP 1017S. The training record will document an employee's experience, training and capability. The training file will be maintained in the analysts' laboratory.

SECTION 4: FACILITIES AND EQUIPMENT

4.1 Facilities

ARI's facilities have been designed to allow for efficient sample processing and analysis while maintaining consideration for the health and safety of the staff. The facility accommodates the following operations:

Sample receipt and storage
Sample container preparation and shipment
Sample preparation and analysis (organic and inorganic)
Project planning and management
Quality assurance
Data review and report generation
Computer programming and operations
Records storage
Instrument spare parts storage
Frozen sample archive
Short-term hazardous waste storage

A detailed description of ARI's facilities is included as Appendix C.

4.2 Security

Facilities

To ensure that security at ARI is maintained, access to the facilities is limited to employees and escorted visitors. Upon arrival, ARI visitors are required to register at the reception desk, and must sign out prior to leaving. Visitors will be escorted at all times. A receptionist constantly monitors the main entrance. Other laboratory entrances remain closed at all times and can only be opened from the outside by key. Key access to the facility is controlled; keys are issued on a limited basis depending on access needs.

As a result of controlled access and a monitored alarm system, the entire facility is considered a secure area. This eliminates the need for locked sample storage refrigerators, data storage areas or file cabinets.

Data Access

The Computer Services Manager controls security of, and access to, electronic data on the LIMS. Security measures are required to ensure data integrity, but must not be so restrictive

as to prevent data accessibility. The security measures taken at ARI are to prevent intentional intrusion by outside parties. These measures include building security, limited computer system access, password systems, encryption, firewalls and the use of virus protection programs. ARI′s Intranet is protected from outside tampering by a proxy server (firewall) connection to the Internet.

LIMS - System Security

Building/Computer Room Security

Access to the building is restricted to employees, vendors with security passes, and escorted visitors. Room 203 contains the computer and main console for the LIMS system. This room is closed and locked at all times. Access to this room is limited to Computer Services personnel, escorted repair technicians, and escorted visitors. Only Computer Services personnel will be allowed access to the main console.

System Password Policy

User name and password restrict access to the LIMS computer. Remote access to the LIMS server is not allowed.

Database Access Restrictions

Interaction with the database is menu-controlled and allows the LIMS Manager to restrict access. Technicians may be given the ability to fill a limited number of work lists, with no authorization to distribute data. Some users may be given “read only” access to the database.

Users will be given access to the database only to complete tasks for those analyses for which they are responsible. No users are to be given access to the shell or command prompt unless 1) they have completed the appropriate training and 2) administrative access to the computer systems is required by their job function

4.3 Safety

Ensuring that all sample processing and analysis procedures are performed under safe conditions is an important consideration at ARI. While safety is the responsibility of all staff members, ARI′s Safety Committee meets monthly to review the safety activities of all laboratory sections and to ensure that all operations and equipment meet safety criteria. *The*

Chemical Hygiene Plan details those safety procedures and requirements that must be followed at ARI. *The Chemical Hygiene Plan* is reviewed annually and updated as needed to incorporate any changes to ARI's safety program.

4.4 Instrumentation and Support Equipment

4.4.1 Instrumentation

Generation of quality data is dependent upon instrumentation and support equipment that is in optimum operating condition. All instrumentation and support equipment will be optimally maintained following method requirements and/or manufacturer's recommendations. Preventative maintenance is performed on a scheduled basis, with more frequent maintenance during periods of increased sample load or after analysis of highly contaminated samples. Separate, permanently bound logbooks are provided for and kept at or near each instrument. The logbooks are used to record all instrument maintenance, routine and non-routine. When non-routine maintenance is required the following information must be recorded:

1. A statement of the problem or symptom that requires correction.
2. Details of the maintenance procedure including listing the parts repaired or replaced.
3. Documentation that the instrument has returned to routine performance.

Spare parts are kept on hand when possible; necessary parts are ordered on an expedited basis to minimize downtime.

Currently available Laboratory Instrumentation is detailed in Appendix D.

4.4.2 Support Equipment

4.4.2.1 Thermometers in use at ARI are traceable to an NIST standard and are calibrated or verified annually. The procedures are described in SOP 1020S. When appropriate, thermometers are assigned a correction factor based upon the most recent calibration. ARI personnel must calculate and record corrected temperatures.

4.4.2.2 Water Bath temperatures are recorded before each use to assure the temperature is acceptable for its intended use.

4.4.2.3 Incubator temperatures (corrected) are recorded and at least twice a day while in use. The date and time of each observation is recorded.

4.4.2.3 Oven temperatures are recorded before and after each use.

4.4.2.4 Refrigerator and Freezer temperatures are recorded automatically every 30 minutes by ARI's "ThermoLogger" computer system. The temperature of several refrigerators and freezers not connected to "Thermologger" are recorded daily.

4.4.2.4 Balance accuracy is verified daily prior to use with two Class S weights that bracket the normal weighting range of the balance. A balance must be accurate to ±0.1% or ±0.5 mg whichever is greater. All analytical balances are professionally cleaned and calibrated annually by an outside contractor. Class S weights are calibrated every five years by an outside contractor. Calibration reports are filed in the QA Office.

4.4.2.5 pH Meters are standardized prior to each use with at least two standards, one at 4.0 and one at 7.0 pH units. The meters are checked prior to each use with a pH 7.0 buffer.

4.4.2.6 Variable Volume Pipette accuracy is verified monthly following the procedure in SOP 1015S.

4.4.2.7 Mechanical Burettes are calibrated quarterly following the procedure in SOP 1015S.

4.4.2.8 Sample Containers – Upon client request ARI supplies containers for collection of field samples. All containers supplied for organic and trace metals analyses are certified pre-cleaned by the manufacturer. When the manufacturer's certified concentration is greater than ARI's reporting limit for a specific project, a container is used to prepare a method (bottle) blank. ARI certifies that the containers from the same lot are suitable for sample collection when target analytes are not detected in the bottle blank. Containers for conventional analyses are not pre-cleaned and are certified internally by ARI following the procedures in Appendix 12.3 of ARI SOP 001S (Sample Receiving).

Container lot numbers are recorded when containers are sent to a client.

4.4.3 Chemical Standards and Reagents

4.4.3.1 Reagent Water Supply

ARI maintains a centralized water purification system. The quality of the water produced is monitored and documented daily in a bound logbook. All reagent / de-ionized water used within the laboratory meet or exceed ASTM Type II Standards. Water used in the Volatile Organic Laboratory is also filtered through activated charcoal to remove organic compounds.

4.4.3.2 Chemical Standards

Most standards used to determine the concentration of target analytes are purchased as certified solutions. In general the standards are traceable to a National Institute of Standards & Technology standard. A Certificate of Analysis and/or traceability for quantitative standards is filed in the QA Section when available. All standards (traceable, non-traceable and those prepared by ARI) are verified by comparison with standard reference materials or existing standards in use. ARI documents the source, date of receipt, required storage conditions and an expiration date for all standards. Containers used to store standards are labeled with an expiration date. Receiving, storage and preparation of calibration standards is described in SOPs 526S (Metals Analysis), 620S (Conventional Analysis), 704S (Volatile Organic Analysis) and 1012S (GC and GC-MS Analyses).

4.4.3.3 Chemical Reagents

Many of the analytical processes in use at ARI require chemical reagents that are not directly used in the calibration process. These reagents are used for analyte preservation, adjustment of pH, formation of colorimetric indicators, etc. The reagents are purchased in a grade and purity sufficient for their intended use. The receipt of all reagents is recorded in the Chemical Receiving Logbook where a unique Inventory Number is assigned to each reagent. Each original reagent container is labeled with an Inventory Number, the date it is opened and an expiration date as appropriate. A Certificate of Analysis is obtained for reagents when available and archived in the QA Office.

Solutions prepared from reagents are recorded in the Reagent Preparation Logbook. The logbook includes a unique Reagent Number that is traceable to the Chemical Receiving

Logbook. Reagent containers are labeled with Reagent Number, date of preparation, expiration date, and preparer's identification.

Procedures for Reagent Receiving and Preparation are detailed in SOP 1013S.

Trace Metals Acids

To ensure the quality of acids, nitric and hydrochloric, used for trace metals analyses, only the highest quality, certified "metals free" acids are purchased. Each lot received is analyzed for purity prior to use in the laboratory to assure that it is acceptable for use. Whenever possible, entire lots will be reserved for use exclusively by ARI. This minimizes the possibility of receiving contaminated or unacceptable acid.

Solvents

To ensure the quality of solvents used for sample preparation and analysis, the highest purity of solvents required for sample processing will be used. Purity checks are performed on solvent lots received by the laboratory. Only those solvent lots determined acceptable will be used for sample processing. Whenever possible, entire solvent lots will be reserved for use. This minimizes the possibility of receiving contaminated or unacceptable solvents.

Compressed Gases

To reduce the possibility of system contamination, compressed gases and liquids used for operating analytical instrumentation will be of a specified purity level. Any cylinder suspected of introducing contamination into a system will be promptly replaced.

4.5 Computer Systems

ARI maintains several data systems. These are used to automate such diverse functions as accounting, payroll, sales and marketing, sample receiving, instrument data collection, production of hardcopy and electronic data deliverables, intra- and internet applications and project management. Specific information about these systems is contained in Appendix D and various SOPs.

ARI maintains a Laboratory Information Management System (LIMS) that stores analytical data, calculates final results and produces final reports (both hardcopy and electronic). The LIMS

system is the major data system used at ARI. A separate Software Quality Assurance Plan outlines the QA/QC procedures for the LIMS system.

SECTION 5: LABORATORY DOCUMENTATION AND RECORDS

All laboratory operations and procedures performed during sample processing are documented in logbooks, notebooks and on laboratory forms and bench sheets. Analytical data and copies of paper documents are also stored electronically. Consistent use of standard documents throughout the laboratory ensures that all activities will be traceable and serves as objective evidence of the work performed.

All procedures performed at ARI will be detailed in Standard Operating Procedures (SOPs). Sample preparation and analysis SOPs will reference approved analytical methods and detail the actual procedures followed by ARI staff. SOPs for non-analytical activities will detail the procedures developed specifically for use at ARI.

5.1 Responsibilities

All staff members are responsible for complete and accurate documentation of laboratory activities. Each laboratory section develops a comprehensive set of documents (bench sheets, forms, etc.) to record all activities performed in that section. All staff members are responsible for reviewing and understanding SOPs, and must sign a record to document this fact. The QAPM is responsible for maintaining control of laboratory documents and ensuring their consistent use.

To ensure that all documents, SOPs in particular, accurately reflect the activities performed at ARI, section supervisors and managers are required to review all documents annually and recommend changes to the QAP. The QAPM is responsible for coordinating document revisions and ensuring that all staff members have access to the most current laboratory documents.

5.2 Document Control

ARI′s Quality Assurance Program requires that all forms and SOPs used within the laboratory be monitored to ensure that only the currently approved version of the documents are in use, centrally organized, and readily available to all staff members. All documents will include a revision date. The LQAP and SOPs will also have an effective date. The time between the revision and effective dates will be used for training and orderly implementation of changes.

Electronic copies of laboratory documents will be maintained as part of the quality assurance files. Each laboratory section maintains working copies of pertinent forms and SOPs. The QAPM coordinates the generation of new forms or SOPs and modifications to existing documents. Log number assignments will be as follows:

Laboratory Section	Form Number	SOP Number
Client Services	0001 - 0999	001 - 099
Computer Systems	1000 - 1999	100 - 199
Data Services	2000 - 2999	200 - 299
Extractions	3000 - 3999	300 - 399
GC Laboratory	4000 - 4999	400 - 499
Metals Laboratory	5000 - 5999	500 - 599
Conventional Laboratory	6000 - 6999	600 - 699
Volatile Organic Laboratory	8000 - 8999	700 - 799
Semi-volatile Laboratory	7000 - 7999	800 - 899
Quality Assurance Monitoring	10000 - 10999	1000 - 1099
GeoTech Laboratory	11000 - 11999	1100 - 1199

Document numbers will be include an F for forms and an S for SOPs i.e. 101F or 1234S. Document Control Logs of all forms and SOPs, detailing the form name and number, revision number and revision date will be maintained by the QA Officer. Outdated documents will be maintained in an electronic archive file.

The QAPM will distribute new and revised documents to the appropriate laboratory sections. Section staff will replace outdated copies of the document with the revised version. Laboratory forms and SOPs will be generated or revised on an “as needed” basis, and will be reviewed and revised as at least annually. Only the latest version of a form or SOP will be available in each laboratory. Section supervisors will periodically review these documents and recommend changes to be implemented by the QAPM. A comprehensive review of all laboratory documentation will be performed annually at the direction of the QAPM.

To maintain document security, release of documents to clients or other outside agencies will be controlled by the QAPM. The QAPM will record the document to be released, revision number, person and agency receiving the document, and the release date. All documents generated by the laboratory will be considered proprietary. ARI permission must be obtained by anyone releasing the document to other agencies or including the document in a project or quality assurance plan.

5.3 Reference Documentation

To provide an understanding of the procedures employed to generate quality data, a comprehensive set of reference materials is available to staff members. All activities performed within the laboratory can be referenced to a method or SOP. The laboratory maintains copies of the following method compilations:

Code of Federal Regulations (Section 40)
Test Methods for Evaluating Solid Waste (USEPA SW-846)
USEPA Contract Laboratory Program Statement of Work for Organics Analysis
USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis
Methods for Chemical Analysis of Water and Waste (USEPA 500 and 600 series methods)
Standard Methods for the Examination of Water and Wastewater
Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound (PSEP)
US Naval Facilities Engineering Support Activity –NFESC (formerly NEESA).
Hazardous Waste Remedial Actions Program (HAZWRAP)
State of Alaska Department of Environmental Conservation (ADEC)
Oregon Department of Environmental Quality (DEQ) Petroleum Hydrocarbon Methods
Washington Department of Ecology (WDOE) Guidance for Remediation of Releases from Underground Storage Tanks (Appendix L)
Washington State SARA
AFCEE Project Quality Assurance Plan
Washington State EPH/VPH Methods
National Environmental Laboratory Accreditation Conference
Department of Defense Quality Systems Manual
Washington State Sediment Sampling and Analysis Plan

Other methods followed within the laboratory are also available. Published modifications to analytical methods will be reviewed and incorporated into laboratory SOPs. If a method for a parameter is developed by ARI, it will be detailed in an SOP. SOPs will be available for all laboratory activities. Each laboratory section will maintain a file or notebook of SOPs pertinent to that section. A compilation of all laboratory SOPs is maintained as part of the Quality Assurance Program files. A listing of laboratory SOPs is included as Appendix E.

The Quality Assurance Manual provides an overview of the laboratory-wide Quality Assurance program. A copy of the Quality Assurance Manual is distributed to all laboratory sections. Distribution of the QAP is coordinated by the QAPM.

ARI maintains a file of various laboratory and environmental publications and reference texts. These reference materials are available to all staff members. Operation and maintenance manuals are available for all equipment and instrumentation used within the laboratory. Additionally, senior level staff members are available to serve as reference sources. These staff members have numerous years of pertinent experience and can provide insight and guidance for all procedures and laboratory activities.

5.4 Quality Assurance Policies

Quality Assurance Policies provide standards and procedures to guide ARI employees in proper implementation of the QA Program. Appendix P includes current QA Policies.

5.5 Worksheets and Logbooks

Use of Laboratory Forms and Logbooks

All activities noted on laboratory forms and logs are recorded in blue ink. Initials of the staff member performing the activity, as well as the date the activity is performed are noted on all forms and logs. Any supplementary information about the activity, such as unusual observations or suspected procedural errors are noted on the forms and logs. The QAPM or his/her designee prepares and controls laboratory logbooks.

Changes to existing information is annotated by drawing a single line through the original entry and initialing and dating the deletion. Correct information is written above the deleted entry. When appropriate to clarify the intent of the change a note describing the reason for the change is added. The use of correction fluids or other techniques that cover an entry in its entirety is forbidden on laboratory documents.

Since sample processing within an analytical laboratory involves many detailed steps, documentation can be quite extensive and varied. The following guidelines will be followed to encourage consistency in laboratory record keeping:

Standard Logbooks

Preparation of all stock and working standards is documented in the appropriate standards logbook. Each entry includes preparation date, initial and final concentrations (including solute and solvent amounts), standard ID number, expiration date and the identity of the person preparing the standard. Stock solution entries include standard lot number and supplier. Working solution entries include the stock solution ID number. Commercially prepared stock standards are recorded in the stock standard logbook.

Sample Storage Temperature Logs

The temperature of all refrigerators and freezers used for sample and standards storage is monitored daily. The temperature and recorder's initials are recorded on the temperature log attached to each unit. The acceptable temperature range for each unit is noted on the log sheet. Any out of control temperatures and/or corrective actions, must be noted on the log sheet and reported to appropriate personnel (Lab Supervisor and QA Manager)

Balance Calibration Logs

The true and measured values for each calibration check weight are recorded, along with the date and recorder's initials. Any actions taken, such as notifying the QAPM of malfunctions is indicated alongside the entry for that date.

Instrument Logs

The Instrument Run Logs must detail all samples analyzed on a given instrument for a given parameter. Instrument conditions, analysis date and time for each sample, analyst initials and standard or sample identifications in the analytical sequence must be recorded in the log. Comments related to sample analysis and minor maintenance are noted on the instrument logs. For GC/MS analyses, instrument performance is documented by recording internal standard response alongside the sample identification.

Sample Preparation/Analysis Worksheets

Sample preparation and analysis activities are documented on appropriate worksheets. Sample identifications, weights or volumes used, intermediate cleanups, final volumes, preparation dates and analyst initials will be noted as well as any observations about

sample condition. Any issues encountered during sample preparation are also noted. Surrogate and spiking solution ID numbers, and concentrations added to the samples, must be indicated on the bench sheet.

For some parameters, analytical results are summarized on an analysis worksheet. Sample identifications, sample preparation information, sample results, quality control results, analysis date, analyst initials and reported detection limits must be indicated on the worksheet. Any necessary data qualifiers are also noted on the worksheet.

Maintenance Logs

All major maintenance performed on instrumentation or laboratory equipment must be documented. Maintenance performed, date and analyst performing the maintenance, and steps taken to verify that the maintenance was successful are detailed in the log. Routine maintenance of GC-MS instruments is documented on “maintenance cards” attached to each instrument. The demonstration that GC instruments are in-control following maintenance is documented in the instrument run log.

Individual Laboratory Notebooks

Staff members preparing USEPA CLP samples must maintain unique laboratory notebooks for these analyses. Each case submitted is documented on a separate, sequentially numbered page. A listing of all samples prepared as part of the case, the date and the preparer′s initials, and any notes specific to sample preparation must be annotated in the logbook. Individual notebooks are used only when required by a specific contract. All sample preparation information is recorded on a laboratory bench sheet.

5.5 Document /Data Storage and Archival

Logbooks

All active logbooks will remain in the appropriate laboratory sections. Completed logbooks will be forwarded to the QAPM for archival.

Magnetic Tapes and Diskettes

When instrument capabilities permit, all data generated is archived and stored on magnetic tapes or disks. The electronic media remains on file for five years.

Chromatograms and Instrument Documentation

Electronic or paper copies of chromatograms, instrument calibrations, quantification reports and any other printed documentation generated during sample analysis are maintained as part of the permanent data files. All hardcopy data remain on file at ARI for five (5) years or as specified by contract.

Project Data and Documentation

Project data and support documentation, electronic or paper copies, will be filed a minimum of five years, or as specified by contract.

SECTION 6: SAMPLE CONTROL

All samples analyzed by the laboratory will be monitored in accordance with sample control procedures. Sample control includes operations such as container preparation, sample collection, receipt and storage, and tracking of the sample throughout all processing steps. Documentation of all sample control activities and adherence to standard procedures is an important aspect of ensuring that data quality objectives are met.

6.1 Sample Collection

Production of quality analytical data begins with proper sample collection. Improper sampling procedures may result in inaccurate final results. Although the laboratory is not routinely involved with sample collection, it will minimize the possibility for error by providing clients with appropriate sample containers and sampling instructions for the requested parameters. If, upon receipt, sample integrity appears to be compromised, the client will be immediately notified to allow for re-sampling if necessary.

6.2 Sample Container Preparation and Shipment

To minimize the possibility of contamination from containers furnished by outside sources, the laboratory will furnish all necessary sample containers for client projects when requested by the client. Sample containers, pre-cleaned to EPA specifications, or certified clean by the manufacturer or ARI, are supplied for most parameters. Containers for special purposes may be acquired upon request. Lot numbers for containers are tracked to link bottle orders to lot numbers.

A blank sample label is affixed to each sample container prior sending the container to a client. The sample label allows for recording of the following information at the time of collection: client name, client sample identification, sampling site, date and time of sample collection, analytical parameters, and any preservatives used. Sample labels provided by ARI are coated to prevent bleeding of recorded information if labels become wet.

To ensure that the correct number of appropriate sample containers are prepared and submitted to the client, a Bottle Request is completed by a Client Services staff member or Project Manager at the time sample containers are ordered by the client. All necessary preservatives are also noted on the Bottle Request. The Bottle Request is then forwarded to

appropriate personnel in the Sample Receiving Section for order preparation. All required containers will be gathered and preservatives added as specified. A copy of the Bottle Request accompanies the sample containers to allow the client to verify that the order is properly filled. Additional containers will be supplied for quality control purposes and in case of container breakage or sampling complications. A complete listing of containers and preservatives used within the laboratory is included as Appendix F.

To facilitate transportation of containers to the sampling site, sample containers will be placed in coolers along with appropriate packing material. The inclusion of packing materials, such as vermiculite or “bubblewrap”, is provided to minimize the possibility of container breakage and cross-contamination. Sample containers will be organized in the coolers per analytical or client specifications. Depending on client preference and project requirements, coolers and sample containers will be shipped to a specified location, delivered by ARI courier, or held at the laboratory for pick up. To ensure that sample identification, analytical parameters, and sample custody are properly documented, Chain of Custody records will accompany all sample container shipments. When appropriate, as for drinking water source sampling events or for parameters that require preservation in the field, sample collection instructions will also be included with shipments.

6.3 Sample Admission

All samples received by the laboratory are processed in a central Sample Receiving area. To ensure the safety of staff members receiving samples, coolers will be opened under a hood or in a well-ventilated area. Appropriate protection, such as disposable gloves, safety glasses and laboratory coats will be worn during sample receipt and log-in. Additionally, all general safety practices as specified in ARI’s Chemical Hygiene Plan will be employed.

Upon receipt, sample coolers will be inspected for general condition and custody seals. Time and date of sample receipt, as well as identification of the staff member receiving the samples, will be indicated on each Chain of Custody record accompanying the shipment. Cooler temperatures will be determined using an IR temperature measuring device or by placing a thermometer in the cooler immediately after the cooler is opened. If samples cannot be logged-in within 30 minutes after receipt, the sample coolers will be tagged and placed in the walk-in sample storage refrigerator for short-term storage. Chain of Custody records for the

stored coolers will remain in Log-In to ensure that processing of the stored samples is not overlooked.

Samples to be processed will be removed from the coolers and organized by sample identification. The number and type of sample containers received will be verified against the Chain of Custody record. Each sample container will be examined to verify that the condition is acceptable and that sample integrity has not been compromised during shipment. Sample containers broken during shipment should be handled according to procedures detailed in the Chemical Hygiene Plan (Section 5, Waste Disposal Procedures).

After sample organization and initial inspection has been completed, sample information will be entered into the LIMS, and a Service Request will be generated for the sample set. The Service Request serves as a work order for the laboratory. The Service Request will contain the following information:

Client Name
Client Project Name and/or Number
Client Contact
Verified Time of Sample Receipt (VTSR)
Required Turnaround Time
Laboratory Job Number
Client Sample Identifiers(s)
Laboratory Sample Number(s)
Required Parameters
Additional Analytical Requirements/Comments

Also entered into the LIMS are the number of sample containers for each sample, sample conditions, and cooler temperatures.

A sequential laboratory job number will be assigned to each sample set. Laboratory sample numbers, determined by the job number and a sequential letter, will be assigned to each sample. Containers for each sample will also be numbered sequentially. The accuracy of sample container labeling is verified by a second person. These identifiers will be used to monitor the sample set and container throughout sample processing. All samples logged for the sample set and the analytical parameters required for each sample will be indicated on the Service Request. Client specific quality control requirements and any other pertinent information indicated on the Chain of Custody Record will also be noted. Discrepancies

between the Chain of Custody record and sample containers will be noted, as well as discrepancy resolutions. To reduce the possibility of inaccurate sample processing, the sample receiving staff working with the Project Manager will resolve all noted discrepancies prior to releasing the samples to the analytical sections.

Upon completion of sample log-in, all documentation will be placed in a master folder and forwarded to the assigned Project Manager for review and approval. The master folder will be color-coded as follows:

Master File Color	Designation
Red	Accelerated Turnaround (≤ week)
Blue	Accelerated Turnaround/Fuels
Clear	Routine Turnaround

The Project Manager will review all aspects of the documentation, specify any additional analytical requirements and resolve any remaining discrepancies before sample processing begins. After Project Manager final approval has been obtained (indicated by the Project Managers initials and the date on the Service Request and laboratory-specific parameter sheets), the master file will be returned to Log-In for preparation of laboratory job folders. A job folder will be created for each laboratory section involved in sample processing for a given project. Laboratory job folders are color-coded as follows:

Job Folder Color	Designation
Red	Accelerated Turnaround (≤ 10 days)
Manila	Normal Turnaround (11 to 14 days)
Blue	Accelerated Turnaround (≤ 7 days) for Fuels Analyses (NWTPH, AK103 etc.)
Yellow	Extended Turnaround (>14 day TAT)
Other (Green, Purple ,etc)	Client or Project Specific Analyzes

Copies of the Service Request and all pertinent laboratory-specific documentation required to accurately complete sample analysis will be placed in each laboratory job folder. Laboratory

job folders will then be distributed to appropriate laboratory sections for analysis and incorporation into the section tracking system.

Subcontracting Policies

ARI may be required to subcontract work to other laboratories. The following policies are followed to assure that data produced by a subcontractor is high quality, defensible and will meet the client's expectations.

1. ARI's client must be made aware that samples will be subcontracted and what laboratory will perform the analyses.
2. Subcontractor laboratories must qualify to perform the analyses using the same criteria applied to ARI. When appropriate, subcontracted laboratories must submit proof of certification or accreditation, quality assurance plans, standard operating procedures, results of method detection limit studies, control limits to ARI. ARI may at its discretion perform an on-site assessment of subcontracted laboratories. Failure to submit requested documents or refusal of an on-site assessment will disqualify laboratories from subcontracting ARI sample analyses.
3. ARI will not subcontract Department of Defense work to be performed under the Quality Systems Manual (DoD-QSM) unless the subcontract lab is approved to perform DoD-QSM analyzes.
4. The sample information and analytical requirements are first entered into the ARI LIMS in the same way that samples for in-house analyses are processed. Subcontractor laboratories are contacted to verify their preparedness, and samples are then submitted to them using ARI chain-of-custody forms. These chain-of-custody documents are included in the master folder for the project.
5. ARI may request that subcontract laboratories analyze, on double blind performance testing (PT) sample obtained from commercial vendors at the subcontractor's expense.
6. The laboratory must be willing to maintain an annual contract with ARI, and must list ARI as a co-insured on the subcontract laboratory's liability insurance policies.
7. Financial stability is also evaluated on a lab-by-lab basis.

6.4 Sample Custody

To ensure the traceability of sample possession, chain of custody is documented from sample collection to completion of final analysis, and is maintained during sample storage in archive prior to disposal. This is achieved through completion of a written chain of custody record. Custody of all samples and extracts processed by the laboratory is documented at each step of the analytical process.

The National Enforcement Investigations Center (NEIC) of EPA defines custody in the following ways:

It is in your actual possession, or
It is in your view, after being in your physical possession, or
It was in your possession, then you locked or sealed it up to prevent tampering, or
It is in a secure area.

Sample handling may vary and specific custody procedures have been developed for each laboratory section.

Custody at Sample Log-in

A Chain of Custody Record must accompany all samples received by the laboratory. This record documents all sampling activities as well as persons handling the samples prior to receipt by the laboratory. Sample receiving staff assumes custody of samples upon receipt from the client or courier. Samples will remain in the custody of Sample receiving until the samples are delivered to a laboratory section. Should samples require shipment to a subcontracting laboratory, a separate Chain of Custody Record will be completed to document the sample transfer. Chain of Custody records will be included with sample data reports in the final analytical package submitted to the client. Copies of these records will be filed with project data.

Custody of Volatile Organic Analysis (VOA) Samples

Upon completion of sample the sample receiving process, samples requiring analysis for volatile organic analysis will be placed in the VOA refrigerator designated for incoming samples and logged into the VOA sample receipt logbook. The samples are now in the custody of the VOA laboratory. To avoid possible cross-contamination of low level samples,

those samples known or suspected to contain high levels of contaminants, such as underground storage tank (UST) samples, will be stored in a separate refrigerator prior to analysis.

VOA Laboratory analysts complete the receiving process and move the samples to a refrigerator designated for “active” samples. Samples removed from storage for analysis are considered to be in the custody of the analyst responsible for sample processing. All samples to be analyzed will be listed in the analytical logbook for the selected instrument. Laboratory and client sample identifications, the bottle number and identification of the analyst performing the analysis will be indicated in the logbook. If it is necessary for sample custody to be transferred to another instrument or analyst, the second analyst will record this information. Thus, custody of a given sample can be traced throughout the analytical process, regardless of the number of instruments or analysts involved. Analysts will initial all raw data generated from sample analysis, to further document sample custody.

After completion of sample analysis, soil and intact water sample containers will be placed in the refrigerator designated for sample archival. Any water sample remaining in the container after completion of analysis will be considered compromised and will be discarded. The samples will remain in archive and in the custody of the VOA laboratory until final disposal.

Custody of Semi-volatile Organic Analysis (SVOA) Samples

Upon completion of sample log-in, samples requiring extraction for organic parameters will be placed in walk-in cooler number 5. All samples placed in the cooler will be logged into the *Walk-in Admission Logbook*. Removal of samples from the refrigerator for processing by Extractions or Conventional personnel must be indicated in the *Walk-in Admission Logbook*. Samples stored in this walk-in refrigerator remain in Log-In custody until removed to a laboratory for processing.

The analyst responsible for the custody and initial handling of samples within the sample preparation laboratory will be indicated on the Sample Preparation Worksheet. All analysts involved in the subsequent steps of sample processing will also be indicated on the worksheet. Residual sample volumes will be archived in the refrigerator designated for extractable organic samples. Transfer of residual samples to this refrigerator will be documented in the *Sample*

Archive Refrigerator Logbook. Transfer of prepared sample extracts to the appropriate analytical sections will be documented in the Extract Log in the preparation laboratory and in the Extract Log in the analytical section. Upon extract transfer, the analytical section receiving the extract assumes custody.

Extracts removed from storage for analysis are considered to be in the custody of the analyst responsible for analysis. Removal of extracts for analysis will be indicated in the Extract Log in the analytical section. All extracts to be analyzed will be indicated in the analytical logbook for the selected instrument. Laboratory and client sample identifications, as well as the analyst performing the analysis will be indicated in the logbook. Analysts will initial raw data generated from extract analysis to further document sample custody. After completion of analysis, extracts will be placed in the refrigerator designated for archive. Extracts will remain in storage and in the custody of the analytical section until final disposal.

Custody of Inorganic and Metals Samples

Upon completion of the sample receiving process, samples requiring preparation or analysis for inorganic parameters will be placed in the designated walk-in cooler. Selected samples such as those requiring a critical analysis are placed directly in the laboratory. Removal of samples from the refrigerators for digestion and/or analysis will be indicated in the *Walk-in Admission Logbook* for the appropriate refrigerator. Samples stored in the walk-in refrigerators remain in Log-In custody until the laboratory removes the samples for processing.

The analyst responsible for custody and initial handling of samples within the metals preparation laboratory will be indicated on the Sample Digestion Worksheet. All analysts involved in the subsequent steps of sample processing will also be indicated on the worksheet. Transfer of completed sample digests to the metals instrument (analysis) laboratory will be documented by the metals preparation laboratory. Upon transfer of digests, custody is considered to be the responsibility of the analytical section receiving the digests.

Digests removed from storage are considered to be in the custody of the responsible analyst. All digests to be analyzed will be indicated in the analytical logbook for the selected instrument. Laboratory sample identifications and the analyst performing the analysis will be indicated in the logbook. If it is necessary for digest custody to be transferred to another instrument or

analyst, the second analyst records this information. Thus, custody of a given digest can be traced throughout the analytical process, regardless of the number of instruments or analysts involved. Analysts will initial all raw data generated from digest and analysis to further document sample custody. After completion of analysis, digests will be stored by and remain in the custody of the analytical laboratory personnel until final disposal.

The analyst performing the sample analysis will remove samples requiring analysis for other inorganic (conventional) parameters from storage. Removal will be documented in the *Walk-in Admission Logbook*. Custody of the sample will be considered to be the responsibility of that analyst. All samples to be analyzed will be indicated on the worksheet for the required parameter. Laboratory sample identifications and the analyst performing the analysis will be indicated on the worksheet. If it is necessary for sample custody to be transferred to another instrument or analyst, the second analyst will record this information. Thus, custody of a given sample can be traced throughout the analytical process, regardless of the number of instruments or analysts involved. The analysts' initials will be indicated on the worksheet to further document sample custody.

Special Chain of Custody Requirements

Should a client project require additional or more detailed custody documentation, requirements will be incorporated into the procedures for that project. Samples processed as part of the USEPA Contract Laboratory Program require more stringent chain of custody procedures. For this program, removal of samples and extracts for analysis (or any reason) will be documented in the Sample Control Log. Date, time and reason for removal, and date and time of return, will be fully documented. Removal of samples or extracts for permanent archiving or disposal will also be fully documented in the Sample Control Log.

6.5 Sample Archival and Disposal

After completion of analysis, unused sample aliquots are routinely stored for a specified period of time: 30 days for water samples and 60 days for soil samples. Colored markers are placed on samples with specific storage requirements during the sample receiving process. The color-coding is defined in the following table:

Label Color	Storage Requirement
Red	Hold until further notice
Orange	Suspected Hazardous
Yellow	Shared Sample Containers
Blue	Samples to be frozen

Samples submitted for archival will be logged into the Sample Archive Logbook. Laboratory and client identifications, as well as archive date will be indicated in the logbook. The anticipated disposal date for the sample set will also be noted. The logbook will be reviewed several times during each week to determine samples scheduled for disposal. On or soon after the scheduled disposal date, the samples will be removed from archive storage and disposed.

In consideration of disposal requirements for hazardous samples, each sample processed by the laboratory will be evaluated for contamination levels based on final analytical results. Those samples containing analytes of interest at or above regulated disposal levels will be identified and handled as hazardous waste. A designated staff member coordinates periodic pickup and disposal of hazardous waste by an USEPA approved TSD (Treatment, Storage, and Disposal) Company and maintains hazardous waste disposal records. Specific guidelines for handling hazardous samples and waste are detailed in the Chemical Hygiene Plan (Section 5, Waste Disposal Procedures)

SECTION 7: PROJECT MANAGEMENT AND TRACKING

7.1 Project Management

Concise and accurate communication between a client and ARI, and within the laboratory, is an extremely important requirement for generating quality analytical results. All clients contracting with ARI will be assigned to a Project Manager. The Project Manager confirms that project requirements are consistent with laboratory capabilities, and coordinates with laboratory sections to provide analytical results within specified project timelines. Project organization, monitoring, and follow-up is the responsibility of Project Management staff.

Client project requirements and Project Managers' areas of expertise will be considered for client assignment. To ensure that all clients and projects receive the attention necessary for successful project completion, Project Manager workloads will also be considered. Project Managers will serve as the central focus for all project related activities and communications.

The Project Manager will review work plans and requirements for all pending projects. Any questions related to the work plan will be addressed prior to project commencement. The Project Manager will consult with appropriate analytical sections to clarify any issues regarding procedures and capabilities. Project deliverables requirements will also be addressed at this time. Upon receipt and log-in of project samples, the Project Manager will review all documentation to ensure that samples were properly logged in, and that analytical and QC requirements were correctly specified. The Project Manager will also provide any additional project related information that will assist the analytical sections with sample analysis. Laboratory sections will not process a sample until Project Manager approval has been given. Exceptions are parameters with critical (less than 48 hour) holding times or those that arrive on weekends or holidays when none of the Project Managers can be contacted.

Throughout the project, the Project Manager will monitor all analytical activities to help ensure that the project is completed and delivered on schedule. Any issues arising during sample processing will be promptly discussed with the client. Likewise, the analytical staff will be informed of any client concerns or project modifications. The Project Manager will also address any issues that arise during subsequent review of the analytical data by the client.

7.2 Project Tracking

Monitoring the laboratory workload ensures that adequate staffing and equipment will be available to produce quality analytical data and meet client needs. At the time a client project is tentatively scheduled, information regarding the project will be documented in the Project Management Database. Project particulars, sample quantities, parameters and anticipated sample delivery dates will be specified, as well as any prearranged analytical costs. Project work plans and any other project information will be kept on file with the Project Manager. Schedules for pending projects are communicated to the lab sections through periodic distribution of database printouts. Upon receipt of project samples, the project Inquiry number will be referenced to ensure project requirements are accurately specified. The original project documentation will be placed in the master folder as part of the project file.

Each laboratory section analyzing project samples will be responsible for ensuring that all analyses are accurately completed by the required date. All staff members are required to be aware of holding times, special analytical requirements, and required turnaround times. Analytical sections will remain in close communication with the Project Management staff so that any issues arising during sample analysis can be promptly addressed or discussed with the client.

Project Managers or their designee are responsible for monitoring project status. Sample status reports are generated as needed from LIMS and are distributed to lab sections and Project Managers. These reports allow the Project Managers to review project status and identify any samples which must be expedited to meet project timelines. Additionally, verbal communication between Project Managers and lab sections provides information about project status.

After sample analysis, report generation, and final review have been completed, data and final reports will be forwarded to the Project Manager. If requested, preliminary and interim results will be forwarded to the client. When all final data are available, the Project Manager will assemble the final package, verifying that all analyses were completed and project requirements met. A project narrative detailing the particulars of sample processing will be generated. After assembly and prior to shipment, the Project Manager will perform a final, cursory review of the package for any inconsistencies or incorrect information. The package will then be forwarded to clerical

personnel for photocopying and shipment. The Project Manager will determine final analytical costs and submit this information to the Accounting department for invoicing. Upon completion, all raw data and documentation associated with each client project will be compiled and stored as part of the laboratory project files. A chart detailing laboratory workflow as described in this section is included as Appendix G.

SECTION 8: ANALYTICAL METHODS

To ensure that all data generated are consistent and comparable, clearly defined procedures will be followed for all aspects of sample processing, control and management. Standard Operating Procedures (SOPs) provide detailed guidelines for completing a procedure. Document control procedures and periodic audits will ensure that operations are performed in accordance with the most current SOPs. All routine deviations from published will be noted in the SOPs. Analysis specific deviation will be noted in Analyst Notes and in the Analytical Narrative.

8.1 Responsibilities

It is the responsibility of staff members to perform all procedures in accordance with the guidelines specified in the Standard Operating Procedures. Laboratory management is responsible for ensuring that SOPs are followed throughout the laboratory. The QAPM is responsible for coordinating periodic review and revision of existing SOPs and generation of additional SOPs. The QAPM is also responsible for maintaining SOP document control and ensuring that the most current versions of all SOPs are available to staff members.

8.2 Methods

Laboratory procedures may reference any established methods specified in the following publications:

1. *Code of Federal Regulations (Section 40)*
2. *Test Methods for Evaluating Solid Waste (USEPA SW-846)*
3. *USEPA Contract Laboratory Program Statement of Work for Organic Analysis*
4. *USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis*
5. *Methods for Chemical Analysis of Water and Waste (USEPA 500 and 600 series)*
6. *Standard Methods for the Examination of Water and Wastewater*
7. *Protocols for Measuring Selected Environmental Variables in Puget Sound (PSEP)*
8. *Navy Installation Restoration Laboratory Quality Assurance Guide(February 1996)*
9. *Hazardous Waste Remedial Actions Program (HAZWRAP)*
10. *State of Alaska Department of Environmental Conservation (ADEC)*
11. *Oregon Department of Environmental Quality (DEQ) Petroleum Hydrocarbon Methods*
12. *Washington Department of Ecology (WA-Ecology) Guidance for Remediation of Releases from Underground Storage Tanks (Appendix L)*
13. *The Department of Defense Quality Systems Manual (DoD-QSM)*
14. *Washington State Sediment Sampling and Analysis Plan*

The laboratory will adhere to established methods whenever possible. Occasionally, however, procedures determined to provide more accurate final results will be incorporated into the method. Should the laboratory procedures deviate from the established method, all modifications will be detailed in the associated SOP. A listing of laboratory SOPs is included as Appendix E.

8.3 Standard Operating Procedures

Standard Operating Procedures (SOPs) are detailed, step-by-step instructions for completing a laboratory operation. An SOP is available for all procedures within the laboratory, from initial project identification to final data archival. SOPs are generated for procedures developed within the laboratory and for those that follow established methods.

To ensure consistency in defining procedural guidelines, all SOPs that describe analytical procedures will contain the following sections:

1) Method, matrix or matrices, detection limit, scope & application, components to be analyzed
2) Summary of the test method
3) Definitions
4) Interferences
5) Safety
6) Equipment and supplies
7) Reagents and standards
8) Sample collection, preservation, shipment and storage
9) Quality control
10) Calibration and standardization
11) Procedure
12) Data analysis and calculations
13) Method performance
14) Pollution prevention
15) Data assessment and acceptance criteria for quality control measures
16) Corrective actions for out of control data
17) Contingencies for handling out-of-control or unacceptable data
18) Waste management
19) References
20) Appendices, tables, diagrams, flowcharts and validation data.

SOPs will be monitored through the laboratory document control system. Each SOP will be assigned a document control number as detailed in Section 5.2 of this LQAP. SOPs are revised whenever a laboratory procedure is changed or modified. All SOPs are reviewed and revised as necessary at least once a year. Personnel normally performing the procedure or

analysis perform the review. SOPs will be generated for each new procedure implemented within the laboratory. Review, modification, new SOP generation, and distribution will be coordinated through the QAPM. The QAPM will periodically audit the laboratory sections to verify that the most current versions of all SOPs are in use. Document release will be controlled as detailed in section 5.2.

8.4 Method Selection and Use

Method selection will be based on availability of analytical instruments and equipment, chemical standards, expected method performance and marketability. Methods that are defined and accepted by regulatory agencies and familiar to ARI's clients are preferred. The Laboratory Manager and QAPM in consultation with marketing, client service, and laboratory supervisory staff are responsible for selecting appropriate methods. Client or project-specific methods may be used when appropriate.

The most recently promulgated method will be used for all procedures. Non-promulgated methods will be investigated if requested by a client. Section supervisors and managers are responsible for ensuring that the procedures in use reflect the requirements of the promulgated methods. Any modifications made to the method must be documented in the SOPs. Method modifications may be acceptable, provided all acceptance criteria specified in the method are met.

Section supervisors and managers review newly promulgated methods. SOPs will be modified as necessary to reflect the new methods. When possible, the annual SOP review will be coordinated with anticipated method promulgation dates. This is especially useful for large method compilations, such as SW-846. If the annual SOP review and method promulgation cannot be coordinated, SOPs will be revised as soon as possible after a method has been promulgated, especially when method changes are significant.

SOPs will be generated to reflect the most commonly used methods and protocols. If more than one method is used for an analysis, separate SOPs should be generated. Several methods may be incorporated into one SOP, provided that each method is clearly identified and defined in the SOP. Method modifications or special requirements for ongoing projects, or for specific programs (Navy, CLP, etc.), will be incorporated into the SOP. These

requirements will be annotated to indicate that they are project/program specific. Analysts and technicians will be responsible for ensuring that, when required, project or program specific procedures are followed. SOPs will be controlled as specified in section 5.2.

8.5 Method Performance

Method performance must be demonstrated for all new methods prior to using methods for sample analysis. Section supervisors and managers are responsible for ensuring that method performance is demonstrated and support procedures have been performed.

Method performance will be demonstrated in the following manner:

A draft SOP will be generated for the method. The SOP must provide sufficient detail to perform the analysis and must accurately reflect the published method. Any steps in the method for which analyst discretion is allowed must be clearly defined.

A method detection limit (MDL) study must be performed for the method. Method detection limits must be verified to be at or lower than any method-specified detection limits. Method detection and reporting limits must be established.

Method precision and accuracy must be evaluated. This may be determined using an MDL or IDL study. Replicates will be evaluated for precision; analyte values will be compared with spike amounts to determine accuracy. Any method-specified precision and accuracy criteria must be met.

All method performance results will be reviewed and compiled by the section supervisor. Results will be filed with the QA section. A final SOP will be generated and distributed. MDL updates will be communicated to Computer Services for LIMS updates and distributed to laboratory sections as needed.

SECTION 9: INSTRUMENT CONTROL

9.1 Detection Limits

To verify that reported limits are within instrument and method capabilities, three levels of detection have been established: instrument detection limits, method detection limits, and reporting limits. Instrument and method detection limits are statistically based values, determined from replicate analyses of analytical standards. Reporting limits are based upon the experience and judgment of an analyst. Reported values will be qualified based on the established limits. All limits will be summarized and controlled by the QAPM and are included as Appendix I.

Instrument Detection Limits

The instrument detection limit (IDL) is considered to be the smallest signal above background noise that an instrument can reliably detect. This limit reflects whether or not the observed signal has been caused by a real signal or is only a random fluctuation of noise from the blank. The IDL does not take into consideration the performance or efficiency of analytical methods.

Instrument detection limits are determined annually, or when ever a major change has been made, for each instrument in the metals analysis laboratory. Seven replicates, of a blank, or standards containing analytes at levels three to five times the expected IDLs are analyzed on three non-consecutive days. The IDL value for an analyte is three times the average of the standard deviations from the three replicate sets of analyses.

Method Detection Limits

The method detection limit (MDL) is considered to be the lowest concentration of an analyte that a method can detect with 99% confidence. Method detection limits will be established for all analytical parameters according to the guidelines specified in the Code of Federal Regulations, Section 40. Seven replicate samples are fortified with target analytes at levels that are one to five times (but not exceeding 10 times) the expected detection limits. The MDL for an analyte is determined to be the standard deviation of the replicates times the appropriate

student's t-test value. More than seven replicates may be processed, but all replicates must be used in the MDL determination. MDLs are verified by analyzing a sample spiked at a concentration 3 to 5 times the calculated MDL concentration. When the analyte(s) are detected the MDL is verified. When the analytes is not detected, the concentration in the verification sample is increased until it is detected. The concentration at which the analytes is first detected then becomes the MDL.

Laboratory supervisors or managers review all statistically determined MDLs for accuracy and validity. The section supervisor or manager is responsible for ensuring that any unusable MDL studies are reprocessed. Once accepted, MDL study results and associated raw data will be forwarded to the QA section for further review and additional approval. MDLs approved by both section management and QA will be considered final and acceptable for use. Finalized MDL values are forwarded to Computer Services for incorporation into ARI's LIMS.

MDL studies will be conducted for all analyses performed by the laboratory on representative water, sediment and, tissue samples when appropriate and suitable sample matrices are available. MDL studies will be performed on all instruments used for sample analysis. To allow for reevaluation of method performance, MDL studies will be performed on an annual basis. The QAPM is responsible for ensuring that all MDL studies are performed at least annually. Section supervisors and managers are responsible for determining if and when additional MDL studies should be performed due to changes in analytical methods, instrumentation or personnel.

Reporting Limits

Reporting Limits (RL) are the lowest quantitative value routinely reported. Analytical results below the RL will be expressed as "less than" the reporting limit. RLs are estimated values based upon the MDLs, experience and judgment of the analyst, method efficiency, and analyte sensitivity. No reporting limit will be lower than its corresponding MDL. RLs will be verified on a regular basis either by having a calibration standard at the limit or by analyzing a standard at the RL immediately following initial calibration.

Analytical Standards

Generation of high quality results is dependent upon the use of accurately prepared analytical standards. Many stock standards used within the laboratory are commercially prepared solutions with certified analyte concentrations. Neat standards used for stock standard preparation are of the highest purity obtainable. Standard preparations are fully documented in appropriate logbooks.

Responsibilities

It is the responsibility of each laboratory employee involved with standards preparation to ensure that all standards are correctly and accurately prepared through the use of good laboratory practices and analytical verification. It is also the responsibility of these staff members to properly document the receipt and/or preparation of all standards. Management is responsible for ensuring that all staff members follow specified standards preparation and inventory procedures. The QAPM is responsible for periodically auditing standard preparation records to verify compliance with the laboratory Quality Assurance Program.

Organic Standards Preparation

Two types of standards are utilized for extractable organic compounds: neat standards from which stock solutions are prepared, and commercially prepared stock solutions from which working solutions are prepared. The type of standard depends upon availability. Commercially prepared standards are preferred when available.

Preparation of stock solutions will be documented in the Stock Solutions Log. To ensure traceability, commercially prepared stock solutions will also be documented in the Stock Standard Solutions Log. Each solution will be assigned a unique stock number determined by the page number and entry number on the page, preceded by “S” to indicate the solution is a stock, volatile stock standard are labeled “VS”. For example, the third entry on page 44 will be assigned the stock number S44-3. For stock solutions prepared from neat standards, the compound(s), supplier, lot number, preparation schematic, preparation date, expiration date, and analyst initials will be recorded. After preparing the standard, another analyst should review the preparation information to verify accuracy. For commercially prepared stock solutions, the compound, supplier, lot number and expiration date will be recorded. As a stock

solution is not actually prepared in-house for these commercial solutions, it is not necessary to record or verify a preparation schematic.

Preparation of working solutions (including spike and surrogate solutions) will be documented in the Working Standard Solutions Logbook. Each solution will be assigned a working standard number determined by the page number and entry number on the page. For example, the second entry on page 73 will be assigned the working standard number 73-2. For volatile organic standards, the working standard number is preceded by "VW". The compound, stock solution reference, preparation schematic, preparation date, expiration date, and analyst initials will be recorded. After preparing the standard, another analyst will review the preparation information to verify accuracy. After analyzing the standard and confirming that it is acceptable, analytical verification will be documented in the logbook.

Discarded or consumed standards will be annotated in the logbook by drawing a single line through the entry, indicating "discarded" or "consumed" above the line with confirming initial and date. Existing standard numbers will not be reused. Instead, each new stock or working solution made will be assigned a new number.

Standards preparation will be performed in accordance with good laboratory practices. Syringes, glassware and other preparation equipment will be thoroughly cleaned prior to and after use. Standard material weights and solution volumes will be accurate to ± 3%. Neat standards that are less than 97% pure must be corrected for concentration. Standard solutions will be stored in amber bottles with Teflon-lined caps. Each standard solution will be labeled with the solution number, compound, analyst initials and expiration date. Stock solutions will be stored in the appropriate standards freezer; working solutions will be stored in the appropriate standards refrigerator.

Metals Standard Preparation

Commercially prepared single element stock solutions are used for all elements. Preparation of working solutions from these single element stocks will be documented in the Solutions Logbook. Preparation of check standards will also be documented in the Solutions Logbook. The element, preparation schematic, preparation date, expiration date, and analyst initials will be recorded. Working calibration standards are prepared weekly for furnace and ICP analyses

and as needed for ICP-MS. Calibration verification standards are prepared daily for GFA analyses and as needed for ICP and ICP-MS analyses.

Standards preparation will be performed in accordance with good laboratory practices. All preparation equipment will be thoroughly cleaned prior to and after use.

Inorganic (Wet Chemistry) Standard Preparation

Working standards for wet chemistry parameters will be prepared on a daily basis, prior to starting an analysis. Stock and check standard solutions will be replaced as solutions expire or are consumed. Stock and check standard solutions will be labeled with the compound, preparation data (weight and volume), units of concentration, preparation date, expiration date, and analyst initials.

Standards preparation will be performed in accordance with good laboratory practices. Glassware and other preparation equipment will be thoroughly cleaned prior to and after use. Standard material weights and solution volumes will be accurate to ± 3%. Stock standards will be stored in containers appropriate for the parameter.

9.3 Calibration

Instrumentation and equipment used for sample processing and analysis must be operating optimally to ensure that accurate analytical results are generated. Verification of optimum operation is accomplished through various tuning and calibration procedures. Criteria for determining the accuracy of calibration are specified for all instrumentation and equipment. Prior to sample analysis, calibrations will be analyzed and evaluated against specified acceptance criteria. Acceptance criteria are either published as part of the method or generated at ARI using control charts. Calibration verifications will also be analyzed throughout an analytical sequence to ensure that instrument performance continues to meet acceptance criteria.

Gas Chromatography/Mass Spectrometry (GC/MS)

All GC/MS systems will be evaluated through analysis of an instrument performance check solution and calibration standards. The composition of the standards varies depending on the analysis performed on the system. System evaluation will be performed prior to sample

analysis. Evaluation criteria used for GC/MS analyses are as specified for the SW846 methods.

Instrument Performance Check Solution - Prior to analysis, the system will be evaluated to ensure that mass spectral ion abundance criteria are met. Bromofluorobenzene (BFB) is analyzed for volatile organic analyses and Decafluorotriphenylphosphine (DFTPP) is analyzed for semi-volatile organic analyses. All ions must meet method-specified criteria.

The instrument performance check solution will be analyzed at a minimum of every 12 hours during the analytical sequence. Each analysis of the check solution will be verified against the specified criteria.

Calibration - After instrument performance has been verified, each GC/MS system will be calibrated to verify response linearity. For volatile organic analyses, up to eight standards ranging from 1 to 200 µg/L will be analyzed. For semi-volatile organic analyses, five to seven standards ranging from 2 to 80 µg/L will be analyzed. The standard levels evaluated will vary depending on the compound. Initial calibration results will meet percent relative standard deviation acceptance criteria.

A continuing calibration verification standard at a mid-level concentration (routinely 50 µg/L for VOA and 250 µg/L for SVOA) will be analyzed at a minimum of every 12 hours during the analytical sequence. For continuing calibrations, minimum response factor and percent difference criteria will be considered in evaluating the acceptability of the calibration. Initial and continuing calibration acceptance criteria for volatile and semi-volatile organic analyses are presented in Appendix J. All calibration data printouts will include the following documentation:

Date of calibration,
Identification of standard used
Identification of person performing the calibration

The analyst performing the calibration will include documentation of any problems encountered during the calibration analyses with the data, and will also note any corrective actions taken. The calibration data will be tabulated, and summary statistics will be generated. These results will be kept on file with the raw data in the Data Services section.

Internal Standard Responses - Internal standard responses and retention times in all standards will be evaluated immediately after analysis. This will serve as a baseline from which all sample internal standard responses and retention times will be evaluated.

Gas Chromatography (GC)

Each GC and HPLC system will be calibrated to verify response linearity. Depending on the parameter, five to seven standards at concentrations covering the linear range of the

instrument will be analyzed. Percent relative standard deviations for initial calibrations will not exceed SW-846 limits or 25% when those limits are not applicable.

A continuing calibration standard at mid-range concentration will be analyzed after every 10 samples or more frequently if the method or conditions warrant. Percent differences between initial and continuing calibrations will not exceed SW-846 limits or 25% when those limits are not applicable.

Calibration for organochlorine pesticides will follow SW-846 guidelines. The initial calibration sequence specifies the analysis of Resolution Check, Performance Evaluation, five-point initial calibration, individual standards and instrument blanks. Criteria for evaluating these standards are as follows:

> Performance Evaluation - The Performance Evaluation standard will be analyzed immediately following the Resolution Check standard. All standard peaks will be completely resolved. Individual breakdowns of DDT and Endrin will be less than or equal to 15% on both columns. A Performance Evaluation standard will also be analyzed at the end of the calibration sequence.
>
> Initial Calibration - The percent relative standard deviation (RSD) will not exceed SW-846 guidelines or 20% on each column.
>
> Continuing Calibration - A midpoint Aroclor 1660 and or a midpoint pesticide standard along with a performance evaluation standard are analyzed after every ten (10) sample analyses. The continuing calibration standards will be within 85 - 115% of the initial calibration. The Performance Evaluation standard will meet previously specified criteria.

The analytical sequence may continue indefinitely, provided that calibration criteria are met throughout the sequence. Additionally, retention times for all compounds will fall within the retention time windows established by the initial calibration sequence of the three standard concentration levels.

All calibration data printouts will include the following documentation:

> *Date of calibration,*
> *Identification of standard used, and*
> *Identification of person performing the calibration.*

The analyst performing the calibration will include documentation of any problems encountered during the calibration analyses with the data, and will note any corrective actions taken. The calibration data will be tabulated, and summary statistics will be generated.

Metals

Analytical instrumentation for metals will be evaluated through the analysis of calibration standards, calibration blanks, and calibration verification standards. Initial calibrations will be performed prior to sample analysis.

Inductively Coupled Plasma Atomic Emission Spectrometry (ICP)

Initial standardization is performed daily, or more frequently as required, by analyzing a blank and four multiple element standards with a single concentration for each analytical wavelength. The calibration is immediately verified with the analysis of an initial calibration verification standard (ICV) obtained from a source independent from the IC standard. The calibration will then be verified throughout the analytical sequence by analyzing a continuing calibration verification standard (CCV) after every 10 sample analyses. The calibration check standard values will be within ± 10% of the true value.

After initial calibration, a calibration blank (ICB) will be analyzed to check for baseline drift or carryover. The level of analyte in the calibration blank should be ±2 RL. Calibration blanks (CCB) will be analyzed immediately following each calibration verification standard analysis.

Following calibration verification a standard at the reporting limit (CRI) is analyzed for all elements. Warning limits have been set at ±1RL and any sample determined to have a concentration below this standard will be reported as undetected.

The upper limit of the calibration range, linear dynamic range, is established for each analytical wavelength using standards of increasing concentrations. These standards are analyzed against the normal calibration curve and must be within 10% of their true value to verify linearity. At a minimum this upper range will be checked every six months or whenever major changes are made to the instrument. Any sample analyzed with a concentration above this linear dynamic range will be diluted and reanalyzed.

Also to verify the inter-element correction equations, inter-element correction standards (ICS) are analyzed both at the start and end of the analytic run. Both the major interfering and the interfered with elements are evaluated.

Atomic Absorption Spectroscopy (Graphite Furnace and Cold Vapor)

Atomic absorption instrumentation is initially calibrated using a minimum of three standards of varying concentrations and a calibration blank. Initial calibration is

performed daily or more frequently if conditions warrant. The calibration is immediately verified with the analysis of an independent source initial calibration verification standard (ICV). The calibration will then be verified throughout the analytical sequence by analyzing a continuing calibration verification standard (CCV) after every 10 sample analyses. The initial calibration verification standard value will be within ± 10% of the true value whereas the CCV will be considered in control if it is within ±10% for Graphite Furnace analysis or ±20% for Cold Vapor analysis.

After initial calibration, a calibration blank (ICB) will be analyzed to check for baseline drift or carryover. The level of analyte detected in the calibration blank should be ±1 RL. Calibration blanks (CCB) will be analyzed immediately following each calibration verification standard analysis.

Following calibration verification a standard at the reporting limit is analyzed for all elements. Warning limits have been set at ±1RL and any sample determined to have a concentration below this standard will be reported as undetected. Any sample determined to have a concentration above the high calibration standard will be diluted and reanalyzed.

Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

Initial standardization is performed daily, or more frequently as required, by analyzing a blank and four multiple element standards. The calibration is immediately verified with the analysis of an independent source initial calibration verification standard (ICV). The calibration will then be verified throughout the analytical sequence by analyzing a continuing calibration verification standard (CCV) after every 10 sample analyses. The calibration check standard values will be within ± 10% of the true value.

After initial calibration, a calibration blank (ICB) will be analyzed to check for baseline drift or carryover. The level of analyte in the calibration blank should be ±1 RL. Calibration blanks (CCB) will be analyzed immediately following each calibration verification standard analysis.

Following calibration verification a standard at the reporting limit (CRI) is analyzed for all elements. Warning limits have been set at ±1RL and any sample determined to have a concentration below this standard will be reported as undetected.

The upper limit of the calibration range, linear dynamic range, is established for each analytical wavelength using high level standards. These standards are analyzed daily, or as necessary, against the normal calibration curve and must be within 10% of their true value to verify linearity. Any sample analyzed with a concentration above this linear dynamic range will be diluted and reanalyzed.

Also to verify the inter-element correction equations, inter-element correction standards (ICS) are analyzed both at the start and end of the analytic run. Both the major interfering and the interfered with elements are evaluated.

Inorganic Analyses other than Metals (Conventional Analyses)

Instrumentation and equipment used in analyzing samples for conventional wet chemical parameters (predominantly inorganic anions and aggregate organic characteristics) will be evaluated through the analysis of either internally prepared primary standards or externally derived Standard Reference Materials.

Depending upon the analysis, calibration is based upon direct stoichiometric relationships, regression analysis, or a combination of the two. Stoichiometry generally involves standardization of a titrant against a known primary standard and then the use of that titrant for determining the concentration of an unknown analyte (e.g. the use of sodium thiosulfate in the iodometric titration of dissolved oxygen). Regression analysis involves the determination of the mathematical relationship between analyte concentration and the response produced by the measurement being employed. Regression analysis is used for colorimetric determinations, ion specific electrode analysis and ion chromatography. The curve of response versus concentration is fit by the method of least squares using linear, polynomial or logarithmic regression dependant upon the pattern of response being measured.

Calibration is repeated for each analytical batch. Immediately following calibration, the standardized titrant or the calibration curve will be verified by the analysis of an Initial Calibration Verification standard (ICV) and Initial Calibration Verification Blank (ICB). The verification standard will be derived from a source other than that used for standardization or development of the standard curve. The ICV must return a value within 10% of its known concentration. The ICB must be less than the Reporting Limit (RL) or the lowest point on the standard curve, whichever is less. Initial calibration verification must be successfully completed prior to the analysis of any samples.

Calibration verification will be repeated after every ten samples processed during an analytical run. This Continuing Calibration Verification (CCV) will validate the method performance through an analytical sequence. If the continuing calibration values for either the standard or blank are out-of-control, the analyst will verify the outlying condition and, if verified, the analysis will stop and the method will be re-calibrated. All samples run between the outlying

CCV and the preceding in-control CCV will be re-analyzed. In-control verification standards and blanks must bracket all samples within an analytical run.

Initial calibration depending upon the analysis is based on a direct stoichiometric relationship, a linear regression analysis or a combination of the two. Stoichiometry generally involves standardization of a titrant and use of that titrant for determining the concentration of an unknown analyte (e.g. the use of thiosulfate in iodometric determination of dissolved oxygen). Regression analysis involves the determination of the mathematical relationship between the analyte concentration and the response produced by the measurement being employed. The curve is fit by the method of least squares using a linear, polynomial or logarithmic regression depending on the response being measured. The regression coefficient will be greater than or equal to 0.995 for the calibration to be considered acceptable.

Initial calibration curve is verified throughout the analytical sequence by analyzing a calibration verification standard after every 10 sample analyses. The calibration verification standard value will be within ± 10% of the initial calibration.

After initial calibration, a calibration blank will be analyzed to determine target analyte concentration levels. The level of analyte detected in the calibration blank will be less than the lowest standard concentration in the initial calibration.

SECTION 10: DATA VALIDATION and REVIEW

One hundred percent (100%) of laboratory data generated at ARI are subjected to a four level validation (review) process prior to release from the laboratory. The four levels of review are:

1. Analyst review
2. Peer review
3. Supervisory review
4. Administrative review

The data review process is outlined below and detailed in SOPs 200S through 206S.

In addition, Quality Assurance Personnel review 10% or more of all completed data packages for technical accuracy, project compliance and completeness. The data validation outlined below is completed in addition to the initial project review explained in Section 7 and QA specific reviews outlined in Section 11. If it is determined at any point during the analysis, reporting, or review process that data are unacceptable, prompt and appropriate corrective action must be taken. The corrective action will be determined by the situation. It is the responsibility of all staff members involved in data reporting and review to be aware of the quality control requirements and to be able to identify occurrences that require corrective action.

Analyst review:

Each analyst is responsible for producing quality data that meets ARI′s established requirements for precision and accuracy and is consistent with a client's expectation.

Prior to sample preparation or analysis an analyst will verify that:

1. Sample holding time has not expired.
2. The condition of the sample or extract is described accurately on the laboratory bench sheet.

3. Specified methods of analysis are appropriate and will meet project required Data Quality Objectives.
4. Equipment and Instrumentation are in proper operating condition.
5. Instrument calibration and/or calibration verification are in control.

During sample preparation or analysis an analyst will:

1. Verify that Method Blanks and Laboratory Control Samples are in control.
2. Verify that QC (replicate, matrix spike analyses, SRM, etc.) samples meet precision and accuracy requirements.
3. In addition to verifying that quality control requirements are met, the analyst will review each sample to determine if any compound of interest is present at levels above the calibrated range of the instrument.
5. Check for data translation or transcription errors
6. Record all details of the analysis in the appropriate bench sheet or logbook.
7. Note any unusual circumstances encountered.

Following the analysis or sample preparation an analyst will:

1. Examine each sample and blank to identify possible false positive or false negative results.
2. Determine whether any sample requires reanalysis due to unacceptable quality control.
3. Review data for any unusual observances that may compromise the quality of the data, such as matrix interference
4. Review and verify that data entry and calculations are accurate and no transcription errors have occurred.
5. Document anomalous results or other analytical concerns on the bench sheet, corrective action form or Analyst Notes for incorporation into the case narrative.
6. Note data with qualifying flags as necessary.

7. Enter reviewed data into LIMS as appropriate, incorporate all necessary sample and quality control information into the data package and forward it for further review.

Peer review:

A second analyst trained in the appropriate SOPs will complete a peer review. Peer review will include at a minimum:

1. Verification that all QA (holding times, calibrations, method blanks, LCS, spiked sample analyses, etc.) criteria are in control.
2. Examination the data for possible calculation and transcription errors.
3. Review bench sheets and analyst notes for completeness and clarity.
4. Approve the analytical results or recommend corrective action to the laboratory supervisor.

When a second trained analyst is not available a peer review is not completed.

Supervisory Review:

Following analyst and peer review the data is forwarded to the laboratory section supervisor for review. The supervisor will:

1. Review the data package for completeness and clarity.
2. Follow-up on the peer review recommendations.

Designated reviewers normally perform the peer and supervisory reviews for GC-MS data. The reviewers are identified on the organizational chart in Appendix A.

Administrative Review:

The results of all analyses are reviewed for compliance with quality control criteria and technical correctness before data is released to the Project Manager for distribution to clients. Designated reviewers in the Metals, Conventional and Organic laboratories perform administrative reviews. Personnel responsible for administrative reviews are noted in the Organizational Chart in Appendix A to this LQAP.

Administrative review is the final data validation process. Personnel performing the administrative review are responsible for the final sign-off and release of the data. Following administrative review the data is released to Project Managers for incorporation into the final data deliverable package.

Administrative review will:

1. Verify that the analytical package submitted for reporting is complete and contains all necessary information and documentation.
2. Verify that appropriate and necessary data qualifying flags (Listed in Appendix N) have been used.
3. Verify that method blank and LCS data are acceptable, quality control requirements were met for surrogates in all samples and blanks, and that all necessary re-analyses or dilutions were performed.
4. Check the technical validity (i.e. are total metal ≥ dissolved metals, is the cation/anion balance correct, etc.) of the complete data set.
5. Verify that all necessary final data reports have been generated and that all necessary data and documentation are included in the package.
6. Approve data reports for release.

10.2 Quality Assurance Review

10% (1 out each 10) final data packages are reviewed by ARI′s QA staff for compliance with ARI′s QA Program. This assessment includes, but is not limited to, review of the following areas:

1. Reporting and analysis requirements
2. Initial and continuing calibration records
3. Quality control sample results (method blank, LCS, spikes, replicates, reference materials)
4. Internal and surrogate standard results
5. Detection and reporting limits
6. Analyte identifications.

Data review activities are summarized and documented by the reviewer. The review notes are filed with the associated raw data in the project file. Any QA-related deficiencies identified during the data review will be forwarded to the QAPM for corrective action.

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SECTION 11: QUALITY CONTROL SAMPLE ANALYSIS AND EVALUATION

Routine analysis of quality control (QC) samples is necessary to validate the quality of data produced in ARI's laboratory. ARI routinely utilizes the following quality control analyses as defined in Section 11.3:

1. method blank (MB)
2. holding blank (HB)
3. surrogate standard analyses (SS)
4. laboratory control sample (LCS)
5. laboratory control sample duplicate (LCSD)
6. standardized reference material (SRM)
7. sample(matrix) replicate (MD)

8 matrix spike (MS)

9. matrix spike duplicate (MSD)

The number and type of QC analyses depend on the analytical method and/or the QA/QC protocol required for a specific project. A range of acceptable result is defined for each type of QC analysis. When all quality control sample results are acceptable, the analysis is considered to be "in-control" and the data suitable for its intended use. Conversely, quality control sample results that do not meet the specified acceptance criteria indicate that the procedure may not be generating acceptable data and corrective action may be necessary to bring the process back "in-control".

Detailed information concerning sample preparation batches, QC analyses and surrogate standards follow:

11.1 Sample Preparation Batch

All QC samples will be associated with a discrete sample preparation batch. A preparation batch is defined as 20 or fewer field samples of similar matrix processed together by the same analysts, at the same time, following the same method and using the same lot of reagents. Additional batch requirements are detailed in ARI's method specific standard operating procedures. Each preparation batch will be uniquely identified. All samples, field and QC, will be assigned an ARI LIMS ID number and will be linked to their respective preparation batch. Each sample batch will contain all required QC samples in addition to a maximum of twenty field samples.

ARI will accommodate client, QC protocol or QAPP specific sample batching schemes.

11.2 QC Sample Requirements

Each preparation batch will include, at a minimum, a method blank (MB) and a laboratory control sample (LCS). Additional QC samples will be analyzed based upon the specific QC protocol required, data deliverable requirements or client request. ARI recommends that QC samples used to measure analytical precision also be included in each sample batch. These may include: a matrix spike and a matrix spike duplicate pair; a sample duplicate and a matrix spike pair or an LCS duplicate (LCSD) for comparison with the LCS.

11.3 QC Sample Definitions

11.3.1 Method Blank (MB)

A method blank is an aliquot of water or solid sample matrix that is free of target analytes and is processed as part of a sample batch. The method blank is used to verify that contaminants or compounds of interest are not introduced into samples during laboratory processing. Method blanks will be spiked with surrogate standards for all organic analyses.

ARI defines an acceptable method blank as one that contains no target analytes at a concentration greater than one-half ARI's reporting limit or 5% of an appropriate regulatory limit or 10% of the analyte concentration in the sample which ever is greatest.

A minimum of one method blank will be included in each preparation batch. A maximum of twenty samples may be associated with one method blank. An acceptable method blank is

required prior to analysis of field samples from a preparation batch. For methods not requiring pre-analysis sample preparation, a minimum of one method blank will be analyzed immediately prior to sample analysis, periodically throughout the analytical sequence, and also at the end of the sequence.

The results of the method blank analysis will be reported with the sample results.

11.3.2 Holding Blank (HB)

Holding blanks are organic-free water samples that are placed in each volatile organic sample storage refrigerator to monitor for possible cross-contamination of samples within the storage units. A holding blank from each refrigerator will be analyzed every 14 days. Holding Blank analyses will be reviewed by laboratory management and archived in ARI's electronic document archive.

11.3.3 Laboratory Control Sample (LCS)

An LCS is processed as part of each preparation batch, and is used to determine method efficiency. An LCS is an aliquot of water or solid matrix free of target analytes to which selected target analytes are added in known quantities. The analytes spiked into LCS samples are listed in ARI's method specific SOPs. LCS will be spiked with surrogate standards for all organic analyses.

Following analysis the percent recovery of each added analyte is calculated and compared to historical control limits. Current control limits are listed in Appendix K of this document. When calculated recovery values for all spiked analytes are within specified limits, the analytical process is considered to be in control. Any recovery value not within specified limits requires corrective action prior to analysis of any field samples from the associated preparation batch.

A minimum of one LCS will be prepared for each sample preparation batch. LCS analysis for those methods not requiring pre-analysis sample preparation will be performed after each continuing calibration. The results of all LCS performed will be reported with the sample results. A maximum of twenty samples may be associated with one LCS.

Specific clients or QA protocol may require the analysis of a duplicate LCS. When LCS duplicates are analyzed the failure of any analyte in either LCS to meet QC limits must trigger a corrective action.

11.3.4 Replicate Analysis

Replicate analyses are often used to determine method precision. Replicates are two or more identical analyses performed on subsamples of the same field sample at the same time. Replicate analyses should be performed on samples that are expected to contain measurable concentrations of target analytes.

The calculated percent difference between replicates must be within specified limits or corrective actions are required. Percent differences exceeding the specified limit signal the need for procedure evaluation unless the excessive difference between the replicate samples is clearly matrix related.

For inorganic analyses, a minimum of one replicate set should be processed for each analytical batch. Replicate sample analyses are not routinely performed for organic parameters. Instead, analytical precision is evaluated through the analysis of a duplicate matrix spike sample (MSD).

In order to perform replicate analyses, ARI's must receive sufficient volume to prepare the replicate aliquots.

Field replicates submitted to the laboratory will be analyzed as discrete samples.

11.3.5 Matrix Spike

A matrix spike is an environmental sample to which known quantities of selected target analytes have been added. The matrix spike is processed as part of an analytical batch and is used to measure the efficiency and accuracy of the analytical process for a particular sample matrix. The analytes spiked into MS samples are listed in ARI's method specific SOPs. MS samples will be spiked with surrogate standards for all organic analyses.

Following MS analysis the percent recovery of each spiked analyte is calculated and compared to historical control limits. If recovery values for the spiked compounds fall within specified

limits, the analytical process is considered to be in control. When calculated recovery is outside of historical limits corrective action is recommended.

Matrix spike duplicate (MSD) analyses are often used to measure method precision and accuracy. In this case the relative percent difference for recovery of spiked compounds is calculated and compared to established criteria.

Unless directed otherwise, ARI's policy is to prepare a matrix spike and a duplicate with each batch of samples for inorganic analysis and an MS/MSD set for each batch of samples for organic analyses. Analyte recovery and RPD values are reported with sample data.

11.3.6 Standardized Reference Material (SRM)

An SRM is material analyzed and certified by an outside organization to contain known quantities of selected target analytes independent of analytical method. SRMs are normally purchased from outside suppliers outside of ARI and are supplied with acceptance criteria. Analysis of SRM is used to assess the overall accuracy of ARI's analytical process. SRM are routinely analyzed with each batch of samples for wet chemistry (conventionals analysis) samples. External reference samples are analyzed after instrument calibration and prior to sample analysis. Compound recovery values not within the specified limit signal the need to evaluate either the calibration standards or instrumentation.

11.3.7 Other Quality Indicators

In addition to analyzing the quality control samples outlined previously, various indicators are added to environmental samples to measure the efficiency and accuracy of ARI's analytical process. Surrogate standards are added to extractable organic samples prior to extraction to monitor extraction efficiency. Surrogate standards will also be added to volatile organic samples prior to analysis to monitor purging efficiency. Internal standards are added to metals digestates for ICP-MS analyses and to organic samples or extracts prior to analysis to verify instrument operation.

The calculated recovery of surrogate analytes is compared to historical control limits to aid in assessing analytical efficiency for a given sample matrix.

11.4 Control Limits

To provide a means for evaluating whether or not a process is in control, acceptance limits have been established. These are based on internal, historical data for organic analyses and method specified limits for inorganic analyses. Samples associated with a specific program or contract (such as the USEPA Contract Laboratory Program) will be evaluated against program/contract-specified criteria. Routine samples will be evaluated against internally generated control limits. Project specific control limits will be used as required provided they have been reviewed for feasibility and approved by laboratory management.

Results of QA analyses are transferred from the LIMS to a control limit and chart generation program. The QAPM coordinates control chart and control limit generation. Control limits will be generated for LCS compound recoveries, surrogate recoveries, and matrix spike compound recoveries, on a method and matrix specific basis. Advisory control limits will be utilized for analyses performed on an infrequent basis until a sufficient number of usable data points are collected. Control limits are updated at least annually, but may be updated more frequently if method or instrument changes have been made. Laboratory control and acceptance limits are detailed in Appendix K.

Two levels of control limits are utilized in evaluating process control: warning limits and action limits. Limits are statistically determined from values obtained from LCSs or other control samples. Warning limits, within which 95% of all results are expected, equal ± two standard deviations from the average result. Action limits, within which 99.7% of all results are expected, are equal to ± three standard deviations from the average result. Mean values, warning limits, and action limits are necessary for thorough evaluation of process control.

11.5 Control Charts

Control charts, in conjunction with other control sample analyses, are useful in verifying that an analytical procedure is performing as expected. The control chart provides a pictorial representation of how closely control sample results approximate expected values, as well as showing analytical trends. Indicated on the control chart are the mean and upper and lower warning and action limits. The warning and action limits are used to determine whether or not an analytical process is in control. The mean is used to determine whether results obtained for

a procedure are trending upward or downward, which may ultimately affect the accuracy of sample results.

The QA Officer will coordinate generation of control charts based on laboratory data at least semi-annually. These control charts will be distributed to and reviewed by section supervisors and managers. Any significant trends or variations in results will be identified, and the source of the trend corrected. Copies of control charts will remain on file in the QA section. At the bench/instrument level, individual results from quality control samples are evaluated against the limits.

SECTION 12: CORRECTIVE ACTIONS AND REESTABLISHMENT OF CONTROL

To produce quality data, it is important that all aspects of the analytical process are under control and that all specified quality control criteria are met. On occasion, however, procedures, reagents, standards, and instrumentation can fail to meet specified criteria. Should any of those situations occur, the quality of data produced may be compromised. When procedures no longer appear to be in control, sample processing will be halted and appropriate actions will be taken to identify and rectify any instrument malfunctions or process-related issues. Prior to resuming sample analysis, verification of control will be made through the analysis of various control samples. Actions taken and observations made during reestablishment of control will be fully documented on the bench sheet or as an Analyst Note. Only when control has been regained and all actions documented will sample processing resume. This ensures that no results generated during the suspect period will be reported.

12.1 Responsibilities

It is the responsibility of all laboratory personnel involved with sample processing to be able to determine whether or not a procedure is in control and to verify that all data are produced under conditions that are “in control”. It is at the analytical level that unacceptable conditions are most easily detected and addressed. These personnel are also responsible for employing and documenting all necessary corrective actions taken to regain control of a procedure. Samples processed during suspect periods will be reprocessed, and suspect data will be appropriately annotated to indicate that it is of questionable quality. The analytical staff will verify that all data submitted for review has been generated under acceptable conditions. All anomalies will be documented on the Analyst Notes form and will include such information as: type and source of anomaly, reasons for the anomaly, and actions taken to correct the problem. All personnel involved with subsequent and final data review are responsible for verifying that data were generated under acceptable conditions. If suspect data are identified at the review level, responsible analysts should be contacted to determine whether additional actions (such as reanalysis) will be taken. In addition, reviewers will confirm that anomalies

noted by the analyst were indeed addressed and that appropriate corrective actions were taken.

On occasion, it is not possible to generate data that meet all Quality Control Standards. This may be due to sample volume limitations or sample matrix effects. It is the responsibility of the analytical and data review staff to document these situations and to maintain communication with the Project Management staff. The Project Management staff, in turn, is responsible for notifying the client or specifying additional actions to be taken. Project Managers are further responsible for ensuring that clients fully understand which data are questionable and the reasons why acceptable results could not be generated.

It is the responsibility of the QAPM to perform regular reviews of corrective action procedures to ensure that unacceptable conditions or suspect data will be identified prior to releasing results. Section managers and supervisors are responsible for ensuring that appropriate corrective action procedures are in place and that all staff members are trained to identify and act upon “out of control” situations.

12.2 Corrective Actions

There are various stages of the analytical process where the procedure may fall out of control and require corrective action. In general, all procedures and equipment will be monitored to verify that control is maintained during sample processing. The following details those stages as well as the actions taken to reestablish and verify control.

Sample Preparation

During sample preparation, all glassware associated with a specific sample will be clearly labeled to eliminate the possibility of sample mix-up or mislabeling. Laboratory staff will ensure that sample-identifying labels are accurately completed and that correct sample identification is maintained at all times. If a sample appears to have been misidentified or mixed with another sample during preparation, the suspect samples will be discarded and new aliquots taken. If there is insufficient sample for a second preparation, the situation will be documented on the bench sheet and the Project Manager will be immediately notified.

Addition of surrogate standards or matrix spiking solutions will be carefully monitored to ensure that all samples are accurately fortified. Volumes and standard solution numbers of all

standards added to samples will be recorded on the bench sheet. If there is suspicion that a sample has been incorrectly spiked a new sample aliquot should be prepared. If there is insufficient volume for re-preparation, the bench sheet will be annotated to indicate which samples may be inaccurately fortified.

If sample matrix hinders processing per standard procedures, the section supervisor or manager will be consulted for guidance on appropriate actions. Preparation of smaller sample aliquots or employment of different procedures may be necessary. Any deviations from normal protocols will be documented on the bench sheet.

If at any time during sample preparation sample integrity is compromised or a procedural error is noted, the sample will be discarded and re-prepared. If insufficient sample volume is available for re-preparation, the situation will be documented on the bench sheet and the Project Manager will be immediately notified.

Calibration and Tuning

Prior to sample analysis, all instrumentation will be calibrated and tuned to ensure that equipment meets all criteria necessary for production of quality data. Equipment must meet the calibration criteria specified in the section entitled “Calibrations”, per manufacturer specifications or per project/contract requirements. If these criteria are not met, corrective actions must be employed. Any corrective actions taken will be fully documented in the appropriate logbook, indicating the problem, the actions taken, and verification. Samples will not be analyzed until initial verification of system performance has been made. In the event that continuing calibration results do not meet criteria, sample analysis will not resume until corrective actions have been employed or the system has been re-calibrated.

GC/MS Analyses - Analysis of the instrument performance check solution (BFB or DFTPP) will meet the specified ion abundance criteria. Initial calibration standards at a minimum of five concentrations will meet specified response factor and percent relative standard deviation criteria. It criteria are not met for initial calibration, the system will be inspected for malfunction. The initial tuning and calibration will be repeated, with all necessary corrective actions taken, until calibration criteria are met.

A check of the calibration curve will be performed at a minimum of once every 12 hours. All response factor criteria will be met. Additionally, the percent difference between the initial and continuing calibrations will meet specified criteria. If criteria

are not met, the system will be inspected for malfunction. The initial tuning and calibration verification will be repeated, with all necessary corrective actions taken, until calibration criteria are met.

Internal standard responses and retention times for standards will meet specified criteria. Any sample not meeting internal standard criteria will be reanalyzed. If reanalysis yields the same response and the instrument is determined to be functioning correctly, the failure to meet criteria will be attributed to sample matrix interference. No further re-analyses will be required.

GC Analyses - Organochlorine pesticide calibrations will be evaluated using either USEPA CLP or SW-846 guidelines. The Resolution Check standard will meet resolution criteria and Endrin and DDT breakdown in the Performance Evaluation standard will meet breakdown criteria. Initial calibrations will meet percent relative standard deviation criteria. If, during the initial calibration sequence, criteria are not met, the system will be inspected for malfunction and the initial calibration be reanalyzed. Samples will not be analyzed until all initial calibration criteria are met.

Continuing calibrations of either the mid-level calibration standard or Performance Evaluation standard will be analyzed every 12 hours. If continuing calibration criteria are not met, the system will be inspected for malfunction and corrective actions will be taken to bring the system back into compliance. If, after corrective actions, the system is still not in compliance, re-calibration will be performed. After the system has been successfully corrected or re-calibrated, all samples previously analyzed between the acceptable and unacceptable continuing calibration will be reanalyzed.

If, during the analytical sequence, retention time shifting occurs, the system will be inspected for malfunction and corrective actions will be taken to bring the system back into compliance. If, after corrective actions, the system is still not in compliance, re-calibration will be performed. After the system has been successfully corrected or re-calibrated, all samples with retention times outside the specified windows will be reanalyzed.

For all other analyses, initial calibration standards analyzed at a minimum of five concentrations will meet percent relative standard deviation criteria. If criteria are not met for initial calibration, the system will be inspected for malfunction. The calibration will be repeated, with all necessary corrective actions taken, until calibration criteria are met.

A check of the calibration curve will be performed after every 10 samples. All percent differences between the initial and continuing calibrations will meet specified criteria. If criteria are not met, the system will be inspected for malfunction and re-calibration will be performed. Samples analyzed between an acceptable and unacceptable calibration check will be reanalyzed.

Metals and Inorganic Analyses - Initial calibrations will be verified by analyzing a calibration check standard immediately after calibration. The percent differences between the initial calibration and calibration check standard will meet specified percent difference criteria. If criteria are not met, the system will be inspected for

malfunction. The initial calibration and calibration check will be reanalyzed until acceptance criteria are met.

The calibration check standard analyzed after every 10 samples will meet percent difference criteria. If the calibration check standard is not acceptable, the system will be inspected for malfunction and re-calibration will be performed as necessary. Samples analyzed between acceptable and unacceptable calibration check standards will be reanalyzed.

Instrument Blanks

Prior to sample analysis, instrument and/or calibration blanks may be evaluated for the presence of target analytes. If analytes are detected, the concentrations must be below the reporting limits for those analytes. If analytes are detected at levels above the reporting limits, the source of contamination will be identified. Sample analysis will not commence until analyte levels in instrument and calibration blanks are below the reporting limits. Instrument and calibration blanks are analyzed for VOA analysis only if sample carryover is suspected.

Instrument and calibration blanks will also be analyzed throughout the analytical sequence. These will not contain target analytes at levels above the method detection limits for organic parameters or the reporting limit for inorganic parameters. If one or more analytes exceed the RL, an additional blank will be analyzed. If analyte levels are still above the method detection limits, the system will be inspected for malfunctions and the source of contamination will be identified. Sample analysis will not resume until instrument and calibration blank analyte levels are below the RL. Organic samples analyzed between acceptable and unacceptable blanks will be evaluated to determine the need for reanalysis per the following guidelines:

If no target analytes are detected in the samples, reanalysis will not be required.

If sample target analyte levels are above the method detection limits, samples will be reanalyzed at analyst discretion. Reanalysis will be dependent upon the analyte levels and whether or not there is likelihood that analytes detected are a direct result of system contamination.

If the analytes present at unacceptable levels in the instrument blank are not of interest or concern in the associated samples, reanalysis will not be required. This is often a consideration for ICP analyses where analytes of concern may be only a subset of the possible analytes.

Methods for the analysis of inorganic analytes require that all samples associated with an out of control blank be re-analyzed.

Method Blanks

Prior to sample analysis, method blanks will be evaluated for the presence of target analytes. Ideally, no target analytes should be present in the method blank. If analytes are detected at or above the Reporting Limit, the method blank will be reanalyzed to verify that the contamination is not a result of instrument carryover or malfunction. If the presence of target analytes is confirmed, the concentrations must be below the RL for those analytes.

Several volatile and semi-volatile compounds and certain elements are considered to be common laboratory contaminants. Concentrations of these common laboratory contaminants may exceed the method detection limits, but may not be present at concentrations greater than five times the method reporting limits. Target analytes considered to be common laboratory contaminants are:

Volatile Organic Compounds

Methylene Chloride
Acetone
2-Butanone

Semi-volatile Compounds

Dimethylphthalate
Diethylphthalate
Di-n-butylphthalate
Butylbenzylphthalate
bis-(2-Ethylhexyl) phthalate
Di-n-octylphthalate

If target analyte concentrations in the method blank exceed the acceptable levels and instrument malfunction or contamination has been ruled out, the method blank and all associated samples will be re-prepared and reanalyzed. If there is insufficient sample volume remaining for reprocessing, the Project Manager will be notified. If it is necessary to report results associated with an unacceptable method blank, the results will be qualified to indicate possible laboratory contamination.

In the event that an analyte detected in the samples ≥ 20 times the method blank levels re-preparation and reanalysis is not required. It is assumed that any contamination in the method blank is insignificant and will not affect final quantified results.

Laboratory Control Samples

Prior to sample analysis, the laboratory control sample (LCS) will be evaluated to verify that recovery values for all spiked compounds are within the specified acceptance limits. If LCS recoveries are out of control, corrective action is required. Corrective actions may include anything from a written explanation in the case narrative up to re-preparation and reanalysis of the entire sample batch.

Internal Standards

For volatile and semi-volatile organic analyses, internal standard results will be evaluated after each analytical run to verify that the values are within acceptance limits. Internal standard values will be within -50% to +100% of the internal standard values in the continuing calibration. If any internal standard does not meet the criteria, the system will be evaluated to confirm that all instrumentation is operating properly. The sample will then be reanalyzed. If the reanalysis results do not meet acceptance criteria, it will be assumed that the sample matrix is affecting internal standard values. Further reanalysis will not be required.

Surrogate

Surrogate recovery values will be evaluated after each analytical run to verify that the values are within acceptance limits. If recovery values are outside acceptance limits, the system will be evaluated to confirm that all instrumentation is operating properly. Documentation and bench sheets will be reviewed to verify that the concentrations of surrogate spike solutions added are accurate. For extractable organic analysis, bench sheets will be reviewed to determine if any additional dilutions or concentrations were performed. Bench sheets will also be reviewed for any explanatory notes about the sample.

If no system documentation, solution preparation or spiking errors are identified, the following considerations will be made:

When a volatile organic surrogate recovery value is outside of acceptable limits, the sample will be reanalyzed. If the reanalysis results are within acceptance limits, it will be assumed that the initial analysis was in error. If the reanalysis results are not within acceptance limits, it will be assumed that sample matrix is affecting surrogate recovery. Further reanalysis will not be required.

For semi-volatile organic analysis, one acid and one base/neutral surrogate recovery may be outside acceptance limits with no corrective action required provided the recoveries are at least 10%. If more than one acid or base surrogate standard is outside acceptance limits, or if any surrogate recovery value is less than 10%, the sample will be re-extracted and reanalyzed. If the reanalysis results are not within acceptance limits, it will be assumed that sample matrix is affecting surrogate recovery assuming all other QC analyses are acceptable. Further reanalysis will not be required. *Matrix spikes will not be re-extracted for unacceptable surrogate recovery values.*

For other extractable organic analysis, if a surrogate recovery value is outside of acceptance limits, the data will be reviewed to determine if the unacceptable surrogate is a result of matrix effect. If matrix interference is determined, the sample will be re-extracted or if re-extraction is not deemed useful, fully documented in the analytical narrative associated with the analyses. If a surrogate recovery is too low, based on the opinion of the final QA Data Reviewer, the sample will be re-extracted and reanalyzed.

Matrix Spikes

Matrix spikes will be evaluated to verify that recovery values for all spiked compounds are within the specified acceptance limits. If unacceptable results are obtained, the system will be evaluated to confirm that all instrumentation is operating properly. Documentation and bench sheets will be reviewed to verify that the concentrations of spike solutions added are accurate. Sample preparation bench sheets will be reviewed to determine if any additional dilutions or concentrations were performed. Bench sheets will also be reviewed for any explanatory notes about the sample.

If no system, documentation, solution preparation, or spiking errors are identified, the following considerations will be made:

Organic Analyses:

If a matrix spike recovery value is outside the acceptance limits, but the LCS meets recovery acceptance criteria, re-extraction will not be required. It will be assumed that the unacceptable recovery value is a result of matrix effect.

If both LCS and matrix spike recovery values are outside the acceptance limits, the sample batch will be re-extracted and reanalyzed. This indicates the possibility of a systematic error that may affect the accuracy of final results.

Inorganic analyses:

Matrix spikes with unacceptable recovery values will be re-prepared and reanalyzed. If the reanalysis results are not within acceptance limits, it will be assumed that the sample matrix is affecting the recovery values. Further reanalysis will not be required.

A post-digestion spike analysis will be performed for all metals analyses processed following EPA-CLP guidelines.

Sample and Matrix Spike Replicates

Sample and matrix spike replicates will be evaluated to verify that percent differences between the replicates are within acceptable limits. Percent differences for metals and inorganic sample replicates will be within ±20%. When percent difference criteria are not met, the system will be evaluated to confirm that all instrumentation is operating properly. Documentation and bench sheets will be reviewed to verify that the concentrations of spike solutions added are accurate. Sample preparation bench sheets will be reviewed to determine if any additional dilutions or concentrations were performed. Bench sheets will also be reviewed for any explanatory notes about the sample.

If no system, documentation, solution preparation, or spiking errors are identified, the following considerations will be made:

If percent difference values between sample replicates for metals and inorganic analyses do not meet acceptance criteria the Project Manager in consultation with ARI's client will determine whether to re-analyze the samples or flag the analytical results. If the samples are reanalyzed and results are not within acceptance limits, it will be assumed that the sample is not homogeneous, causing the poor analytical precision. Further re-analyses will not be required.

Replicate sample analyses are not routinely performed for organic parameters.

If percent difference values between matrix spike replicates do not meet acceptance criteria, but spike recovery values are acceptable, no re-extraction or analysis will be required. It will be assumed that the sample is not homogeneous, causing the poor analytical precision.

If percent difference values between matrix spike replicates do not meet acceptance criteria and recovery values in one or both replicates are not acceptable, the sample and associated matrix spike replicates will be re-prepared and reanalyzed. If the reanalysis results are not within acceptance limits, it will be assumed that the

sample is not homogeneous, causing the poor analytical precision. Further re-analyses will not be required.

Samples

In addition to monitoring sample quality control indicators, ARI evaluates samples to determine the need for reanalysis. Conditions considered while evaluating samples are:

If a target analyte detected in a sample exceeds the upper limit of the instrument calibration range, the sample is diluted and reanalyzed. Dilution and reanalysis continues until the analyte concentration falls within the linear range of calibration. If the sample requires dilution to such a level that surrogates are no longer detectable and analytical accuracy is questionable, the sample will be re-prepared using a smaller sample aliquot.

Samples will be evaluated for matrix interference that may affect analyte detection and quantification. Appropriate cleanup procedures will be employed to remove interference. Samples will be diluted and reanalyzed as required to minimize background interference. If it is not possible to remove all interference, reported results will be qualified as necessary.

If low-level analytes detected in a sample are suspected to be a result of instrument carryover, the sample will be reanalyzed. If analyte levels remain approximately the same the initial results will be considered valid. If analytes are not detected during reanalysis, it will be assumed that the initial detection was due to carryover, and the initial results will not be reported.

If an instrument malfunction or procedural error occurs during analysis, all affected samples will be reanalyzed. If the malfunction appears to be an isolated incident, it will not be necessary to inspect the analytical system. If the malfunction appears to be an ongoing problem, the system will be inspected and necessary maintenance/corrective actions will be taken prior to resuming analysis.

Sample Storage Temperatures

Every sample storage unit's temperature will be evaluated at the beginning of each day. Temperatures will be between 2 and 6 °C for refrigerators and < -10 °C for freezers. If a temperature is outside the specified range, the unit's temperature will be adjusted to bring the temperature back within limits. The Temperature Log will be annotated to document the adjustment.

If adjustment does not bring the temperature within range, or if adjustment is not possible, the Laboratory Supervisor will be notified and will take corrective action. The Temperature Log will be annotated to document the action. If the temperature fluctuation is chronic or extreme, the

samples will be removed from the unit and placed in another storage unit until the malfunctioning unit is repaired or replaced.

Balance Calibrations

Balances are serviced once a year by a certified technician. The service includes preventative maintenance and calibration.

Balance accuracy will be verified prior to balance use. The recorded weight will be within the acceptance criteria specified on the Calibration Log. If the recorded weight is not within the acceptance limits, the QAPM will be notified. The Calibration Log will be annotated to document the action. The balance will not be used until it can be verified that acceptance criteria can be met.

Water Supply System

The water supply for the volatile organic and inorganic laboratories will be monitored daily for the presence of contaminants through the analysis of method and/or instrument blanks. Organic contaminants, especially chloroform, are early indicators of the need for preventative maintenance. If organic or other contaminants are detected, the system filters will be changed. After filters have been changed, an additional aliquot of water will be analyzed to confirm that contaminants are no longer present.

The water supply for the metals laboratory will be monitored daily. When the resistivity falls below 18 megaohm, system maintenance will be performed.

Section 13: LABORATORY EVALUATION AND AUDITS

Routine evaluations of the laboratory ensure that all necessary quality control activities have been implemented and are being effectively utilized. It is the responsibility of the QAPM to ensure that quality control activities are periodically evaluated for compliance. Findings from these evaluations allow the laboratory to address and modify any procedures that are not in accordance with the laboratory Quality Assurance Program or accreditation program requirements.

A number of tools are available for monitoring laboratory performance. ARI evaluates the quality of laboratory performance through the use of

Internal QA Audits
Technical System Audits
Data Quality Reviews
Audits by Outside Agencies (External Audits)
Performance Evaluation Analyses
Annual Management Review

Each audit provides an objective evaluation of laboratory performance. All internal audits and reviews are conducted according to specified guidelines. In addition, a collective review of audit findings provides an overall evaluation of the laboratory. Deficiencies noted during the course of an audit or performance evaluation will be addressed, a root cause analysis performed, and appropriate corrective actions will be taken. Follow-up audits will be conducted to verify that corrective actions have been satisfactorily implemented.

Internal QA Audits

The Quality Assurance Officer regularly evaluates quality control activities within the laboratory to verify accuracy and compliance. The QAPM or designee routinely audits the following activities:

Balance verification records

Sample storage cooler temperature records

Oven, incubator and water bath temperature records

Chain of Custody records

Standard preparation records

Documentation and Response to Client Complaints

Chain of Custody Procedures

Documentation of Computer and Software Revisions

Checklists are utilized to ensure consistent and complete audits. The checklists are included in SOP 1005S. Internal QA audit results will be summarized and reported to both staff and management. Corrective actions will be initiated as necessary. A schedule of internal QA audits is provided in Appendix L.

When an audit finding indicates possible errors or deficiencies in analytical data, ARI will correct the error and notify all affected clients within 2 working days.

Technical System Audits

An audit of technical systems within the laboratory will be conducted at least annually. The audit will focus on the quality control and data generation/collection systems. The QAPM will conduct the audit with assistance from section managers and data reviewers. This evaluation will address areas such as:

Calibration records

Maintenance records

Control charts

Computer vs. hard copy data

Adherence to SOPs and methods

Support system records (DI water, balances, pipettes, etc.)

In addition, audit results from the past year will be reviewed to verify that all necessary corrective actions have been addressed and implemented.

Data Quality Reviews

Reviews of final data packages by the QAPM or his/her designee. The Data quality review verifies that the final data deliverables meet project and quality systems specifications

Audits by Outside Agencies (External Audits)

As a requirement for many accreditation programs, on-site review of laboratory facilities and operations are conducted by clients or other outside agencies. The laboratory may be periodically audited by the following agencies:

State of Washington Department of Ecology
A United States Department of Defense Agency (US Army, US Navy or US Air Force)
State of Oregon Environmental Laboratory Accreditation Program (ORELAP) as an Accrediting Body for The NELAP Institute.

External audits are beneficial in that they provide an independent evaluation of the laboratory without internal influence or bias. The laboratory will be available for evaluation at the convenience of the auditing agency. Laboratory personnel will be available during the audit to address questions or provide information regarding laboratory procedures. All comments, deficiencies, and areas of potential improvement noted by the auditor will be reviewed, and appropriate corrective actions will be taken to resolve the noted issues. A listing of laboratory accreditations is included as Appendix M.

Performance Evaluations

Performance Evaluation (PE) sample analysis is a means of evaluating individual performance as well as the overall analytical system. In addition to the external audit, PE sample (PES) analysis is a requirement of many certification and accreditation programs. The laboratory routinely participates in the following performance evaluation programs:

Analytical Standards, Inc.(ASI) Performance Evaluation Studies
USEPA Water Pollution (WP) Performance Evaluation Studies (Commercial Supplier)
USEPA Water Supply (WS) Performance Evaluation Studies (Commercial Supplier)
USEPA Contract Laboratory Program Quarterly Performance Evaluations (as required)
AASHTO (for geotechnical samples)

A PES is a sample containing specific analytes in concentrations unknown to analysts. Comparison of the laboratory result to the "true" value determines the accuracy of the

reported result and indicates the laboratory's ability to perform a given analysis. These results are also used to verify individual analyst proficiency. The QAPM will periodically submit internal “blind” performance evaluation samples to the laboratory sections for analysis. Values obtained by the laboratory will be compared to expected or true values. Parameters with reported values outside of the specified acceptable ranges will be evaluated by the analytical staff to determine the source of error. All necessary corrective actions will then be documented and implemented.

Quality Assurance Reports to Management and Staff

In order to ensure that laboratory managers are kept apprised of quality related activities and laboratory performance, a “Quality Assurance Report to Management” the QAPM will be produced annually and distributed to ARI management. The report will, at a minimum include:

1. Information concerning current and ongoing internal and external audits
2. Status and results of current or ongoing internal or external proficiency analyses
3. Identification of Quality Control problems in the laboratory
4. Information on all ongoing Corrective Actions
5. Current status of external certifications
6. Current status of the Staff Training Program
7. Outline of new and/or future Quality Assurance Program initiatives

The QAPM is responsible for follow-up and resolution of any deficiencies discussed in the report. Unresolved issues will remain on subsequent reports until addressed. Information such as performance evaluation results and audit reports will be distributed to the laboratory staff.

The application of these combined activities provides comprehensive monitoring and assessment of laboratory performance, and ensures that all data produced by ARI will be of the highest possible quality.

Annual Management Review

In the last quarter of each year, executive management will perform a comprehensive review of ARI quality system and analytical procedures to assess their continued suitability and effectiveness. Management will consider the following during the review process:

- Suitability of policies and procedures
- Reports fro management and supervisory personnel
- Results of internal audits
- Corrective and preventative actions
- Results of recent external quality systems audits
- PT results
- Changes in volume and type of analyzes performed
- Client Feedback
- Complaints
- Other relevant factors such as quality control activities, available resources and analyst training

Section 14: APPENDICES

A. Laboratory Organization and Key Personnel Resumes
B. Training and Demonstration of Proficiency
C. Laboratory Facilities
D. Laboratory Instrumentation and Computers
E. Standard Operating Procedures
F. Sample Collection Containers, Preservation and Holding Times
G. Laboratory Workflow
H. Analytical Methods
I. Method Detection Limits and Reporting Limits
J. Quality Control Recovery Limits
K. Internal Audit Schedule
L. Laboratory Accreditations
M. Data Reporting Qualifiers
N. Standards for Personal Conduct
O. QA Policies
P. Modifications to ARI's LQAP

Appendix A

Laboratory Organization Chart
and
Key Personnel Resumes

KEY PERSONNEL RESUMES

Mark Weidner

Laboratory Director

Profile

Mr. Weidner co-founded Analytical Resources, Inc., along with Brian Bebee, Sue Dunnihoo and David Mitchell. Prior to his co-founding of ARI in 1985, Mr. Weidner was the Head Mass Spectroscopist at Michigan State University and an instructor at the Finnigan Institute. As Laboratory Director, Mr. Weidner is responsible for overall laboratory performance, as well as facility expansion and major purchasing. Mr. Weidner is intimately familiar with all operational and analytical aspects of ARI and initiated many of the procedures currently in use.

Education:

M.S., Medicinal Chemistry, Purdue University, W. Lafayette, IN (1978).

B.S., Biochemistry, Michigan State University, E. Lansing, MI (1975).

Experience:

Laboratory Director/Co-founder, Analytical Resources, Inc., Seattle, WA (1985 to present).

Senior Chemist, City of Seattle, Seattle, WA (1981 to 1985).

Instructor, Finnigan Institute, Cincinnati, OH (1979 to 1981).

Mass Spectroscopist, Michigan State University (1978 to 1979).

Brian Bebee

Laboratory Manager

Administrative Services Manager

Profile:

Mr. Bebee co-founded Analytical Resources, Inc., along with Mark Weidner, Sue Dunnihoo, and David Mitchell. Prior to his co-founding of ARI, Mr. Bebee had gained extensive GC/MS experience as a GC/MS Chemist at the Municipality of Metropolitan Seattle, (METRO). When he co-founded ARI in 1985, Mr. Bebee became the Organics Division Manager until 1993, when he assumed the position of Laboratory Manager. As Laboratory Manager, Mr. Bebee is responsible for the day to day flow of all laboratory operations, including personnel, instrument, and procedural concerns. He is also responsible for the direct supervision of the Volatile and Semivolatile Laboratories.

Education:

A.A., Oceanography, Marine Biology, Biology, Shoreline Community College (1973).

Experience:

Laboratory Manager, Analytical Resources, Inc., Seattle, WA (1987 to present).

Organics Division Manager/Co-founder, Analytical Resources, Inc., Seattle, WA (1985 to 1987).

GC/MS/DS Operator, Municipality of Metropolitan Seattle, Seattle, WA (1980 to 1985).

Senior Water Quality Technician, Municipality of Metropolitan Seattle (METRO), Seattle, WA (1976 to 1980).

Water Quality Technician, Municipality of Metropolitan Seattle (METRO), Seattle, WA (1973 to 1976)

David Mitchell

Quality Assurance Program Manager

Profile:

Mr. Mitchell co-founded Analytical Resources, Inc., along with Mark Weidner, Sue Dunnihoo, and Brian Bebee. Prior to his co-founding of ARI, Mr. Mitchell had gained extensive experience in the environmental chemistry field as Senior Chemist and Trace Organics Laboratory Supervisor at the Municipality of Metropolitan Seattle (METRO). His responsibilities include the management of ARI's Quality Assurance/Quality Control Program.

Education:

Graduate Work in Chemistry (Organic/Biological), University of Wyoming, Laramie, WY (1970 to 1974).

B.S., Chemistry, Upper Iowa College, Fayette, IA (1970).

Experience:

Quality Assurance Manager, Analytical Resources Inc., Seattle, WA (1998 to Present)

Client Services Manager, Analytical Resources Inc., Seattle WA (1987 to 1998)

Vice President/Co-founder of Analytical Resources, Inc., Seattle, WA (1985 to 1987).

Senior Chemist, METRO Trace Organics Laboratory, Seattle, WA (1979 to 1985).

Research Associate, Northwestern University Medical School (1974 to 1979).

Susan Dunnihoo

Director, Client Services

Profile:

Ms. Dunnihoo co-founded Analytical Resources, Inc., along with Mark Weidner, Brian Bebee, and David Mitchell. Prior to her co-founding of ARI, Ms. Dunnihoo had gained extensive experience in the environmental chemistry field through her work at Laucks Testing Laboratories, the City of Tacoma, and the Municipality of Metropolitan Seattle (METRO). As Director of Client Services, Ms. Dunnihoo is responsible for assisting project managers in responding to the needs of ARI clients, and for communicating to the laboratory the analytical capabilities that should be added to satisfy future client needs. Ms. Dunnihoo also acts as project manager for a number of projects.

Education

Graduate work in Chemical Oceanography, University of Washington (1976-1980)

ACS Certified BA, Chemistry, Augsburg College, Minneapolis, MN (1976)

Experience

Director, Client Services, Analytical Resources, Inc., Seattle, WA (2007-present)

Client Services Manager, Analytical Resources, Inc., Seattle, WA (1998-2007)

Computer Services Manager, Analytical Resources, Inc., Seattle, WA (1985 to 2000)

Corporate Secretary, Analytical Resources, Inc., Seattle, WA (1985 to present)

Chemist, Laucks Testing Laboratories, Seattle, WA (1983 to 1985)

Chemist, City of Tacoma, Plant II, Tacoma, WA (1982 to 1983)

GC/MS/DS Operator, METRO TPSS Lab, Seattle, WA (1980 to 1982)

Jay Kuhn

Inorganic Division Manager

Profile:

Mr. Kuhn oversees ARI's Inorganic Division, which includes the Metals Sample Preparation, Metals Analysis, and Conventional Wet Chemistry sections. He has extensive experience in the environmental chemistry field, with an emphasis in inorganic analyses. Mr. Kuhn is experienced with in-house and EPA standard methods and protocols, as well as the operation, maintenance, and repair of ICP-MS, ICAP, CVAA, and Graphite Furnace instruments.

Education

Graduate work in Environmental Chemistry, University of Washington, Seattle, WA.

B.S. Chemistry, University of California at Santa Barbara (1980)

Experience

Inorganic Division Manager, Analytical Resources, Inc., Seattle, WA (1992 to present)

Metals Division Manager, Analytical Resources, Inc., Seattle, WA (1990 to 1992)

Research Technologist III and Laboratory Manager, UW College of Forest Resources Chemical Analysis Cost Center (1985-1990)

Research Technologist, UW College of Forest Resources Chemical Analysis Cost Center (1981 to 1985)

Appendix B

Training

Qualification Requirements

In addition to on-the-job training, ARI recommends a specific level of education and experience for the following positions:

GC/MS Laboratory Supervisor

A Bachelor's degree in chemistry or scientific/engineering discipline, three years experience operating GC/MS systems and one year supervisory experience.

GC Laboratory Supervisor

A Bachelor's degree in chemistry or scientific/engineering discipline, three years experience operating GC systems and one year supervisory experience.

Sample Preparation Laboratory Supervisor

A Bachelor's degree in chemistry or scientific/engineering discipline, three years experience in organic sample preparation and one year supervisory experience.

Data Systems/LIMS Manager

A Bachelor's degree with four or more computer-related courses and three years experience in systems management or programming. A minimum of one year experience with software utilized for laboratory report generation is also recommended.

Programmer Analyst

A Bachelor's degree with four or more computer-related courses and two years experience in systems or application programming. A minimum of one year experience with software utilized for laboratory report generation is also recommended.

Quality Assurance Officer

A Bachelor's degree in chemistry or a scientific/engineering discipline and three years of laboratory experience, including one year of applied experience with quality assurance.

Project Manager

A Bachelor's degree in chemistry or a scientific/engineering discipline and three years of laboratory experience, including one year of applied experience with quality assurance.

GC/MS Chemist

A Bachelor's degree in chemistry or a scientific/engineering discipline and at least one year experience operating a GC/MS system. Three years of GC/MS operations and spectral interpretation experience may be substituted in lieu of educational requirements.

Mass Spectral Interpretation Specialist

A Bachelor's degree in chemistry or a scientific/engineering discipline and participation in training course(s) in mass spectral interpretation. Also, at least two years of experience in mass spectral interpretation is recommended.

Purge and Trap Expert

A Bachelor's degree in chemistry or a scientific/engineering discipline and one year experience operating a purge and trap type liquid concentrator interfaced to a GC/MS system.

GC Chemist

A Bachelor's degree in chemistry or a scientific/engineering discipline and at least one year experience operating a GC system. Three years of GC operations and maintenance experience may be substituted in lieu of educational requirements.

Pesticide Analysis Expert

A Bachelor's degree in chemistry or a scientific/engineering discipline and at least one year experience operating a GC system. Three years of GC operations and spectral interpretation experience may be substituted in lieu of educational requirements.

ICP Spectroscopist

A Bachelor's degree in chemistry or a scientific/engineering discipline and Four years of applied experience with ICP analysis of environmental samples. Four years of ICP experience may be substituted in lieu of educational requirements.

ICP Operator

A Bachelor's degree in chemistry or a scientific/engineering discipline and one year of experience operating and maintaining ICP instrumentation. Three years of ICP experience may be substituted in lieu of educational requirements.

Atomic Absorption (AA) Operator

A Bachelor's degree in chemistry or a scientific/engineering discipline and one year of experience operating and maintaining graphite furnace and cold vapor AA instrumentation. Three years of AA experience may be substituted in lieu of educational requirements.

Conventionals (Classical Chemistry) Analyst

A Bachelor's degree in chemistry of a scientific/engineering discipline and one year of experience with classical chemistry procedures. Three years of classical chemistry experience may be substituted in lieu of educational requirements.

Sample Preparation Expert

A high school diploma and one college level course in chemistry. One year of experience in sample preparation is also recommended.

Appendix C

Laboratory Facilities

ANALYTICAL RESOURCES INC. occupies a total of 23,500 square feet of floor space located at 4611 S. 134th Place in Tukwila, Washington. The laboratory facility, constructed between September 2001 and June 2002, includes:

- State-of-the-art heating, ventilation and air conditioning (HVAC) systems to assure a clean comfortable working environment while maintaining air flow balance designed to minimize the possibility of sample cross contamination between laboratory areas.
- A central service area provides space for three walk-in coolers (356 sq. ft. total), two walk-in freezers (760 cubic ft.), metals archive storage, and sample cooler storage. A 400 sq. ft. walk-in freezer covered by a mezzanine for storage was added in 2005.
- A data network linking all workstations to a centralized server room. All connections are made to managed switches and hubs and are protected by the latest firewall technology and uninterruptible power supplies.
- Distribution systems to deliver pressurized Air, Zero Grade Air, Argon, Helium, Hydrogen, Nitrogen and Argon/Hydrogen to the laboratory areas from a central location.
- A system to deliver ASTM Type 1 water directly to sinks in each laboratory area. Water is purified by filtration, ion exchange and reverse osmosis and continuously re-circulated through a filtration + ion exchange + UV radiation polishing loop that delivers water directly to the laboratories.
- An isolated and ventilated hazardous waste storage area.
- An electronic repair shop and storage room.
- Alarm monitored fire sprinkler and intrusion detection systems

The facilities are divided into five functionally-distinct sections as detailed below:

1) The Organics Division features three main laboratory areas as described below:
   - The <u>Organics Extraction Laboratory</u> (2400 sq. ft.) is utilized to isolate and concentrate organic compounds from various environmental sample matrices. The laboratory contains approximately 200 linear feet of bench space and nine fume hoods. It is equipped with two gel permeation chromatographs, an accelerated solvent extractor (ASE) and a gas chromatograph for extract screening purposes. The laboratory includes a separate area for extraction of aqueous samples, a glassware cleaning area and individual workstations for the laboratory supervisor and analyst.
   - The <u>Semivolatile Organics Analysis Laboratory</u> (3000 sq. ft) has 124 linear feet of instrument bench space plus personal workstations. The Laboratory is equipped with seven Gas Chromatographs (GCs) with six GC-MS instruments, one High Resolution GC/MS (HRGC-MS) and a fume hood for preparation of standard solutions and dilution of samples. Each gas chromatograph is individually vented to the outside for removal of heat and potentially contaminated GC exhaust gases.
   - The <u>Volatile Organics Analysis (VOA) Laboratory</u> (2500 sq. ft) houses seven GC-MS and two GC-PID instruments dedicated to volatile organics analysis. Each instrument is vented to the outside. The laboratory area includes two fume hoods, a sample/standards preparation area, a TCLP preparation/tumbler room and sample holding refrigerators. The HVAC system maintains a positive air pressure in the laboratory using filtered air from outside of the building. This eliminates the possibility of cross contamination of samples with solvents from other areas of the laboratory.

2) The Inorganic Division includes a Trace Metals Laboratory and the Conventional Analyses Laboratory:
   - Trace Metals Laboratory (3000 square feet)
     - The Metals Preparation Laboratory (1200 sq. ft) contains five fume hoods including two 8-foot polypropylene. An additional eight foot polypropylene laminar flow fume hood is housed in a separate class 1000 clean room. The lab is equipped with tumblers, hot-plates, digestion blocks, facilities for glassware cleaning, and a spectrophotometer for cold vapor analysis of mercury, a TCLP tumbler room, and storage areas.
     - The Metals Instrument Laboratory (1300 sq. ft) features two atomic absorption spectrometers for graphite furnace analyses, two inductively coupled argon plasma spectrometers (ICP) for simultaneous analysis of metals species, and an ICP-mass spectrometer for analysis of metals species at low detection levels.
     - A 500 sq. ft. Office provides desk area for Trace Metals laboratory personnel.
   - The Conventional Analyses (Wet Chemistry) Laboratory (2500 sq. ft.) contains approximately 200 linear feet of bench space, eight fume hoods and includes a separate microbiology room. Instruments in this lab include two Rapid-Flow Analyzers, two TOC analyzers, an ion chromatograph, two uv/visible spectrophotometers, and various other equipment necessary for the evaluation of inorganic parameters.

3) The Geotechnical Laboratory includes 2500 square feet of space with special areas and equipment for soil testing, treatability studies, and soil/sediment leaching studies. The Laboratory includes approximately 50 feet of linear bench space and 5 fume hoods.

4) The Sample Receiving Facility consists of an area to accept and log-in samples to ARI's Laboratory Information Management System (LIMS) and an area to prepare and ship sampling supplies.
   - The Sample Receiving Facility (1000 sq. ft.) is equipped with two fume hoods, and 70 feet of bench space. Four computer terminals are available to log samples into ARI's LIMS.
   - The Sampling Containers Facility (500 sq. ft.) is used to prepare sampling containers for shipment to ARI's client designated locations.

4) Administrative Areas (8600 sq. ft.) include:
   - The Quality Assurance Section
   - Executive Offices
   - Project Management Section
   - The Human Resources Section
   - The Computer Services Section
   - One Conference Room
   - A Lunch Room
   - Several Storage Areas

Appendix D

Laboratory Instrumentation and Computers

LABORATORY INSTRUMENTATION and COMPUTERS

Organic Extractions Equipment

(MARS 1) CEM MARS™ (2008) – Microwave extraction apparatus.

(GPC 1) Gel Permeation Chromatograph (1985) – Fluid Metering Inc. pump and ISCO UA-5 UV detector equipped with a 16 position autosampler used for clean-up of samples prior to final analysis.

(GPC 2) Gel Permeation Chromatograph (2003) – Fluid Metering Inc. pump and ISCO UA-5 UV detector equipped with a 16 position autosampler used for clean-up of samples prior to final analysis.

Zymark Turbo-Vap LV (1999) - 24 place

Zymark Turbo-Vap LV (2002) - 24 place

Zymark Turbo-Vap LV (2007) - 24 place

Zymark Rapid Trace Solid Phase Extraction Workstations (2007) - 5 each

Horizon Technology – DryVap Concentrator System Model 5000 – 2 each

Gas Chromatograph - High Resolution Mass Spectrometer (GC/HRMS)

(HR1) Waters Autospec Premier (2009) – A GC-HRMS system with Masslynx Version 4.1 data acquisition & quantitation software. System includes an Agilent 7890A GC and 7683B autosampler.

Gas Chromatograph - Mass Spectrometers (GC/MS)

(FINN5) Finnigan MAT Incos 50 (1989) - A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. System includes an HP 5890 GC, a Tekmar LSC 2000 Purge & Trap and a Dynatech PTA-30 autosampler for VOA analysis of either aqueous or solid samples.

(NT2) Hewlett Packard (1999) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. System includes Agilent 6890 GC, 5973 MSD, and 7683 autosampler.

(NT3) Hewlett Packard (1999) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. System includes an HP 6890 Plus GC, an HP 5973 MSD, an OI Analytical Eclipse 4660 and a Varian Archon autosampler for VOA analysis of aqueous or solid samples.

(NT4) Hewlett Packard (2001) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system includes HP 6890-Plus GC, 5973 MSD and 6890 autosampler

(NT5) Hewlett Packard (2002) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system is equipped with an HP 6890N GC, an HP 5973N MSD, a Tekmar LCS 2000 Purge and Trap and a Dynatech PTA 30 autosampler for VOA analysis of aqueous or solid samples.

(NT6) Hewlett Packard (2002) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system includes an HP 6890 Plus GC, an HP 5973 MSD and an HP 7683 autosampler.

(NT7) Hewlett Packard (2007) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system is equipped with an HP 6890N GC, an HP 5973N MSD, a Tekmar LCS 2000 Purge and Trap and a Dynatech PTA 30 autosampler for VOA analysis of aqueous or solid samples.

(NT8) Agilent (2008) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system is equipped with Agilent 6890N GC, 5975C MSD, and 7683 autosampler.

(NT9) Agilent (2008) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system is equipped with Agilent 6890 GC and 5973 MSD, a Tekmar LSC 2000 Purge and Trap and a Dynatech PTA-30 autosampler for VOA analysis of either aqueous or solid samples.

(NT10) Agilent (2008) – A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system is equipped with Aglient 6850GC,an Agilent 5975C inert MSD GC, an OI Analytical Eclipse 4660 and a Varian Archon autosampler for VOA analysis of aqueous samples.

(NT11) Hewlett Packard (2009) - A GC-MS system networked with a Hewlett Packard Unix Server running Thruput Target 3.5 data analysis software. The system includes an Agilent 6890 N GC, an HP 5973 MSD and a Combi-pal SPME autosampler.

Gas Chromatographs

Hewlett Packard 5890 Series II (2003) – A GC system equipped with both FID and ECD detectors, capillary injectors, an autosampler and Chemstation. Used for screening samples before full extraction.

(ECD1) Hewlett Packard 5890 Series II (2004) - A GC system equipped with dual ECD detectors, an Agilent 6890 autosampler and HP Chem Station data system.

(ECD3) Hewlett Packard 5890 Series II (1991) – A GC system equipped with Dual ECD detectors, two Cool on column capillary injectors, an HP7673 autosampler and ChromPerfect data system.

(ECD4) Hewlett Packard 5890 Series II (1994) – A GC system equipped with dual ECD detectors, a split/splitless capillary injector, HP6890 autosampler and Chemstation data system.

(FID2) Hewlett Packard 5890 Series II (2004) – A GC system equipped with an FID detector, a capillary injector, an HP 7673A autosampler and HP Chem Station data system.

(FID3 A, B) Hewlett Packard 6890 (1996) – A GC system equipped with dual FID detectors, two capillary injectors, a dual tower HP 6890 autosampler, and HP Chem Station data system. A Restek GC Racer has been added to enhanced performance.

(FID4 A, B) Hewlett Packard 6890 (1996) – A GC system equipped with dual FID detectors, two capillary injectors, a dual tower HP 6890 autosampler, and HP Chem Station data system. A Restek GC Racer has been added to enhanced performance.

(PID1) Hewlett Packard 5890 Series II (2002) – A GC system equipped PID and FID detectors in series, an Dynatech PT30 autosampler and Tekmar LCS 2000 Sample Concentrator and Chemstation data system.

(PID2) Hewlett Packard 5890 Series II – (2005) –A GC system equipped with dual PID detectors, one in series with an FID, a Dynatech PT30 autosampler, a Tekmar 2000 sample concentrator and HP Chem Station data system.

(PID 3) Hewlett Packard 5890 Series II – (2006) –A GC system equipped with PID and FID detectors in series, a Dynatech PT30 WS autosampler, a Tekmar 2000 sample concentrator and HP Chem Station data system.

(ECD5) Hewlett Packard 6890 Plus Micro – (2002) – A GC system equipped with dual ECD detectors, an HP 7683 autosampler and an HP Chem Station data system.

(ECD6) Hewlett Packard 6890 Plus Micro – (2008) – A GC system equipped with dual ECD detectors, an Agilent 6890 autosampler and an HP Chem Station data system.

(FID5) Hewlett Packard 5890E Series II (2005) – A GC system equipped with dual FID detectors, an HP 7683 autosampler and HP Chem Station data acquisition system.

(FID6) Hewlett Packard 5890 Series II (2005) – A GC system equipped with an FID detector, an HP 7694 Headspace Sampler and HP Chem Station data acquisition system.

(FID7) Agilent 6850 (2008) – A GC system equipped with a single FID detectors, an Agilent 6850 autosampler and HP Chem Station data acquisition system.

(ECD7) Hewlett Packard 6890 Plus Micro – (2008) – A GC system equipped with dual ECD detectors, an Agilent 6890 autosampler, and HP Chem Station data system.

(FID8) Agilent 6890N (2008) – A GC system equipped with a dual FID detectors, an Agilent 7683B autosampler and HP Chem Station data acquisition system.

(FID9) Agilent 6850 (2009) – A GC system equipped with a single FID detector, an Agilent 6850 autosampler and HP Chem Station data acquisition system.

Inorganic Instrumentation

Perkin-Elmer SCIEX ELAN 6000 ICP-MS (1996) - A completely automated ICP-Mass Spectrometer with autosampler and multitasking software Computer controlled using ELAN NT Windows based software.

Perkin-Elmer Optima 7300DV ICP (2009) – Automated dual view simultaneous ICP with an Elemental Scientific SC-2 fast autosampler system

Perkin-Elmer Optima 4300 ICP (2001) - A completely automated dual view simultaneous ICP with auto-sampler and multitasking software.

Varian 300Z (1992) - A single channel atomic absorption graphite furnace instrument equipped with Zeeman background correction, and an auto-sampler

Varian 300Z (1991) - A single channel atomic absorption graphite furnace instrument with Zeeman background correction, equipped with an auto-sampler

CETAC M-6000A Mercury Analyzer (2000) – A fully automated high sensitivity cold vapor atomic absorption instrument dedicated to trace and ultratrace Mercury analysis. System is computer controlled with windows base software and an auto-sampler

Dionex Ion Chromatography DX 500 (1997) – A fully automated system with an auto-sampler for quantitative anion analyses. The system is computer controlled using Peaknet software.

Dionex Ion Chromatography 2100 (2009) – A fully automated system with an auto-sampler for quantitative anion analyses. The system is computer controlled using Chromeleon CHM-2 Version 7.0 software.

Thermo Genesys 10 (2003) - UV-VIS Spectrophotometer used for quantitative conventionals analysis.

Thermo Genesys 10 (2005) - UV-VIS Spectrophotometer used for quantitative conventionals analysis.

Lachat QuickChem 8000 Flow Injection Analyzer (2003) – Automated flow injection instrument dedicated to low level nutrient analysis

Lachat QuickChem 8500 Flow Injection Analyzer (2007) – Automated flow injection instrument dedicated to low level nutrient analysis

Dohrmann Apollo 9000 (2001) - Total Organic Carbon (TOC) Analyzer. Includes an autosampler for water analysis and a boat sampler for solids analysis.

Dohrmann Apollo 9000 (2009) - Total Organic Carbon (TOC) Analyzer. Includes an autosampler for water analysis and a boat sampler for solids analysis.

Kontes Midi-Vap Cyanide Distillation Systems (3 each)(1995-2008) – Each of the systems is capable of simultaneously distilling up to 10 samples for cyanide analysis using small sample aliquots.

Centrifuge (1987) - Beckman Model GP with swinging bucket rotor and inserts for 250 ml bottles and scintillation vials

Aim 500 Block Digestion System (2006) with Controller

Environmental Express Hot Block digestion blocks (10 ea) (1999-2008) for digestion of samples prior to trace metals analysis.

Hach COD Digestion Blocks (2)

Hach Ratio Nephelometer

Incubators: Lab-Line Ambi Hi-Lo Chamber and **Thermolyne 41900.**

GeoTech Laboratory Equipment

Trautwein Sigma 1 (2008) – Triaxial loading system

Sedigraph III Model 5120 (2007) – Automatic particle size analyzer

Beckman Coulter LS 13320 (2008) – Laser diffraction particle size analyzer with microliquid and universal liquid modules

Trautwein Soil Equipment – 12 position flexible wall permeability station

Soil Test Load Frame – with 500, 2,000 and 10,000 pound load cells for QU, UU, and CU triaxial tests, with pore pressure.

Soil Consolidation Apparatus – 16 tsf

Biosciences BI-1000 – 8 position electrolytic respirometer

Microtox – photo-luminescence toxicity test instrument

Beckman JP-21 – refrigerated centrifuge with 6 x 500 ml fixed angle head

IEC DRP-6000 – refrigerated centrifuge with a 4 x 1,000 ml swinging bucket head

Plas-Labs Anaerobic Test Chambers – 3 each

U.S. Army Corps of Engineers – column settling; column and batch leaching apparatus

Network Servers

ARI's central laboratory computer is a Dell PC Server, PowerEdge 2300/450, running Microsoft Windows NT 4.0 SP6. This system is home to ARI's Laboratory Information Management System (LIMS) database developed by Northwest Analytical of Portland, OR. The LIMS receives electronic data from all lab sections and produces hardcopy and electronic deliverables. In addition, the LIMS stores sample demographic data while providing a common tracking mechanism for all laboratory information.

The LIMS is connected to two sub-networks. Most data, with the notable exception of Conventionals and Geotech, is transferred electronically as text files from other data systems to the LIMS. This key process enhances data integrity by reducing manual entry and manipulation of instrument output.

The metals section uses an Intel PC Server with the Windows 2000 Server operating system. This system runs as a file server for dBASE IV and MS Access 2000 database applications. Once data is collected by the metals instrument computers, dBASE is used to aggregate and process the results and transfer it to the LIMS. The MS Access software has been customized by ARI's metals data supervisor to generate metals CLP forms and other internal reports. This server also provides additional services such as DHCP, WSUS, and the corporate vacation calendar.

The organics section uses an HP-UX Server with the HP-UX 10.20 operating system. This system runs Target 3.4 data analysis software. All GC/MS and other GC instruments are networked to this system. In addition to providing one common platform for organics data processing, the Target software produces CLP forms for organics data packages.

The conventional analysis laboratory uses individual PC Workstations with MS Excel for data reduction. Filled spreadsheets are saved to Server3. Data is manually copied from the MS Excel spreadsheet into the LIMS systems using LIMS worklists specific to a test method.

Server2 is the primary internal/external interface and provides email, NTP, web (internet and intranet), DHCP, proxy, document (Geotech), CVS, database, and authentication services. The OS is SME Server v5.6 (Linux) and the hardware is a VA FullOn 2300 with dual 800 MHz Pentium III processors. Access to Server2 is limited to authorized users and only IT personal have access to the shell.

Server3, running Windows 2000 Advanced Server, is the primary document server for ARI and is used to warehouse all scanned (pdf) data packages. The hardware for Server3 consists of

a generic box with a 2.4 MHz Intel Pentium 4 processor. Packages saved to this server are indexed using the CI service of Windows and are available for searching via the ARI intranet.

All servers are secured in a locked room where only management and IT staff have access. Some users have external access to the network but this is limited to current employees and only through an end-to-end encrypted VPN (OpenVPN).

Note: Extensive in-house replacement parts are available for lab instruments and computers, including spare circuit boards. A majority of all service maintenance is performed by ARI employees.

Appendix E

ARI Active Standard Operating Procedures (SOP)

A list of ARI's current Standard Operating Procedures (SOPs) is available on ARI's web site at:

http://www.arilabs.com/portal/downloads/ARI-SOPs.zip

SOPs are updated periodically. Assure that you have ARI's current SOPs by downloading the files at the time of use.

Appendix F

Sample Containers, Preservation and Holding Times

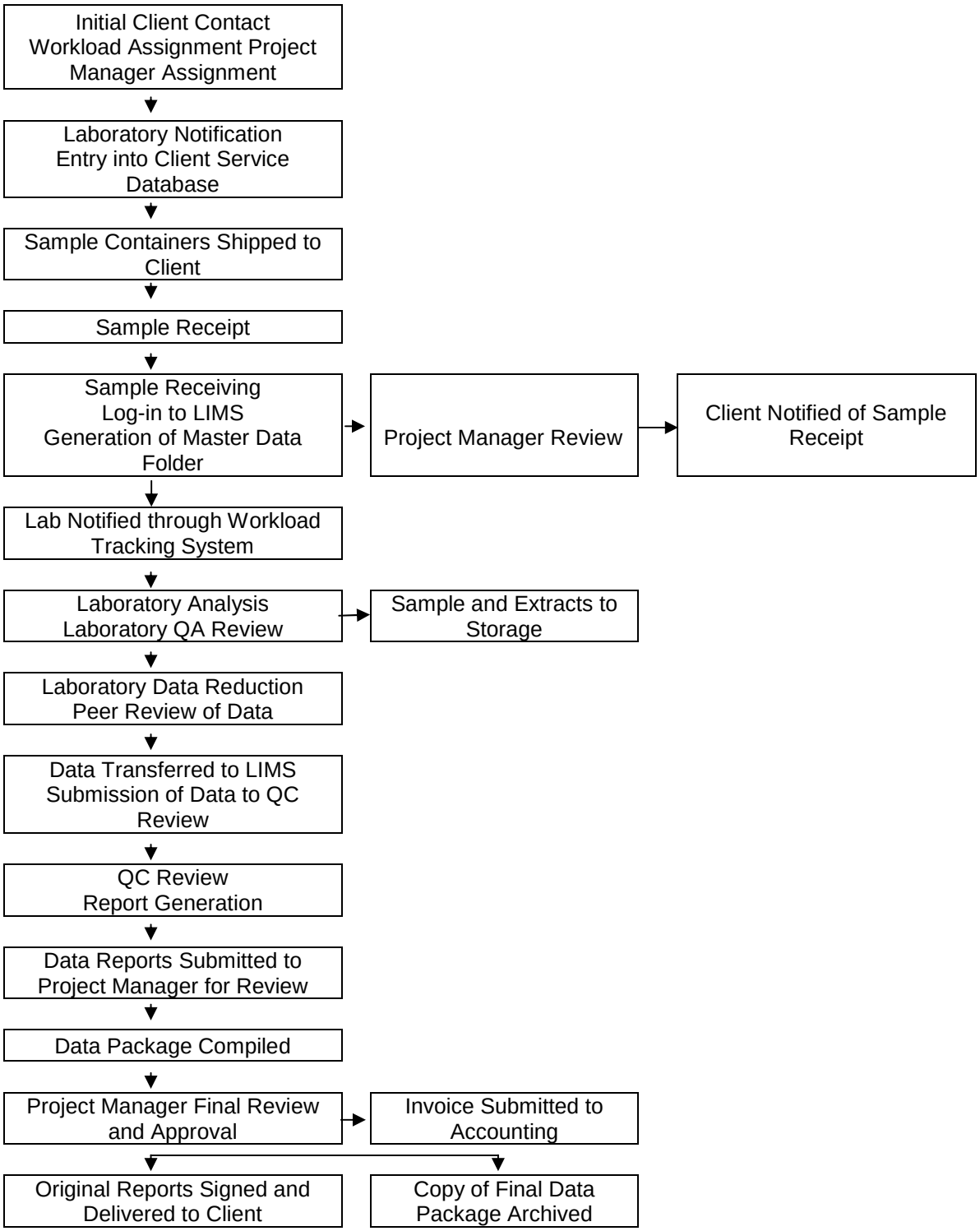
A summary of sample containers, preservatives and holding times is available on ARI's web site at:

http://www.arilabs.com/portal/downloads/

The summary is updated periodically. Assure that you have ARI's current document by downloading the files at the time of use.

Appendix G

Laboratory Workflow


Initial Client Contact
Workload Assignment Project Manager Assignment
Laboratory Notification
Entry into Client Service Database
Sample Containers Shipped to Client
Sample Receipt
Sample Receiving
Log-in to LIMS
Generation of Master Data Folder
Project Manager Review
Client Notified of Sample Receipt
Lab Notified through Workload Tracking System
Laboratory Analysis
Laboratory QA Review
Sample and Extracts to Storage
Laboratory Data Reduction
Peer Review of Data
Data Transferred to LIMS
Submission of Data to QC Review
QC Review
Report Generation
Data Reports Submitted to Project Manager for Review
Data Package Compiled
Project Manager Final Review and Approval
Invoice Submitted to Accounting
Original Reports Signed and Delivered to Client
Copy of Final Data Package Archived

Appendix H

Analytical Methods

ORGANIC ANALYSES

Parameter	Methods	Technique
Volatiles (GC/MS)	524.2/624/8260B	GC/MS
	Low Level Vinyl Chloride & 1,1 – Dichloroethene	GC-MS-SIM
Volatiles (GC)		
Volatile Aromatics	602/8021B	GC/PID
Semivolatiles (GC/MS)		
Semivolatile Organics	625/8270D	GC/MS
Polynuclear Aromatic Hydrocarbons (PNA/PAH)	625/8270D	GC/MS (SIM)
Isotope Dilution Semivolatiles	1625	GC/MS
Butyl Tin Species	Krone (1988)	GC/MS-SIM
Pesticides/GC Analyses		
Chlorinated Pesticides	608/8081A	GC/ECD
Aroclors/PCBs	608/8082	GC/ECD
PCB Congeners	ARI Method	GC/ECD
Phenols	604/8041	GC/FID
Chlorinated Phenols	8041 (mod)	GC/ECD
Pentachlorophenol	8151A (mod)	GC/ECD
Organophosphorous Pesticides	614/8141A	GC/NPD
Polynuclear Aromatic Hydrocarbons (PNA/PAH)	610/8100	GC/FID
Chlorinated Hydrocarbons	612/8121	GC/ECD
Herbicides	615/8151A	GC/ECD
Glycols	ARI Method(SOP 426S R2)	GC/FID
Hydrocarbon ID	NWTPH-HCID	GC/FID
Gasoline Range Hydrocarbons	(N)WTPH-G/AK101/WI-GRO	GC/FID
Diesel Range Hydrocarbons	(NWTPH-D/AK102/WI-DRO)	GC/FID
Extractable Petroleum Hydrocarbons	ARI Method	GC/FID
Volatile Petroleum Hydrocarbons	ARI Method	GC/PID
Organic Sample Preparation and Clean Up		
TCLP / SPLP Extraction		1311 / 1312
Sonication		3550B
Soxhlet		3540C
Accelerated Solvent Extraction (ASE)		3545B
Separatory Funnel		3510C
Continuous Liquid-Liquid		3520C
Alumina Clean-up		3610B

Florisil Clean-up	3620B
Gel Permeation (GPC)	3640A
Silica Gel	3630C
Sulfur Clean-up	3660B
Sulfuric Acid Clean-up	3665A

INORGANIC ANALYSES

Parameter	Methods	Technique
Wet Chemistry		
Acidity	2310/305.1	Titrimetric
Alkalinity	2320/310.1	Titrimetric
Ammonia	4500NH_3H/350.1	AutomatedPhenate/ISE
Biological Oxygen Demand-BOD		
Carbonaceous – BOD	5210.B/405.1	5-day Winkler Titration
Bromide	4500Br.B	Phenol Red Colorimetric
Anions	300.0	Ion Chromatography
Cation Exchange Capacity	9080	Neutral Ammonium Acetate
Chemical Oxygen Demand	5220.D/410.4	Closed Reflux, Colorimetric
Chromium Hexavalent (Cr6+)	3500Cr-D/7196A	Diphenylcarbazide
Chloride	4500CI.E/325.2	Automated Ferricyanide
Chlorophyll a	10200.H	Spectrophotometric
Coliform, Total / Fecal	9222.B/D	Membrane Filtration
Color	2120.B/110.2	Visual Comparison
Conductivity	2510/120.1	Electrometric
Corrosivity (CaCO3 Saturation)	2330	Calc. (pH, Alk, TDS, Ca)
Cyanide, Total	4500CN.C/335.2/9010	PBA, Colorometric
Cyanide, Amenable	4500CN.G/335.1	Alkaline Chlorination
Cyanide, WAD	4500CN.I	Weak Acid Distillation
Dissolved Oxygen	4500-O.C/360.2	Winkler Titration
Fats/Oils/Grease	5520.B/413.1/9070A	Gravimetric
Fluoride	4500F.C/340.2	Ion Specific Electrode
	300.0	Ion Chromatography
Formaldehyde	ASTM D-19 P216	Colorimetric
Hardness, Calculation	2340.B/6010B	Ca, Mg Calculation
Heterotrophic Plate Count	9215.D	Membrane Filtration
Iron (II) ferrous	3500Fe.D	Phenanthrolene
Nitrate + Nitrite	4500NO_3F/353.2	Automated Cd Reduction
Nitrate	4500NO_3F/353.2	Calculated
	300.0	Ion Chromatography
Nitrite	4500NO_3.F/353.2mod	Automated Colorimetric
	300.0	Ion Chromatography
Oil & Grease, Solids	5520.D/907	Gravimetric
Oil & Grease, Polar/Non Polar	5520.F	Gravimetric
PH	150.1	Electrometric
Phenols	5530.D/420.1/9065	4-AAP w/ Distillation
Phosphorous, Total	4500P.B/365.2	Colorimetric w/ digestion

Phosphorous, Ortho (SRP)	4500P.B/365.2	Colorimetric
	300.0	Ion Chromatography
Salinity	2520	Conductimetric
Silicate	4500Si.E/370.1	Heteropoly Blue
Total Kjeldahl Nitrogen (TKN)	4500N.org/351.4	Block Digest/ISE
Total Solids	2540.B/160.3	Gravimetric, 104°C
Total Suspended Solids (TSS)	2540.D.160.2	Gravimetric, 104°C
Total Dissolved Solids (TDS)	2540.C/160.1	Gravimetric, 180°C
Total Volatile Solids (TVS)	2540.E/160.4	Gravimetric, 550°C
Settleable Solids	2540.F	Volumetric
Streptococcus, Fecal	9230.C	Membrane Filtration
Sulfide	4500S^2.E/376.1/9034	Iodometric
Sulfide, Low Level	4500S^2.D/376.2	Methylene Blue
Sulfide, Acid Volatile	4500S^2.D/376.2	Methylene Blue
Sulfate	4500SO_4^2.F/375.2/9036	Auto. Methylthymol Blue
	300.0	Ion Chromatography
Sulfite	4500SO_3^2.B.377.1	Iodometric
Total Organic Carbon (TOC)	5310.B415.1/PSEP	Combustion NDIR
Turbidity	2130.B/180.1	Nephelometric
Total Lipids in Tissue	Bligh & Dyer (mod)	Gravimetric

Trace Metals Analyses

Inductively Coupled Plasma (ICP):

Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Sn, Sr, Th, Ti, Tl, V, (Li, Th, U, W - special request only)	Zn200.7 / 6010B	ICP

Graphite Furnace (GFAA):

Ag, As, Cd, Sb, Pb, Se, Tl	200 Series / 7000 Series	GFAA

Cold Vapor (CVAA):

Hg	7470A/7471A	CVAA

Inductively Coupled Plasma/Mass Spectroscopy (ICP-MS):

Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Th, Tl, U, V, Zn	200.8/ 6020 Mod.	ICP/MS

Trace Metals Sample Preparation

Toxicity Characteristic Leaching Procedure	1311
Synthetic Precipitation Leaching Procedure	1312
Digestion for Total Recoverable or Dissolved Metals	3005A
Digestion of Aqueous Samples for Total Metals by ICP	3010A
Digestion of Aqueous Samples for Total Metals by GFAA	3020A
Digestion of Sediment, Sludge and Soil	3050B

Appendix I

Method Detection Limits and Reporting Limits

Summaries of method specific MDL studies and reporting limits are available on ARI's web site at:

http://www.arilabs.com/portal/downloads/ARI-MDLs.zip

MDL's and reporting are updated periodically. Assure that you have ARI's current detection limit data by downloading the files at the time of use.

Appendix J

Quality Control Recovery Limits

Method specific control limits are available on ARI's web site at:

http://www.arilabs.com/portal/downloads/ARI-CLs.zip

Control limits are updated periodically. Assure that you have ARI's current control limits by downloading the files at the time of use.

Appendix K

Internal Audit Schedule

Schedule of Laboratory Quality Assurance Audits

Process To Be Audited	Frequency
Verify Effectiveness of Corrective Actions	Monthly
Verify Refrigerator and Freezer Temperature Logs	Monthly*
Verify Oven and Incubator Temperature Logs	Monthly*
Verify That Balance Records Are Complete	Quarterly*
Verify That Standard Records are Complete	Monthly#
Verify That Logbooks Are Reviewed	Monthly#
Verify That SOPs Are Current and Available in Labs	Monthly#
Review Chain of Custody Documentation	Monthly#
Audit Internal Technical Systems	Annually
Post-Completion Project Review	Monthly**

* all sections will be audited

one section will be audited each month

** frequency may be contract specific i.e. 10% of NFESC projects must be audited

Appendix L

Laboratory Accreditations

Laboratory Accreditations

Analytical Resources Inc. is currently certified to perform environmental analysis by the National Environmental Laboratory Accreditation Program (NELAP), the State of Washington Department of Ecology and the State of Alaska Department of Environmental Conservation. ARI is approved to perform analyzes for the US Navy and the US Army Corps of Engineers following the Department of Defense Quality Systems Manual (DoD-QSM)

ARI's laboratory QA/QC Program has been audited and approved by The Boeing Company and Battelle Pacific Northwest Laboratories.

ARI analyzes drinking water, waste water and solid matrix performance testing (PT) samples semiannually.

List of Accreditations

1) National Environmental Laboratory Accreditation Conference (NELAC) – Accrediting authority is Oregon Environmental Laboratory Accreditation Program (ORELAP).
2) State of Washington, Department of Ecology - Environmental Laboratory Accreditation Program
3) The Alaska State Department of Environmental Conservation - Laboratory Approval Program
4) United States Army Corps of Engineers (USACE)
5) United States Naval Facilities Engineering Service Center (NFESC) (formerly known as NEESA)

Continuing Contracts Resulting from On-Site Laboratory Audits

1) The Boeing Company Corporate Environmental Affairs Division
2) The City of Seattle
3) The Port of Seattle

Appendix M

Data Reporting Qualifiers

Data Reporting Qualifiers

Effective 7/10/2009

Inorganic Data

U Indicates that the target analyte was not detected at the reported concentration

* Duplicate RPD is not within established control limits

B Reported value is less than the CRDL but ≥ the Reporting Limit

N Matrix Spike recovery not within established control limits

NA Not Applicable, analyte not spiked

H The natural concentration of the spiked element is so much greater than the concentration spiked that an accurate determination of spike recovery is not possible

L Analyte concentration is ≤5 times the Reporting Limit and the replicate control limit defaults to ±1 RL instead of the normal 20% RPD

Organic Data

U Indicates that the target analyte was not detected at the reported concentration

* Flagged value is not within established control limits

B Analyte detected in an associated Method Blank at a concentration greater than one-half of ARI's Reporting Limit or 5% of the regulatory limit or 5% of the analyte concentration in the sample.

J Estimated concentration when the value is less than ARI's established reporting limits

D The spiked compound was not detected due to sample extract dilution

E Estimated concentration calculated for an analyte response above the valid instrument calibration range. A dilution is required to obtain an accurate quantification of the analyte.

Q Indicates a detected analyte with an initial or continuing calibration that does not meet established acceptance criteria (<20%RSD, <20%Drift or minimum RRF).

S Indicates an analyte response that has saturated the detector. The calculated concentration is not valid; a dilution is required to obtain valid quantification of the analyte

NA The flagged analyte was not analyzed for

NR Spiked compound recovery is not reported due to chromatographic interference

NS The flagged analyte was not spiked into the sample

M Estimated value for an analyte detected and confirmed by an analyst but with low spectral match parameters. This flag is used only for GC-MS analyses

M2 The sample contains PCB congeners that do not match any standard Aroclor pattern. The PCBs are identified and quantified as the Aroclor whose pattern most closely matches that of the sample. The reported value is an estimate.

N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a “tentative identification”

Y The analyte is not detected at or above the reported concentration. The reporting limit is raised due to chromatographic interference. The Y flag is equivalent to the U flag with a raised reporting limit.

C The analyte was positively identified on only one of two chromatographic columns. Chromatographic interference prevented a positive identification on the second column

P The analyte was detected on both chromatographic columns but the quantified values differ by ≥40% RPD with no obvious chromatographic interference

Geotechnical Data

A The total of all fines fractions. This flag is used to report total fines when only sieve analysis is requested and balances total grain size with sample weight.

F Samples were frozen prior to particle size determination

SM Sample matrix was not appropriate for the requested analysis. This normally refers to samples contaminated with an organic product that interferes with the sieving process and/or moisture content, porosity and saturation calculations

SS Sample did not contain the proportion of “fines” required to perform the pipette portion of the grain size analysis

W Weight of sample in some pipette aliquots was below the level required for accurate weighting

Appendix N

Standards for Personal Conduct

Standards of Conduct

Since effective working relationships depend upon each of us, ARI expects certain minimum standards of personal conduct.

This list highlights general Company expectations and standards and does not include all possible offenses or types of conduct which may result in discipline or discharge. Management reserves the absolute right to determine the appropriate degree of discipline, including discharge, warranted in individual cases.

Employees engaged in the following activities, or similar activities deemed equally serious, will normally be terminated:

theft or embezzlement
disclosure of trade secrets or industrial espionage;
willful violation of safety or security regulations;
conviction of a felony;
working for a competitor or establishing a competing business.

In addition, dismissal may result from other serious offenses such as:

being intoxicated, under the influence or in possession of illegal drugs on the job;
falsification of records;
abuse, destruction, waste or unauthorized use of equipment, facilities or materials;
gambling on the premises;
chronic tardiness or absenteeism;
insubordination;
unwillingness to perform the job;
unauthorized requisition of materials from vendors.

There may be no alcoholic beverages on the Company premises, other than at times designated as Company functions. At such times, non-alcoholic beverages will be provided as well.

Personal and corporate honesty and integrity have built the character of ARI. This good character is fundamental to our well-being, future growth and progress. It is vitally important that we avoid both the fact and the appearance of conflicts of personal interest with that of the firm, its clients, and any other professional contacts.

This policy requires that ARI employees have no relationships or engage in any activities that might impair their independence of judgment. Employees must not accept gifts, benefits, or hospitality that might tend to influence them in the performance of their duties. It is expected that there will be no employment by any competing company, nor any employment by any outside interest or engagement in outside activity which might impair an employee's ability to render the full-time service to the company that employment involves.

If any possible conflict of interest situation arises, the individual concerned must make prior disclosure of the facts so that action may be taken to determine whether a problem exists and,

Standards of Personnel Conduct – continued

if so, how best to eliminate it. Likewise, any financial interest in an organization doing business with ARI or which competes with us should be revealed to Company management. (Excluded from this requirement is ownership of securities traded in major stock exchanges or other recognized trading markets.)

Our standards are those generally expected of employees in any well-regarded, ethical business organization.

ARI further expects that each employee will:

Be dressed and groomed appropriately for a business office. Employees in the laboratory areas are expected to dress in compliance with established safety procedures. Specific standards will be discussed with each employee during Health and Safety orientation. Your supervisor and the Administrative Services Manager always are available to answer questions.

Maintain the confidential nature of Company information. Removal of Company documents, records, stored materials, computer printouts, or any similar information, or copies of such material or information from the office without specific permission is prohibited. Likewise, revealing confidential information to an unauthorized person or using such information in an unauthorized way is prohibited. If there could be any possible question about the applicability of this requirement to a given circumstance, ask your supervisor.

Use Company computer capabilities and facilities only for authorized business at authorized times and locations; observe strictly all computer security measures and precautions; enter, alter or delete no computer instructions or stored material apart from that required by faithful performance of assigned duties; remove, copy, use or permit to be used no computer software developed for, purchased by, or otherwise used by ARI except as required by faithful performance of assigned duties.

Conduct business dealings with clients and members of the public in a courteous manner.

Appendix O

Quality Assurance Policies

QUALITY ASSURANCE POLICY -

POLICY NUMBER: **1** -

SUBJECT: **CORRECTIONS TO DATA/BENCHSHEETS** -

DATE: - **8/2/96** -

Manual corrections made on any raw data, bench sheet, logbook or document used during sample processing will be made in the following manner:

1. Draw a single line through the information to be deleted or corrected. The original information must remain readable.

2. Enter any new information, preferably above the original information.

3. Initial and date the correction.

QUALITY ASSURANCE POLICY -

POLICY NUMBER: **2** -

SUBJECT: **LINING OUT UNUSED BENCHSHEET PORTIONS** -

DATE: - **8/2/96** -

All unused portions of logbook pages and benchsheets will be lined through so that information cannot be added at a later date. This will be completed in the following manner:

1. Line out unused portions of a logbook page or benchsheet by drawing a single line or "Z" through the unused portions.

2. Initial and date the page beside the lineout.

3. Do not line out a page or section until it is certain that no additional information will be added to the unused portions.

QUALITY ASSURANCE POLICY -

POLICY NUMBER: 3 -

SUBJECT: STOP WORK ORDERS -

DATE: - 8/28/96 -

It is the responsibility of all staff members to address situations that may require the issuance of a "stop work order". Potential and actual "stop work orders" will be handled as follows:

1. If an analyst or technician observes a situation which will or may have a negative impact on data quality, that person will notify her/his section supervisor immediately.

2. The section supervisor will assess the situation. If it appears that a "stop work order" may be required, the section supervisor will notify the appropriate manager (inorganic or organic).

3. The supervisor and manager will then decide if a "stop work order" should be issued. The manager will make a final decision on whether or not to issue a "stop work order". The incident will be reported to the Quality Assurance Program Manager using a Corrective Action Request form.

4. If a "stop work order" is issued, the manager will inform the Project Managers and the QA section. The section supervisor will notify section staff of the order.

5. The laboratory manager involved will oversee the development and implementation of a Corrective Action Plan (CAP). Upon completion of the CAP the "stop work order" may be rescinded.

6. Prior to rescinding a "stop work order", verification must be made that control has been regained and that work may begin. Only the inorganic or organic manager may rescind a "stop work order".

7. When the "stop work order" is rescinded, the Project Managers, analytical staff and QA section will be notified. The QA section will require documentation verifying that the procedure is back in control.

QUALITY ASSURANCE POLICY -

POLICY NUMBER: **4** -

SUBJECT: **SOP Review** -

DATE: **9/3/96** -

All Standard Operating Procedure (SOP) documents will be reviewed and updated at least annually by qualified staff members. Laboratory management will review and approve all modifications to the SOPs.

QUALITY ASSURANCE POLICY -

POLICY NUMBER: **5** -

SUBJECT: **Reporting Dilutions** -

DATE: **9/11/96** -

Dilution factors will be recorded as whole numbers followed by "X" (i.e., 5X, 10X, etc.). This reporting convention will be used on run logs, bench sheets, raw data and final reports for all diluted samples, extracts or digestates or standards.

QUALITY ASSURANCE POLICY -

POLICY NUMBER: **6 -**

SUBJECT: **Formatting for SOPs – Computer Related -**

DATE: **1/31/00 -**

Conventions for formatting computer-related instructions in SOPs

Commands should be indented and formatted as **`bold courier`** and one or two font sizes smaller:

```
USE PARAMS ORDER PARAMS
BROW
```

Many systems and languages are *case-sensitive*, and case should match the syntax and/or stylistic standards of the language.

If only one command, like ***`SET CENTURY ON`***, is needed, it can be included in the rest of the text, so long as it is also italicized.

If the user must substitute a particular value in place of a general descriptor, italicize the descriptor, make it lowercase, and *do not make it bold*:

```
USE PARAMS ORDER PARAMS
COPY TO TEMPARM FOR JOB = 'job' .AND. SAMPLE = 'sample'
```

In general, keywords, variable names, formatting codes, and descriptors should be in *`courier`* and *`italicized`*.

QUALITY ASSURANCE POLICY -

POLICY NUMBER:	**7**
SUBJECT:	**Manual Adjustment of Data**
DATE of IMPLEMENTATION:	**1/1/01**

Modern chromatographic instruments include computer software to identify a detector response as a chromatographic peak, characterize that peak and determine the relative height or area of the signal. The software utilizes parameters (threshold, slope, etc) that are adjusted by the instrument operator to optimize the results.

A single set of operator controlled settings that determine peak characteristics for an entire data file is defined as an "automated procedure". An automated procedure often characterizes chromatographic peaks incorrectly. ARI requires that trained analysts identify and resolve these errors using an alternate automated procedure or a "manual adjustment" of the data. Manual adjustment is defined as the process used by an analyst to adjust an individual peak or a subset of data in a chromatographic file.

1. The settings for a routine automated procedure normally used to process chromatographic data must be described in the method Standard Operating Procedure (SOP).

2. Trained analysts may substitute one automated procedure for another in order to optimize peak characteristics. The use of an alternate automated procedure must be permanently documented using either a software generated log file or analyst notes.

3. Manual adjustment of chromatographic peak characteristics will be used to correct the results of an automated procedure that, in a trained analyst's opinion, are clearly incorrect and will result in erroneous peak identification, integration or quantification.

4. Manual adjustment will be implemented in a reasonable and consistent manner. Guidelines for performing manual adjustment will be documented in method SOPs.

5. All manually adjusted data will be clearly identified for approval in the data review process. A permanent record of all manual adjustments will be maintained in both electronic and hardcopy versions of the raw data.

6. Manual adjustment of chromatographic files will not be used to falsify data for any purpose. Falsification of data through the use of manual peak adjustment is unethical, unlawful and will result in termination of the offending analyst.

Approval:

_____

Quality Assurance Program Manager Date

QUALITY ASSURANCE POLICY -

POLICY NUMBER:	**8 -**
SUBJECT:	**Performance Evaluation Samples -**
IMPLEMENTATION DATE:	**1/1/01 -**

Performance Evaluation Samples (PES) will be analyzed on a periodic basis to monitor laboratory performance and/or meet the requirements of an external accreditation program. PES samples contain target analytes in concentrations unknown to laboratory personnel. PES may be submitted by a third party or prepared internally under the direction of ARI's QA personnel.

PES will be submitted blind to the laboratory whenever possible.

PES will be logged-in, prepared, analyzed and reported as a routine sample without special consideration.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**9**
SUBJECT:	**Modifications to Analytical Methods Procedures or Reports**
DATE of IMPLEMENTATION:	**8/24/05**

This Policy defines the processes used to initiate and validate modifications to analytical processes, QA/QC protocol, data processing programs and algorithms, data reporting formats or other changes to analytical procedures or SOPs at Analytical Resources Inc. (ARI). The procedures outlined will also be used to validate project specific changes to analytical protocol and new analytical methods.

Changes to analytical procedures must be approved by ARI's Management (Managers and/or Supervisors) and be well documented using the following procedure:

1. Modification may be requested by any staff member. The modification must be requested using ARI's Corrective Actions Tracking System. Corrective Action requests for changes to analytical protocol or reports will assigned to the appropriate manager or supervisor by the initiator. As an alternative the request may be assigned to the QA Section. The Corrective Actions assignee may approve the project or re-assign the request for approval to a third party. The QA Section will monitor the progress of all requests.

2. The requestor must detail and justify the proposed modifications or additions when initiating a Corrective Action issue. Modifications must be approved by ARI management prior to any work performed to establish the modification.

3. The following must be in place before final approval and/or implementation of the proposed modification.

A. A new or revised SOP as appropriate including the modification or new protocol.
B. An Initial Demonstration of Proficiency as defined in ARI SOP 1018S for new or modified analytical procedures.
C. An MDL study following the procedure in ARI SOP 1018S for new or modified analytical procedure.
D. When appropriate, successful analysis of a blind Performance Evaluation Sample using new or modified procedures or data processing protocol.
E. Documentation that new or modified software provides the desired result.

4. ARI staff must have sufficient training to implement the procedural changes.

5. Notification of the modifications must be distributed to all affected personnel including appropriate client personnel.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**10**
SUBJECT:	**Reporting of Target and Spiked Analytes For Dual Column GC Analyses**
DATE of IMPLEMENTATION:	**8/24/05**

Analytical Resources Inc. uses single injection, dual column gas chromatographs to simultaneously identify and confirm the presence of target or spiked analytes in some GC analyses. Only one quantitative value is reported for each target or spiked analyte. ARI's policy for deciding which value to report is outlined as follows:

1. ARI considers each column equally valid for compound identification and quantification. Both GC columns must be compliant with all quality assurance parameters outlined in ARI's SOPs and LQAP. Both GC columns must produce valid initial and continuing calibrations using the same calibration model.

2. The analytical value reported will be determined by comparison of the quantitative results of confirmed analytes as follows.

a. The relative percent difference (RPD) between the results on the two columns (R_1 & R_2) is calculated using the formula:

$$RPD = \frac{|R_1 - R_2|}{\left(\frac{R_1 + R_2}{2}\right)} \times 100$$

b. If the RPD is less than 40% the greater of the two values is reported for both target analytes and spiked compounds. When required by specific QA protocol, by contract or client request the lower value will be reported for target analytes.

c. If the RPD is greater than 40%, ARI's analyst must examine the chromatogram for anomalies (overlapping peaks, incorrect integration, negative peaks) and either correct the anomalies (i.e. perform manual integrations) or report the most appropriate target analyte value. The higher value will be reported for spiked analytes. ARI's analyst must provide a written evaluation of all analyses where an RPD exceeds 40% and this information must be passed on to ARI's client or the data user.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**11**
SUBJECT:	**Calculation of Analytical Uncertainty**
DATE of IMPLEMENTATION:	**8/31/06**

Analytical Resources Inc. will use the procedure[1] proposed by Thomas Georgian, PhD to estimate analytical uncertainty. Dr. Georgian's proposes using the formulae below to calculate uncertainty:

For biased corrected analytical results:

100 (c/R)(1± L / R)
Where:
c = Measured concentration of the analyte
R = Average LCS spike recovery
L = ½ the warning or control range

And for unbiased results i.e. R = 100

c (± L / 100)

Example:

For a 10 ppb analytical result when the mean LCS recovery is 50% and the control limits are 20% to 80% an interval for the analytical results is calculated as follows:

100 (10 ppb / 50)(1±30 / 50) = 20 ± 12 ppb

[1] Estimation of Laboratory Analytical Uncertainty Using Laboratory Control Samples, Thomas Georgian, Ph.D., *Environmental Testing & Analysis*, November/December 2000.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**12**
SUBJECT:	**Rounding of Numbers and Reporting Limits**
DATE of IMPLEMENTATION:	**8/24/05**

I. ARI reports analytical results in concentration units as follows:

A. Values expressed as a concentration (mg/L, µg/Kg etc.)

1. Values less than or equal 10 are reported using 2 significant figures.
2. Values greater than 10 are reported using 2 or 3 significant figures.

B. Values expressed as percent (control limits, RSD etc.) are reported using the appropriate whole number. Examples: 6.38 rounds to 6, 9.95 rounds to 10, 99.93 rounds to 100, 145.48 rounds to 145.

II. ARI rounds numbers to the appropriate level of precision using the following rules:

A. If the figure following those to be retained is greater than or equal to 5, the absolute value of the result is to be rounded up: otherwise, the absolute value of the result is rounded down. Examples: -0.4365 rounds to -0.437 and 2.3564 rounds to -2.356; 11.443 is rounded down to 11.44 and 11.455 is rounded up to 11.46.

B. When a series of multiple operations is performed (add, subtract, divide, multiply), all significant figures are carried through the calculations and the final result is rounded to the appropriate number of significant figures.

III. ARI compares concentration values to reporting limits prior to rounding final concentration values. Example: with an RL of 0.50, 0.499 is undetected at 0.50 (0.50U) and 0.504 is detected at 0.50.

III. ARI will round quality control results prior to determining if the value is in control. Example: for spike recovery limits of ± 10% (90 – 110%), a recovery of 110.47is in control at 110% and a calculated recovery of 110.50 is out of control at 111%.

QUALITY ASSURANCE POLICY

POLICY NUMBER:	**12**
SUBJECT:	**Use of "J" Flag when Reporting Analytical Data**
DATE of IMPLEMENTATION:	**3/1/09**

1. ARI uses a "J" flag to indicate that a quantitative result chemical analysis is an estimated value. In general, "J" flags note positively identified compounds that are not in an instrument's verified calibrated range.
2. A "J" indicates quantitative values with a high degree of uncertainty. Data users must consider the greater uncertainty when using "J" flagged quantitative values.
3. ARI will not use "J" flags when reporting the results of metals analyses. Instrumental analysis of metals is subject to inter-element interference, non-specific absorption and sample-to-sample carryover that make quantification of elements below the reporting limit difficult. MDL studies performed on clean sample matrices are not subject to these interferences.
4. ARI will not report analytes below the RL ("J" flag is not used) for any single column GC analysis. (HCID, TPH-D, BTEX, TPH-G, RSK-175, Direct Aqueous Injection)
5. ARI uses "J" flags when reporting results of GC-MS (VOA and SVOA) and dual column GC analyses using the following criteria:
   A. All analyses must meet ARI established QA criteria for calibration and spike recovery.
   B. Analytes must meet method specific identification criteria (i.e. spectral match, retention time and/or relative retention time).
   C. The analyte concentration must exceed the greater of either the MDL or ½ the reporting limit before a "J" flag is applied.
   D. An analyte in a method blank will be "J" flagged only when any associated sample contains the same analyte.
   E. The application of a "J" flag is discretionary, depending on the professional judgment of ARI's data reviewers. GC-MS parameters such as ion ratios, spectral match, background contamination and instrument noise are weighted when considering the application of "J" flags.
6. Some typical circumstances that may warrant the use of a "J" flag:
   A. A compound identified at a concentration between the MDL or ½ RL and ARI's reporting limit (normally the low concentration used to calibrate the instrument).
   B. The quantified values in a dual column GC analysis differ by > 40% with obvious interference on one column. ARI may report the value with the lowest concentration or the least interference.
   C. The analyte is present at low concentration due to extract dilution and identified in a previous analysis of less dilute extract.
   D. Analytes < the RL and reported in previous analyses from the same sampling site.
   E. An analyte is < the RL in a sample and greater than the RL a duplicate or replicate analysis. This often applies to Matrix Spike and Laboratory Control Samples and their duplicates.

Appendix P

Modifications to ARI's LQAP

Modifications to ARI's LQAP

New Revision	Date	Modifications
		1. Updated Appendix D – Instrument/Equipment List 2. Specified length of data archive in Section 5.5
12-010	1/4/08	1. Edit Sections 4.4.1, 4.4.2, 4.4.3.2, 5.5, 6.3 (subcontracting), 8.3, 9.1 (MDLs) and 13 for Navy CAP. 2. Transferred Containers, Preservative & HT Table from Appendix F to Web
12-009	7/21/07	1. Updated SOP list in Appendix E 2. Updated Instrument List in Appendix D 3. Updated Accreditations Appendix L 4. Removed SOP table to web-site
12-008	12/20/06	1. Added Methane, Ethane & Ethene Info to Appendix F Table 2. Updated SOP Table in Appendix E 3. Modified Internal Audit Schedule 4. Archived SOP 355S and removed it from list in Appendix E 5. Updated Instrument / Equipment List in Appendix D
12-007	4/11/06	1. Removed Appendix J – Tuning Criteria are in the SOP 2. Changed BOD RL from 1 to 2 ppm 3. Integrated all SVOA Soil/Sediment MDLs into One Table 4. Added SIM Analysis to Soil/Sediment SVOA MDL Table 5. Added SIM Analysis to Water SVOA MDL Table 6. Updated MDL for SVOA in Water 7. Updated MDLV for Pesticides in Soil (25g to 5mL) 8. Updated MDLV for Pesticides in Soil (12g to 4mL) 9. Updated MDLV for PCB in Water (500 to 1mL) 10. Updated MDLV for PCB in Water (500 to 5mL) 11. Updated MDLV for Chlorinated Phenols in Water (500 to 50mL) 12. Removed Appendix I – MDL & RL Summaries 13. Updated MDL for SIM-PNA 14. Updated MDLV for SIM-PNA 15. Removed Appendix K – Control Limits
12-006	1/16/06	1. Updated MDL for TBT in Pore Water 2. Updated MDL and MDLV for Toxaphene in Soil/Sediment 3. Updated MDLV for VOA 8260B 20 mL Purge 4. Added IDL, MDL & RL for Low RL Mercury 5. Updated all Metals MDL Verifications 6. Updated MDLV for Water VOA using 5 mL purge 7. Updated MDLV for PCB in Soil with Soxhlet Extraction 8. Updated MDLV for SVOA (8270D) Analysis of Water using SepFunnel 9. Updated MDL for GC-MS-SIM Analysis of Skydrol & BHT in Water 10. Updated MDL for Chlorophenols (8041) in Soil 11. Modified RL for Chlorophenols in Soil & Tissue 12. Added Headspace GC (FID5) to Instrument List 13. Updated Footnotes on Glycols RL Table 14. Modified RL for 1,4-Dioxane in Water Method 8270D 15. Updated MDL for Analysis of Soil for VOA 16. Updated MDL for Analysis of Soil for JP-8 17. Updated MDL for Analysis of Sediment for TBT 18. Updated MDLV for Analysis of TBT in Water and Tissue 19. Added MDL for Analysis of PCB in Tissue with 4 ppb RL 20. Updated MDLV for PCB Analysis of Soil (Soxhlet) and Tissue (4 ppb) 21. Updated MDLV for Manchester Analysis of PCB in Water 22. Updated MDLV for Analysis of Gasoline in Soil and Water 23. Updated MDLV for Analysis of BTEX in Soil and Water 23. Updated MDLV for Analysis of Motor Oil in Soil and Water

		24. Updated MDLV for Analysis of VOA-SIM in Water 25. Updated MDLV for Analysis of VOA (20 mL) in Water 26. Updated MDL Table for Conventionals 27. Updated MDLV for Pesticides in Water (500 to .5 mL) 28. Updated MDLV for PCB Analysis of Soil 29. Updated MDLV for Chlorophenols (8041) in Soil 30. Updated MDLV for JP4 in Water and Soil 31. Updated MDLV for JP8 in Soil 32. Updated MDLV for VOA (8260B) in Water 5 mL & 20 mL Purge Volumes 33. Updated MDL for PCB in Soil – Standard Analysis & Medium Level 34. Updated MDL for Pesticides in Water – Standard Analysis 35. Updated MDL for SVOA in Water – Liq-Liq Extraction 36. Updated MDLV for Chlorophenols in Water
12-005	10/24/05	1. Added MDL for Chlorinated Phenol Analysis of Tissue (Method 8041) 2. Modified QA Policy 10 3. Established Implementation Date for QA Policies 09 & 10 4. Updated MDLV for TBT in Water 5. Corrected MDL Value for bis-(2-Ethylhexyl)-phthalate in SVOA Tissue 6. Updated MDL for Pesticides in Soil 7. Modified Title Format of Selected MDL Tables 8. References to 8270 or 8270C changed to 8270D 9. Deleted MDL Tables for SVOA Analyses of Tissue 10. Updated MDLs for SIM-PNA in Water (SepFunnel) and Soil 11. Updated MDLV for Metals 12. Updated MDLV for Manchester Pesticides 13. Updated MDLV for TPH-D In Soil 14. Updated MDLV for SIM-PNA in Water with Liq-Liq Extraction 15. Updated MDLV for JP-4 in Soil 16. Updated MDLV for VOA Water 5 mL Purge 17. Corrected MTCA RL for Methoxyclor & Manchester RL for all Pesticides 18. Updated MDL for Manchester Beta-BHC to reflect latest MDLV 19. Corrected Tissue Pesticide RLs 20. Updated MDLV for LVI-SIM-PNA in Water with Liq-Liq Extraction 21. Updated MDL for VOA-SIM Analysis of Aqueous Samples 22. Updated MDLV for PCB in Water (500 to 5 mL) 23. Updated MDLV for Diesel in Water (NWTPH-D & AK102) 24. Updated MDLV for Chlorophenols in Aqueous Samples 25. Updated MDLV for Chlorophenols in Tissue Samples 26. Removed & Archived Modifications to LQAP for 2002 & 2003 27. Updated MDL for Skydrol/BHT Analysis in Water Using 8270-SIM 28. Removed Direct Aqueous Injection MDLs RL Table. 29. Updated SOP Table (Appendix E)
12-004	8/19/05	1. Added “A” Flag for GeoTech to Appendix N. 2. Updated MDL for JP-4 in Soil 3. Updated MDL for Pesticides in Tissue 4. Updated MDLV for JP-4 in Soil 5. Updated MDLV for Pesticides in Soil 6. Updated MDLV for Pesticides in Water 7. Updated MDLV for PCB in Soil (25g to 1 mL) 8. Updated MDLV for PCB in Water (500 to 5 mL) 9. Updated MDLV for TPH-D in Water 10. Updated MDLV for PNA-SIM in Water (Liq-Liq Extraction) 11. Updated MDLV for VOA in Water (5 mL 8260B) 12. Updated MDLV for VOA in Water (20 mL 8260B) 13. Updated MDL for PSDDA SVOA in Sediment 14. Updated Appendix E – SOP List 15. Corrected MDL for Pesticides in Soil Information (IA-80 not GU-32)

		16. Corrected Reporting Limits for TBT in Water, Sediment & Tissue 17. Added Control Limits for 1,4-Dioxane to SVOA List 18. Added low level RLs for BTEX Compounds 19. Updated MDLV for TBT in Pore Water 20. Updated MDLV for BTEX Water & Soil 21. Updated MDLV for TPH-G in Water & Soil 22. Updated Appendix E SOP Table 23. Updated MDLV for Motor Oil in Soil Using ASE 24. Updated MDLV for Motor Oil in Soil Using MicroTip 25. Updated MDLV for Motor Oil in Water Using SepFunnel 26. Updated MDLV for JP-4 in Water Using SepFunnel
12-003	7/15/05	1. Added MDLV for 5 mL VOA Analysis of Water – Method 8260B 2. Updated MDL for MTCA PCB in Water Samples 3. Added MDL for Soxhlet Extraction of PCBs 4. Removed Aroclor 1242 from MDL Table 5. Control Limits for HEM Changed to Equal Those in SOP 648S 6. Updated MDL for PSDDA PCB Analysis. 7. Added MDL for TBT in Tissue 8. Updated MDL for 20 mL 8260B 9. Updated MDLV for SIM-VOA 10. Updated MDL for Pesticides in Soil 11. Updated MDLV for TPH-D in Soil 12. Added MDLV for PSEP Level Pesticides in Sediment 13. Updated (added missing compounds) PSDDA SVOA MDLs 14. Updated & Corrected Appendix F (Containers & Preservatives) 15. Added “A” Flag for GeoTech to Appendix N.
12-002	6/9/05	1. Updated Motor Oil MDL (NWTPH-Dext & AK103) for Soil 2. Documented MDLV for Gasoline in Soil (Methods NWTPH-G & AK101) 3. Corrected units for DRO & RRO MDL for water from mg/kg to mg/L 4. Added MDL for JP-4 in Water using Sep Funnel Extraction 5. Updated MDL for Sediment Analysis (Krone) of TBT using Sonication 6. Updated MDL for SVOA Water SepFunnel 7. Noted that BTEX –SIM MDL in Table was Medium Level Extraction 8. Added MDL Verification Information for ICP Metals 9. Updated MDL for TBT in Water and Pore Water – SepFunnel 10.Updated MDLV for TPH-D Water – SepFunnel 11. Added EPH and VPH RL Tables 12. Added MDLV for JP-4 Analysis of Water – Sep Funnel 13. Added MDLV for BTEX analysis of Soil 14. Added MDLV for SVOA Water - SepFunnel 15. Added MDLV for TBT Sediment 16. Updated MDL for PSEP Pesticides in Sediment/Soil 17. Updated MDL for Chlorinated Phenols in Water 18. Updated MDL for Pesticides in Water – SepFunnel 19. Added MDLV for 524.5 20. Added MDLV for Metals 21. Updated MDL for Manchester Pesticides 22. Added Appendices to the Table of Contents 23. Added MDL for PCB Analysis of Tissue
12-001	4/5/05	1. List of SOPs (Appendix E) Modified & Updated as Appropriate 2. MDL Verification for DRO in Soil Added 3. MDL Verification for PCB Water Standard Analysis (HO-24) Added 4. AK-101 Removed from BTEX MDL Table for Water 5. Metals IDLs & MDLs Updated 6. BTEX MDL for Analysis of Water and Soil Updated 7. RL for 1,4-Dioxane in SVOA Analysis of Water Changed from 1.0 to 5.0 8. Control Limits for BTEX and Gasoline updated

		9. MDL for Gasoline in Soil Updated 10.MDL for Diesel and Motor Oil in Soil Updated. 11. Split TPH-G Table into Aqueous and Soil Table & added MDLV for Water 12. Entered updated MDLs for SIM-LVI-PNA 13. Changed RL for 20 mL 1,2-Dibromo-3-Chloropropane from 2 to 0.5 ppb 14. Updated MDLs for 524.2 15. Updated Conventionals MDLs 16. Updated MDLs for 5 mL VOA analysis of Water Samples (8260B) 17. Modified MDL Table for TPH-D Analysis of Water 18. Updated TPH-D and TPH-Dext MDL for Water Analyses. 19. Removed EPH and VPH MDLs from the LQAP
11-028	12/31/04	1. Modified definition of "Y" flag in Appendix N 2. Updated MDL for TPH-D Soil 3. Updated Appendix M - Laboratory Certification and Accreditation
11-027	12/15/04	1. Updated SOP List in Appendix E. 2. Added AK-101 to BTEX/GRO Control Limit Table. 3. Lowered RL for Benzene in MDL Summary for Method 8021B 4. Added Additional Surrogates to VOA-SIM BTEX Control Limit Table 5. Corrected BTEX MDLs for 8260-SIM to Reflect Sample Conc. Not On-Column values 6. Updated SOP Table in Appendix E 7. Modified VOA 5 mL Water RLs - Acrylonitrile & 1,2,3-Trichloropropane 8. Modified VOA mL Soil RL – 4-Methyl-2-Pentanone 9. Corrected MDL Value for Methoxychlor in PSDDA Sediment Analysis. 10.Modified definition of "Y" Flag in Appendix N 11.Updated MDL for BTEX Water PID-2 12.Updated MDL for Pesticides MTCA Analysis of Water 13.Updated MDL for PSDDA SVOA Analysis 14.Updated MDL for VOA Soil 15.Updated MDL for SVOA, Water, Liq-Liq 16.Updated MDL for Various PCB (1660) Analyses 17.Updated MDL for TPH-G – Water & Soil 18.Updated MDL for SVOA Soil Micro Sonication 19.Added MDL for Manchester Aroclor 1254 20.Modified Control Limits for EPH Analyses 21.Deleted MDL Table for SVOA, Soil, MacroTIp Extraction 22.Deleted MDL for Soil Skydrol/BHT, GC-MS-SIM 23.Updated Instrumentation Listing (Appendix D)
11-026	11/02/04	1. Updated Control Limits for SIM-PNA 2. Added Control Limit Table for Full Scan PNA Analysis (Method 8270D) 3. Updated SIM-PNA Water MDL for NT-1 4. Updated Appendix E – SOPs 5. Modified PCB MDL Table –Remove Manchester & Combine PSEP/Low Level Sediment MDLs 6. Updated MDL for VOA SIM Water NT3 7. Updated MDL Table for SIM Skydrol/BHT in Water 8. Updated SOP Table in Appendix E.
11-025	9/16/04	1. Added new Appendix N listing Data Qualifiers & changed designations for Appendices N, O & P to O,P & Q respectively 2. Updated MDL Table for PCB Analyses. 3. Combined MDL tables for SVOA Water & Deleted Sep Funnel Table 4. Updated PCB & TPH-D MDL Tables 5. Updated Equipment List (Appendix D) & added GeoTech Equipment 6. Revised MDL Table for FID Analysis of Polar SVOA (EPA Method 8015) 7. Updated MDLs for Pesticide analysis of soil. 8. Sediment Pesticide MDLs added to Soil Table, Sediment Table Deleted 9. Control Limit for MS Recovery of Pyrene in Sediment Corrected

		10.Updated Cyclohexanone MDL (Finn 1, 20 mL purge) 11.Updated SIM-PNA Soil MDL for NT-1 12. Edited MDL Tables for SVOA for consistency and accuracy 13. Modified EPH Reporting Limits 14. Revised formatting on most MDL tables. 15. Corrected dates for VOA Control Limit data 16. Deleted analytes except cyclohexanone from VOA MDL Table for Project Specific Analytes. 17. Added BTEX in Soil to VOA-SIM MDL Table 18. Added Manchester MDL to PCB Table 19. Updated Skydrol/BHT Control Limits
11-024	7/19/04	1. Revised and Updated MDL Tables for TPH Analyses of Soil/Sediment. 2. Revised and Updated MDL Tables for PCB Analyses. Combined All PCB MDL into One Table. 3. Deleted all other MDL tables 4. Updated MDL for VOA analysis of Soil using ARI's In-house Method. 5. Added 1-Methylnaphthalene to SIM-PNA MDL Tables for Water & Soil 6. Updated Appendix D (Lab Equipment) and added GeoTech Section 7. Combined Water & Soil SIM-PNA MDL Tables into One Table 8. Deleted Water-SF & Soil SIM-PNA MDL Tables 9. Updated MDLs for Pesticide – Manchester Extraction 10. Revised VOA Water Control Limits Table 11. Updated MDLs for VOA analysis of Water-8260B-5mL purge
11-023	7/6/04	1. Corrected Conventionals MDL/RL Table 2. Corrected Control Limit for TPH-D MS Recovery in Water Samples. 3. Updated MDLs for NWTPH-D Soil ASE & MicroTip. 4. Removed HPLC MDL Table for analysis of PNA. 5. Removed MDL Table for HCID 6. Removed FID-3B from TPH MDL Tables 7. Updated MDLs & Modified Table for SVOA-PSEP analysis of Sediments 8. Revised Section 11 9. Updated MDL for VOA (524.2) analysis of Water 10. Removed MDLs for VOA-SIM analysis of Soil 11. Updated MDL Table for VOA-Water 20 mL 12. Updated MDL Table for VOA-Water 5 mL
11-022	5/17/04	1. Corrected Extract Final Volume in MDL table for Sediment PCB 2. Deleted FINN 8 from all MDL Tables 3. Corrected RL for Hg in Water.
11-021	5/07/04	1. Implemented default control limits for EPA Method 524.2 2. Decreased RL for Aroclor 1221 to level of other Aroclors 3. Eliminated Control Limits for VOA using ARI SOP 804S. 4 Updated VOA 8260B full scan control limits for water & sediment/soil 5. Updated 10 mL purge VOA-SIM control limits for water 6. Changed effective date for VOA-SIM BTEX control limits 7. Updated 8270-SIM-PNA control limits for water & sediment/soil 8. Updated BTS control limits for water & soil.
11-020	4/26/04	1. Updated MDL (PID1 & 2) for BTEX in water 2. Updated MDL (PID 1) for gasoline in water 3. Deleted MDL Table for ASE extraction of chlorinated pesticides 4. Updated MDL for VOA water 5 mL purge 8260B on NT3 5. Updated MDL for pesticide in water separatory funnel on ECD3 6. Added MDL Table for VPH in water and soil 7. Deleted Control Limit Table for HPLC PNA 8. Updated PCB control limits 9. Updated Herbicide control limits 10. RL for Sulfate to 2.0 & 20.0 ppm for water & solids respectively 11. Updated TPH-D Control Limits

		12. Updated Chlorinated Phenols Control Limits 13. Updated BTEX & TPH-G Control Limits 14. Corrected Pesticide MTCA MDL Table 15. Corrected RL for GC-ECD analyses of HCBD & HCB
11-019	3/11/04	1. Revised holding time for Total Solids in soil & sediment from 7 days to 14 days. 2. Updated MDLs for SVOA water L/L NT4 & NT 6. 3. Updated Metals IDLs and MDLs 4. Added QA Policy 9 – Modifications to method, protocol or reports 5. Updated Conventionals MDLs 6. Added QA Policy 10 – Reporting of dual column GC analytes
11-018	1/21/04	1. Revised Control Limits for GC-MS analysis of SVOA 2. Revised Control Limits for Chlorinated pesticides 3. Updated Appendix E – Table of SOPs 4. Updated and Revised Appendix F – Sample Containers, Preservation and Holding Times 5. Modified Sign-of Sheet to include only QA manager
11-017	1/4/04	1. Minor revisions to Section 13 2. Revisions to subcontracting language in Section 6.3

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SPECIALTY ANALYTICAL

LABORATORY QUALITY ASSURANCE PLAN

REVISION 11
April 2010

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APPROVALS:

LABORATORY DIRECTOR: Cindy Hollgard for Marty French

DATE: 7/9/10

QUALITY ASSURANCE MANAGER: [signature]

DATE: 7/9/2010

CONTROL DOCUMENT NUMBER: 10-101

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STATEMENT OF MANAGEMENT PHILOSOPHY

Specialty Analytical is committed to providing the highest quality services and customer service to our clients. The display of this commitment is the responsibility of each employee in the organization. The requirements of this Laboratory Quality Assurance Program apply to each member of the laboratory at every level.

The Specialty Analytical Quality Assurance Plan provides the guidance document to all personnel in fulfilling the responsibilities to provide the highest quality, regulatory defensible data. It serves as the statement of quality by the Laboratory and all the personnel at Specialty Analytical.

Specialty Analytical insures that no economic incentives will compromise data quality. Management will not place any undue production pressure (including production incentives) on the staff of the laboratory that may compromise data quality.

The purpose of Data Quality Objectives (DQO) is to establish specific targets for accuracy (precision and bias). The initial DQO's for a method is to achieve improved precision and accuracy levels than specified in the method reference. Once sufficient data is produced, control charts are established for each analytical parameter appropriate, and the statistics produced are used as the new DQO's for the method, i.e., the mean and standard deviations become the DQO's for that test, provided they are better than the initial DQO's.

The Laboratory Quality Assurance Manager, with the active support of the Laboratory Management Team, is responsible for the implementation of the Quality Assurance Plan. They have the authority, and obligation, to stop work if it fails to meet the exacting criteria defined in the Plan.

_____

Marty French
Laboratory Director
Specialty Analytical
Clackamas, OR

INTRODUCTION

This Laboratory Quality Assurance Plan (QAP) details the operations to provide the highest quality and legally defensible data at Specialty Analytical. It outlines procedures with a focus on the Quality Assurance/Quality Control Procedures implemented at the Laboratory. These are based on EPA, and in some cases, State guidelines for analysis of multimedia (soil, water, air) samples for organic and inorganic contaminants.

This document specifies the operations in the Laboratory to assure the accuracy, precision, completeness, representativeness, and comparability of all analyses performed in the Laboratory. The purpose is to assure that all data being reported are of the highest quality, and all documentation supporting this is available.

Confidentiality

Specialty Analytical adheres to strict client confidentiality policy. This includes distribution of analytical results and client privileged information only to approved parties. No information is provided without confirmation as to the recipient's identity. Phone numbers, facsimile numbers and email addresses are confirmed on the COC or verified independently.

If necessary, client specific confidentiality agreements will be arranged.

Code of Ethics

Specialty Analytical maintains a program of ethical conduct. All employees must adhere to the following statement of ethical compliance, insuring that all data is of sound quality free from any intentional bias or fraudulent activity.

I. I understand the high ethical standards required of me with regard to the duties I perform and the data I report in connection with my employment at Specialty Analytical.

II. I have read and understand the Laboratory Quality Assurance Manual and will adhere to all Quality Control policies and procedures including the Specialty Analytical Code of Ethics.

III. I agree to the following:

A. I will not intentionally report data values that are not the actual values observed or measured.
B. I will not intentionally report dates and times of data analysis that are not the actual times the data analysis was conducted.
C. I will not condone any accidental or intentional reporting of invalid data by other employees and immediately report the occurrence to the QA officer.
D. I will immediately report any accidental reporting of invalid data to the QA officer.
E. I will keep all client data and information confidential.

I understand that improper, unethical or illegal actions are not permitted and possible punishments and penalties include verbal or written reprimands, unpaid time off, dismissal and potentially legal action including incarceration.

In the event Specialty Analytical is sold or goes out of business the laboratory will notify all clients and insure the transfer of all records that are requested by the client. In the case of a change in ownership, the current ownership will provide in writing acceptance of all liability of the analysis, data and reports up until the time of the legal transfer of ownership. The buyer will provide, in writing, acceptance of all liability of the analysis, data, and reports after the time of legal transfer of ownership and that all records will be maintained for five years.

QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance

Quality Assurance is a system for the integration of planning, assessment, and improvement efforts related to quality in all sections at the laboratory. This includes all actions performed by laboratory personnel, and documentation of laboratory performance. This is designed to identify and correct problems in the analytical process, or demonstrate statistical control of a process in the laboratory. The objective of a quality assurance program is to reduce measurement errors to specified limits, and produce results of acceptable and consistent quality.

Quality Control

Quality Control is daily procedures and actions taken by the laboratory to assure sample integrity, performance of testing and analysis, record maintenance and data processing. It is a systematic approach to inspection, testing, and corrective actions applied to processes estimating sample quality, and to determine any changes required to maintain or achieve a specific level of quality.

A quality control program includes:

1) Strict adherence to Good Laboratory Practices (GLP).

2) Consistent use and application of Standard Operating Procedures (SOP's).

3) Adherence to specific protocols for measurement processes.

4) Use of highly trained and qualified personnel.

5) Use of reliable and maintained equipment.

6) Use of appropriate calibrations, standards, and quality control materials.

7) Close supervision of operations by senior personnel and management.

8) Specific acceptance criteria for all Quality Control parameters.

9) Procedures for identification and correction of out of control data.

LABORATORY ORGANIZATION

AND

RESPONSIBILITIES

Laboratory Organization

Specialty Analytical management reports to the Board of Directors of E.R. Analytical, Inc., through the President of Specialty Analytical. All employees of Specialty Analytical are responsible to the Laboratory Manager, who reports directly to the Board of Directors.

Quality Assurance/Quality Control

Laboratory Manager - The Laboratory Manager has overall responsibility for all aspects of the Quality Assurance/Quality Control program, cost management, personnel management, and project management.

Quality Control Manager - The Quality Control Manager is responsible for adherence on a daily basis to all quality control procedures. This includes Good Laboratory Practices (GLP) compliance, maintenance of the laboratory Quality Assurance/Quality Control program, maintenance of all laboratory accreditation programs, establishment of QC procedures and control limits, and implementing corrective action reports and plans for analysis performed in the laboratory. Additionally, the QAM reviews all project specific quality assurance plans (QAPjP).

Operations Manager - The Operations Manager is responsible on a daily basis for implementation of all quality control procedures. This includes maintaining all required training of analysts and staff, and verification of proper laboratory procedures.

Regulatory Compliance/Health and Safety

Laboratory Manager- The Laboratory Manager has overall responsibility for all aspects of the Regulatory Compliance program, and Health and Safety. This includes proper handling of waste, management of waste disposal, maintenance of the Health and Safety Plan, and obtaining all required licenses for laboratory operation. The Laboratory Manager is also responsible for compliance with all State and Federal Health and Safety regulations.

Client Services

Laboratory Manager - The Laboratory Manager has overall responsibility for all aspects of client services, including data management, project management, sample control, and invoicing/billing. The Laboratory Manager gives guidance for sample handling and storage prior to and after analysis.

Project Manager - The Project Manager maintains project files and computer data entries after sample analysis. The project Manager also is responsible for interaction with clients to provide technical and sample analysis cost information, coordination with Technical Staff members to coordinate analysis types, project completion, method specific QC requirements, etc. Additionally, the Project Manager will handle review of all incoming work to determine if the laboratory has the facilities and resources necessary to complete the job. They will notify the client in writing of any work that will be subcontracted to another laboratory. They will maintain all aspects of sample log in, adherence to proper Chain of Custody (COC) procedures, reconciliation of any COC discrepancies, and maintenance of the integrity of the samples received at the laboratory. The project manager is also responsible for dealing with client complaints. If the

complaints cannot be addressed and rectified in a timely manner , the complaint must be brought to the attention of the Laboratory Manager. All communication with clients including complaints, COC reconciliation, follow up analysis requests or other pertinent information is documented in writing and included in the client file.

Technical Staff

The Technical Staff is responsible for the technical quality of the analyses being performed at the laboratory. They are required to adhere to QA procedures defined by the QAM, maintenance of the instruments, calibration of instruments, processing and validation of data at the bench level, reporting and correcting (with the QAM) of non-conformance, corrective actions to non-conformance as necessary, and meeting client commitments to project schedules. Technical Staff members report to the Operations Manager and the Laboratory Director. The Technical Directors supervise day-to-day operations of each department in the laboratory. They are responsible for monitoring standards of performance in quality control, monitoring the validity of the analysis performed and data generated, ensuring adequate staffing of qualified personnel and provide educational training to the staff.

Minimum education requirements of the Technical Directors:

Chemical Analysis: Bachelors degree in chemical, environmental, biological sciences, physical sciences or engineering, with at least 24 college semester credit hours in chemistry and at least two years experience in the environmental analysis of representative inorganic and organic analytes.

Microbiological or biological Analysis: Bachelors degree in chemical, environmental, biological sciences, physical sciences or engineering, with at least 16 college semester credit hours in microbiology and biology and at least two years experience in the environmental analysis of representative analytes.

Quality Assurance Manager: The Quality Assurance Manager must have documentation of training or experience in QA/QC procedures.

Technical Staff: Specialty Analytical's Technical Director will ensure new and current employees have a combination of education, prior experience, prior training, or completion of Specialty Analytical's employee validation process to ensure accurate and legally defensible data is produced by each employee.

In the event of the absence of any key personnel the following changes to the laboratory organization are as follows:

The responsibilities of the Laboratory Manager will be assumed by the Operations Manager.
The responsibilities of the Quality Assurance Manager will be assumed by the Laboratory Manager.
The responsibilities of the Quality Assurance Manager and/or the Laboratory Manager will be assumed by the Operations Manager.

TRAINING PROGRAMS

AND

IMPLEMENTATION

Training

"No quality assurance program, whether it be voluntary or imposed, can correct frequent mistakes and unreliable performance introduced by insufficient training, inadequate laboratory environment, and poor administrative practices." William Horwitz, Quality Assurance Practices for Health Laboratories, p.547 APHA (1978)

Training Requirements

A vital requirement in quality assurance programs is adequate training of analysts prior to sample analysis being performed. All quality related activities performed in the laboratory will be accomplished by qualified, certified analysts with documented experience, degrees, training, and education. Activities that require certification include sample receiving, sample preparation, standard or reagent preparation, calibration of instruments or tools, data validation, and record/document management. All analysts will be trained in QA/QC principles in addition to technical methodology. This will allow achievement of skill levels that meet standards of quality.

Initial Orientation

All analysts undergo initial Quality Assurance training. Included is a discussion of their ethical and legal responsibilities including potential punishments and penalties for improper or illegal actions, general training requirements of the analysts and regulatory information. All analysts are required to read the Quality Assurance Plan (QAP). Analyst signatures are required to document their understanding and adherence to all Specialty Analytical Quality Assurance policies.

Certification of Analysts

Specialty Analytical allows and requires only certified analysts to perform analytical tasks in the laboratory. To become certified, analysts must demonstrate training or education, knowledge of the method or task to be performed, and performance of the method requirements including an Initial Demonstration of Capability and Method Detection Limit studies. All must be performed prior to analysis of samples in the laboratory unless analyst is under direct supervision of a trained analyst.

To maintain certification the analyst must read each revision of the QAP. This must be documented in their analyst validation file.

Training and Experience - Analysts must meet the minimum requirements in education or experience (or both) prior to beginning the certification process. This can be education, work experience, technical training or other demonstrated knowledge of the job requirements and duties. Evidence of these qualifications will be maintained as training documents by the QAM. These records will document the quality assurance and technical training received by the employee, dates of completion of qualification or renewal, and approval or certification. Recertification will be required on an annual basis. Other documents in the training files will include:

1) Personnel resumes

2) Quality Assurance Examinations

3) Attendance records at training sessions

4) Internal training certifications

5) Results of qualifying sample sets or performance samples

6) Records of observation of sample preparation procedures

7) Professional certificates or training

Technical Training
Prior to beginning sample analysis, analysts must demonstrate knowledge of method requirements by passing certification requirements. These procedures may be specific methods, or Laboratory Standard Operating Procedures. This demonstration includes:

1) Reading the method from a primary source document (EPA or State method, Standard Methods, etc.)

2) Reading and review of the SOP, and identification of any method exception criteria applicable.

3) Acceptable preparation and analysis of a Calibration Curve (if required by method), which must meet statistical requirements of the specific method.

4) Acceptable preparation and analysis of an Initial Demonstration of Capability (IDOC) or Method Validation Study (MVS), which must meet statistical requirements of the method.

5) Acceptable preparation and analysis of a Method Detection Limit Study (MDL), which must meet statistical requirements of the method, and provide detection limits similar to EPA, method, or laboratory requirements, utilizing EPA 40 CFR 136 criteria for calculations.

6) Acceptable preparation and analysis of a single or double blind Performance Evaluation (PE) sample. This can be purchased or prepared in the laboratory as necessary.

The Laboratory Director and Quality Assurance Manager are responsible for initial and continuing certification of analysts.

Re-qualification is required if the analyst has not performed the method regularly during the previous year, or fails to show acceptable performance on PE samples. Annual certification is required, which will include demonstration of MDL and blind PE studies with passing results, another MVS or four consecutive passing Lab Control Standards. The analyst must read the current SOP and documentation is kept in the validation file. Failure to adequately complete annual certification will result in loss of certification and removal of the analyst from performance of the method until rectified.

Quality Assurance Training - General training in requirements of the Laboratory QAP is required of all laboratory personnel. Training will address regulatory requirements, basic and advanced quality control

concepts and practices, individual responsibilities of the technical staff, reporting and correction of non-conformance, performance audits, and laboratory documentation.

SAMPLE CHAIN OF CUSTODY

AND

HANDLING PROCEDURES

Chain of Custody Procedures

Critical to appropriate sample collection and analysis is maintenance of complete chain of custody (COC) procedures. Chain of custody procedures includes identification, inventorying, and documentation of sample collection, transport, and laboratory processing and analysis. Samples are considered to be in an individual's custody if the sample is in the physical possession or view of a responsible individual, secured to prevent tampering (with any tampering that might occur identifiable) or placed in a restricted location by a responsible individual.

Sample Labels - A label is attached to all sample containers at time and location of sample collection. The label must be completed in indelible ink, and contain information on sample number/identification, source or location of sampling point, date and time collected, analysis and remarks about the sample, any preservatives used (may be provided by laboratory on a preprinted label), sample collector's name or initials.

Chain of Custody Document - The Chain of Custody (COC) details the control and documentation required to track and identify a sample(s) from collection to final analysis and disposal. It includes sampling label, custody seals, securing and transfer of custody, and documentation of support information. COC forms are utilized to document the integrity of all samples, record sample collection, transfer of samples between personnel (either samplers, transporters, or laboratory personnel), and receipt at the laboratory. A COC will be filled out for each sample set at the sampling location. See Fig. 1 For an example of the COC.

Chain of Custody forms should contain:

1) A unique sample number for each sample in the sample set

2) Collection date and time for each sample in the sample set

3) Number of containers of each sample

4) Sample description

5) Sample matrices

6) Shipment date and time

7) A laboratory name and shipping address

8) Custody transfer signatures

9) Analysis requested for each sample indicated on the COC.

10) Turn around time needed for the samples listed.

The person responsible for collecting samples is responsible for completing the COC form, and verifying completeness and accuracy. Any changes to the form will be dated and initialed by the individual making the changes.

Chain of Custody forms continued . . .

Transfer of samples accompanied by a COC is accomplished by the individual relinquishing the samples signing and dating the COC form. The individual receiving the samples repeats the signing and dating of the COC form. This document represents the official record for all transfer of custody until sample receipt at the laboratory. Any splits of samples (with another laboratory or agency) will require a separate COC for each facility.

Laboratory Chain of Custody Procedures

Sample control at Specialty Analytical is accomplished by utilizing tracking systems to protect sample integrity. These systems include laboratory Chain of Custody procedures, sample analysis request forms, restricted and controlled sample storage areas, and bench log sheets.

Internal COC procedures include sample inventory, document maintenance procedures, sample collection and shipment documents, and laboratory analytical process documentation.

Internal sample tracking and COC procedures include:

1) At time of sample receipt, the COC is reviewed for completeness of information provided by sampler, and sample tracking information, including status of any COC seals on cooler or box.

2) Samples are inspected for condition of sample containers, temperature of samples is determined and recorded, and sample identifications are noted and compared to the COC for accuracy.

3) If any discrepancies are noted in sample identifications or condition, the client is immediately notified, and the discrepancy is reconciled.

4) Each sample bottle is identified with a unique identifier (laboratory sample number) which is linked to the clients sample description. The laboratory assigned number is utilized throughout the analysis process to track sample status and completion.

5) Any holding time restrictions (i.e. pH samples, etc.) are identified, and the laboratory is immediately informed of the sample(s) presence, to allow completion of extraction and/or analysis within recommended holding times.

6) Samples requiring preservation are checked for proper pH upon receipt. Any samples incorrectly preserved are noted on the COC, and the client is notified immediately. Any corrective action taken as a result of this is noted on the COC and Sample Receipt Reconciliation Form. Only samples requiring VOA analysis are checked at the bench, and this pH is recorded on the bench sheet. Any violation of hold times due to analysis of non-preserved samples past seven days will require client contact and non-conformance to be documented.

Sample Integrity

To maintain proper sample integrity within the laboratory, the following measures are followed:

1) All doors to the laboratory are self-closing, and are secured at all times.

2) Only authorized personnel are allowed in work areas, and all visitors require an escort within the laboratory.

3) Outside exit doors are monitored or locked at all times.

4) Deliveries to the laboratory are restricted to office or loading areas, or are escorted within the laboratory work areas.

Sample Storage Requirements

Samples require proper storage to maintain proper analytical and chain of custody requirements. The following steps are taken to preserve the integrity of samples during storage:

1) Samples and extracts are stored in secured and monitored access areas only.

2) Damaged samples are documented, and client notification occurs immediately upon determination of the damage.

3) Samples will be stored in their original containers, unless damaged, OR properly sub-sampled and transferred to appropriate sample containers.

4) VOA samples will be stored separately from all other samples, with a holding blank to monitor potential cross contamination.

5) No analytical standards will be stored with samples.

Sample Volume Requirements- A minimum amount of sample is required for each specific method being performed. Information on minimum and recommended sample volumes is available from Project Management, or are contained in the Specialty Analytical Statement of Qualifications. Bottle kit requests being filled by Specialty will contain containers sufficient to provide the recommended sample volume. Any questions or concerns on sample volume requirements should be forwarded to Project Management.

Sample Disposal - Upon completion of analysis, any remaining sample will be transferred into long term storage, held at recommended temperatures during this storage. Upon request, any unused portion can be returned to the client. The unused portion will be stored for 60 days from *date of receipt*. Any residual portions will be disposed of in a regulatory approved manner, compliant with all local and federal regulations.

QUALITY ASSURANCE

OBJECTIVES

AND

DEFINITIONS

Quality Assurance Objectives

The purpose of Data Quality Objectives (DQO's) is to establish specific targets for accuracy (precision and bias). The initial DQO's for a method is to achieve improved precision and accuracy levels than specified in the method reference. Once sufficient data is produced, control charts are established for each analytical parameter appropriate, and the statistics produced are used as the new DQO's for the method, i.e., the mean and standard deviations become the DQO's for that test, provided they are better than the initial DQO's.

Specialty Analytical's Quality Assurance Plan has the objectives to verify the production of high quality, defensible, and cost-effective data to its clients. While specific quality assurance plans and items will be required for particular projects, general guidelines are:

1) Data should be accurate within method specifications, and agree within limits with reference values.

2) Data should agree among individual measurements under similar conditions (comparability).

3) Data should be complete in terms of valid data produced as compared to planned (completeness).

4) Data should be comparable to prior data for evaluation, whether produced by Specialty Analytical or not.

5) Data should be representative of the population of parameters measured.

6) Data should be reproducible under similar conditions at any location.

7) Quality Assurance programs should continually upgrade the quality of the laboratory performance.

The goal of the laboratory QAP is to produce data of defined and consistent quality. Guidelines are provided for the assessment and reporting of data quality parameters, and for the incorporation of such assessments into major databases for evaluation and tracking.

Control of sample receiving, login of samples, and tracking of samples throughout the analytical process is maintained to ensure the integrity of the sample. Documentation of instrument performance and preventative maintenance is maintained to allow review of factors effecting data produced during sample analysis.

Determinations of the quality of analytical work through analysis of quality control reference samples, duplicate analysis, matrix spike/spike duplicate, and laboratory control samples are routinely performed, in compliance with method or laboratory requirements.

Maintaining accreditation through efficient state sponsored programs including a proficiency testing program and external audits.

Quality Assurance Definitions

Accuracy - Accuracy is evaluated in two fashions, either as measurement accuracy or analytical accuracy. *Measurement accuracy* is measured by analysis of QC reference materials, and *analytical accuracy* is determined by spiking known concentrations into samples prior to preparation and analysis. Measurement accuracy is independent of matrix effects, while analytical accuracy includes any effects from sample matrices upon the recoveries of the analytes. Accuracy is affected by both systematic and random errors.

Measurement data is evaluated by comparing the percent recoveries of QC reference materials of known and evaluated concentration, independent of routine calibration. These reference materials can be used as prepared, or diluted into an inert matrix. Control limits are determined by control charting the recoveries and performing statistical analysis upon the results. Laboratory Control Samples (blank spikes) are also utilized to evaluate laboratory performance of methods. This is also independent of matrix effects.

Analytical accuracy is evaluated by comparing the percent recoveries of analytes, which have been added to samples at a known concentration. This is evaluated using matrix spikes and spike duplicate samples. Spike samples are analyzed at 5% frequency (1 in 20 samples), or per analytical batch, whichever is more frequent. Recoveries are assessed to determine the method efficiency and matrix interference effects upon analyte recovery.

The equation used to calculate percent recovery of an analyte is:

$$\% \text{ Recovery} = \frac{\text{(Spike Sample Result - Sample Result)}}{\text{Amount of Sample Spiked}} \times 100$$

Analytical precision is evaluated as the percentage difference between results of matrix spike and spike duplicate results. Results of sample and duplicate results can additionally be used for evaluation of precision, depending upon method requirements. Relative percent difference is used for this evaluation, and is calculated using the formula:

$$\text{RPD} = \frac{\text{(MS or original result) - (MSD or duplicate result)}}{\text{Mean of MS (or original) and MSD (or duplicate) results}} \times 100$$

Matrix spike/spike duplicate analysis will be performed at a minimum of 5% frequency (1 in 20), or as required by method specifications. Control charts can be utilized to determine the statistical limits for control limits. Please see the section on control charting in the QAP for details on the statistical analysis.

Representativeness of data produced by the laboratory shall be representative of the overall population of samples collected and analyzed. It will be representative of the laboratory database of accuracy and precision measurements of that parameter, matrix, and analytical method. If the results are reproducible, than the data can be stated to represent the environmental condition at the site of sampling.

Precision is a qualitative term used to denote the scatter of results. Precision is said to improve as the scatter among results becomes smaller. Random error can be referred to as imprecision. This parameter is usually measured as standard deviation.

Bias reflects the inaccuracy of an analytical result due to systematic error.

The most significant aspect of representativeness is sampling methodologies and programs. While representativeness expresses the degree to which sample data accurately represent a characteristic of a population, parameter variations at sampling point, or environmental condition, it is a qualitative parameter which depends on the proper design of a sampling program. Sampling locations and number of samples collected must be selected carefully to provide sufficient information and accurate results in identification of site conditions.

Representativeness is evaluated by describing sampling techniques and the rationale used to select sampling locations. These locations can be biased (based on information from existing data points, instrument surveys, or site conditions), or unbiased. Regardless of approach, the decision making process to determine sampling locations must be specified. If sampling grids are used, it should be shown on a site map. The type of sample (grab or composite), as well as the SOP for sampling, should be specified.

Assessments of representativeness are determined by use of collected samples. These are samples collected so they are equally representative of a given point in space and time. Thus, information on both precision and representativeness are provided.

Comparability is achieved by using standardized sampling and analysis techniques. The goal is to provide data that is reproducible under similar conditions, whether generated by Specialty Analytical, or other firms. Comparability can be verified by using split samples, and having analysis performed at several laboratories using the same methods. Intra-laboratory comparability can be verified by comparisons of historical data from the site, if available. Evidence of comparability can be found by results of inter-laboratory Performance Evaluation (PE) samples administered by a NELAP certified private vendor.

FACILITIES

AND

EQUIPMENT

Facilities

Specialty Analytical occupies 12,000 square feet of space, located in Clackamas, Oregon.
Office space occupies approximately 2,000 square feet of the space, with the remainder allocated to analytical laboratories and hazardous waste management facilities.

The laboratory is planned as a "single room" facility, allowing interaction between Technical Staff in various areas. This allows peer to peer interaction, and provides a forum for discussion of technical facets of jobs currently in the analytical process. The volatile laboratory is provided with an enclosed, positive pressure environment, allowing detection of contaminants at low levels that are also utilized in the laboratory (i.e. methylene chloride, acetone, etc.).
Additional space, providing "clean-room" environments, is used in the laboratory for analysis of metals and volatile at reporting levels below current environmental needs, such as semi-conductor, "pristine" water analysis for non-impacted streams and rivers, and other low level analysis types.

The environmental conditions of the laboratory such as temperature are maintained and monitored where applicable to the performance of the test methods

Equipment

Specialty Analytical maintains analytical equipment inventories sufficient to perform analysis requested routinely by clients. Equipment lists as of the date of the revision of the QAP are listed below. Equipment is constantly being added or upgraded, so call a Specialty Analytical Project Manager or the Quality Assurance Manager for a complete and current equipment list.
Equipment such as refrigerators, ovens and incubators are monitored for proper temperature each working day or when in use. The monitoring is documented in logbooks.

Manufacturer	**Description**
Agilent 6890N GC	Gas Chromatograph with Flame Ionization Detector (FID) and Thermal Conductivity Detector (TCD). Purchased 2002. Utilized in the analysis of glycols, alcohols, specialty chemical analysis, and high purity solvent analysis.
HP 6890 Plus GC	Gas Chromatograph with Dual Flame Ionization Detectors. Equipped with dual split/splitless injectors. Purchased 1999. Utilized in the analysis of semi-volatile petroleum fractions.
HP 5890 II GC (2) with (1) Tekmar LSC 2000 Purge and Trap and 2016 autosampler, and (1) Tekmar LSC 3000 and Varian Archon autosampler.	Gas Chromatograph with Photo ionization Detector and Flame Ionization Detector (PID/FID). Equipped with low-dead volume injector for P&T analysis. Purchased in 1997. Utilized in the analysis of volatile petroleum fractions and aromatic (BTEX) determinations.
HP 6890/5973 GC/MS (2)	Gas Chromatograph/Mass Spectrometer used in the analysis of Semi-volatile compounds, including Polyaromatic Compounds and BNA's. The instrument

	58,000 compound reference library for identification of unknown compounds. One is also equipped with a APEX temperature programmable injection port, enabling large volume injections for parts per trillion level reporting limits.
includes 7673 Autosampler, Enviroquant Data System, and	
HP 5890 II GC with Tekmar LSC2000 and 2016/2032 Purge and Trap unit	Gas Chromatograph with Dual PID/Single FID detectors. Equipped with Low Dead Volume Injector. Used in the analysis of Volatile Petroleum and Aromatic Compounds.1997
HP 6890 Plus GC	Gas Chromatograph with Dual ECD detectors. Equipped with Split/Splitless Injector and 7683 Autosampler. Used in the analysis of PCB's, Pesticides, Herbicides, and Low Level Chlorinated Phenols. Purchased 1998
HP 6890/5973 GC/MS with Archon autosampler and LSC 3000 Purge and Trap Unit	Gas Chromatograph/Mass Spectrometer with Low Dead Volume Injector, and Purge and Trap Autosampler. Includes Enviroquant Data Station with 58,000 compound Reference Library. Used for the analysis of Volatile Compounds and Gasoline Additives. Purchased 1998/2001
HP 6890N/5973 GC/MS with Teledyne/Tekmar Stratum Purge and Trap Unit with Archon	Gas Chromatograph/Mass Spectrometer with Low Dead Volume Injector, and Purge and Trap Autosampler. Includes Enviroquant Data Station with 58,000 compound Reference Library. Used for the analysis of Volatile Compounds and Gasoline Additives. Purchased 2000
Thermo-Jarell Ash IRIS-1000ER Induced Current Plasma Atomic Emission Spectrometer.	Advanced ICP with 300 position Autosampler and Thermospec Data Station. Used in the analysis of Metals to Low PPB levels. Includes research grade camera for identification of all metal species present in a sample, and allows determination of positive interferences of other metals impacting quantification. Purchased 2000.
Tekmar-Dohrmann Apollo 9000 Total Organic Carbon Analyzer.	TOC analyzer including Solids autosampler, allowing both aqueous and solid samples to be analyzed. Purchased 2001.
Mitsubishi TOX-100.	Total Organic Halogen analyzer, including TOX preparation unit for analysis of TOX to low ppb levels. Purchased 2001.
Zellweger Analytics Lachat QuickchemFIA+	Flow Injection system Spectrphotometer, including autosampler and data system.. Used for analysis of nitrate/nitrite, cyanide, TKN, and other nutrient analysis. Purchased 2000.
PE FIMS-400 FIA Mercury System, with AS-90 Autosampler. with Mercury Amalgam System	Flow Injection Analyzer with Cold-vapor generator for automated analysis of Hg in soil and water samples to Low PPT (parts per trillion) levels. Includes autosampler and Data Station. Purchased 1998.
CETAC M-7500 Mercury System, with CETAC ASX-510 Autosampler and ADX-500 Auto-dilutor	Cold Vapor Mercury analyzer for automated analysis of Hg in soil and water samples to Low PPT (parts per trillion) levels. Purchased in 2004.

HP 8452 UV/VIS Spectrophotometer and Autosampler.	UV/VIS spectrophotometer with 7 position autosampler, and 3D Chemstation Data System for identification and quantification of known and unknown compounds. Used for phosphate, Tannin & Lignin, nutrient and unknown compound analysis. Purchased 1998
Dionex Dx 120 Ion Chromatograph	Ion Chromatograph with Autosampler, Membrane Suppression System, and Data System. Used for analysis of nutrients and wet chemistry parameters. Purchased 2000.
Acumet 150 pH/Titration Controller.	pH/Titration controller with Automatic Temperature Compensation. Includes titration module for water determination by Karl Fischer. Used for water determinations, pH analysis, and Ion-Selective Electrode determinations. Purchased 1997
Orion 920 Ionalyzer.	pH/ISE instrument for determination of pH and ISE analysis. Purchased 1998.
Spectronic 20 Genesys Spectrphotometer	Variable wavelenth 325 to 1100nm for wetchemistry analysis. Purchased 2000.
OI Analytical Gel Permeation Chromatagraph	Chromatography system used for removing unwanted analytes from sample extracts. Used in PCB, Pesticide and semi-volatile analysis. Purchased 2000.
Agilent 7500ce Induced Current Plasma Atomic Emission Spectrometer mass spectrometer	Advanced ICP-MS with Cetac ASX-510 Autosampler . Used in the analysis of Metals to Low ppt levels. Allows of positive determination of other metals without interference. Purchased 2002.
Agilent Technologies 6890N GCMS 5975 inert source with 7873A Autosampler.	Gas Chromatograph/Mass Spectrometer used in the analysis of Semi-volatile compounds including Polyaromatic Hydrocarbons, BNA's and Organophosphorous Pesticides. The instrument includes an autosampler, Enviroquant Data System and a reference library with 115,000 compound reference spectra for identification of unknown compounds. Instrument is capable of running in SIM (single ion monitoring) and full scan simultaneously.
Agilent Technologies 1200 Series HPLC	High Performance Liquid Chromatograph with binary gradient pump and diode array, multi-channel UV/VIS detection. Purchased 2007.

All instruments above are Y2K compliant. All data stations have received upgraded software, or have GLP compliant systems in place to ensure proper reporting of data provided.

SUPPLIES CONTROL

AND

PROCUREMENT

Supply Control and Procurement

Purchase and control of materials related to sample analysis, including glassware, reagents, calibration standards, reference materials, instruments, solvents and supplies must be approved prior to utilization in the analysis of samples.

Specifications of Materials - Increased use of analytical instruments with higher sensitivity has increased the quality and productivity of laboratory analysis. It has also required a focus on higher quality materials utilized in the laboratory, as contamination levels acceptable on instruments 5 years ago now affect quality of results.

Required quality of materials begins with requests from the Technical Staff. These are evaluated by the Quality Assurance Manager to assure the required grade is requested. Evaluations must be made as to types and levels of impurities, tolerances of the required method, and type of supply requested. Minimum requirements are for ACS grade reagents, NBS traceable materials, or other acceptable references.

Prior to use, standards are inspected, and tested, to assure conformance with requirements of the methods. Normally, this will be an analysis to verify lack of contamination of the standard, and verification of concentration against a second standard of equal quality, purchased from an independent source. For standards made in the laboratory, comparison against a second standard, made at a separate time, is required for concentration verification.

All materials are checked for suitability as blanks, and compared to a reference source prior to use in the laboratory.

Standard Control

Control of materials is the responsibility of the Technical Staff and the Quality Assurance Manager. The identity, purity, shelf life, original source, tests conducted for verification, and expiration date are all maintained and tracked to assure use of only appropriate standards during sample analysis.

ANALYTICAL PROTOCOLS

AND

REFERENCE METHODOLOGIES

Reference Analytical Methods

For organic and inorganic analysis, Specialty Analytical utilizes procedures provided by the EPA and state regulatory agencies. Wastewater samples are analyzed using methods from 40 CFR part 136, as published and revised in the Federal Register; Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020; and Standard Methods for the Examination of Water and Wastewater, 19th and 20th Edition. Soil, water and hazardous waste samples are analyzed using Test Methods for Evaluating Solid Waste (SW-846), 3rd Edition, and updates. Methods proposed for inclusion in SW-846 may be utilized by the laboratory upon notification and approval of the client. Drinking water samples will be analyzed using 40 CFR 136 methods, Methods for Chemical Analysis of Water and Wastes, Methods for the Determination of Organic Compounds in Drinking Water, and Standard Methods for the Examination of Water and Wastewater. Underground Storage Tank contamination will be analyzed using Northwest Total Petroleum Hydrocarbon Methods and ADEC Analytical Methods No. 101, 102, 103, Alaska Department of Environmental Conservation. Additional test methods for UST analysis may be utilized (EPA or ASTM methods). Air analysis will be accomplished using Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA/600/4-89/018 (and supplements); State of California Air Resources Board (CARB) Source Test Methods, 1990; and NIOSH Manual of Analytical Methods, US Dept. of Health and Human Services, NIOSH, Cincinnati, OH. and ASTM or OSHA methods upon determination of matrix, use of data, and requirements.

Method Exceptions

Any deviations from published methodologies must be documented. Changes that will be performed on a routine basis will be included in the Laboratory Standard Operating Procedure (SOP), approved and signed by the Quality Assurance Manager, and the Laboratory Director.

Method Variances

Occasionally, due to matrix interference or other influences, typical methods may be ineffective in providing acceptable quality data. Parameters such as detection limits, precision, specificity of individual components, etc., may be affected. In order to provide data meeting client specifications, variances to the method may be proposed by the laboratory. In this case, the client's Project Manager will notify the client of the proposed variance, and a copy of the proposed variance may be sent to the client upon request. This will describe the variance, document the reasons for the variance, and show that the conditions for the laboratory variance are similar to the expected conditions in the approved method.

METHOD DETECTION LIMIT

AND

QUANTIFICATION LIMIT

DETERMINATIONS

Method Detection, Quantification, and Reporting Limits

Method Detection Limits (MDL) are defined as the minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero. It also refers to the minimum concentration of an analyte that a method can detect reliably in either a given matrix or blank.

MDL is calculated as:

$$MDL = t_{(99\%)} \ (S)$$

where: $t_{(99\%)}$ = students t value for 99% confidence limit, and n-1 degrees of freedom.
(S) = standard deviation of replicate analysis.

The standard deviation is based on a minimum of 7 replicate analysis.

Quantification Limits, either Practical Quantification Limits (PQL) or Limits of Quantification(LOQ), are determined after MDL calculations are performed. Limits of Quantification are defined as the concentration of an analyte where quantification within specified limits of accuracy can occur. This is normally a multiple of the MDL (2.5 to 10X), and is commonly rounded for ease of reporting and use. PQL's are "assumed" factors applied to the MDL's to simulate real world matrix effects. These vary by matrix from 10X for groundwater to 10,000X for sludge and Hazardous Waste.

Reporting Limits are the standard concentration level at which the laboratory provides "less than" or Not Detected (ND). These levels are above the MDL, and represent the concentration that meets the laboratories LOQ, and accuracy requirements. These limits are commonly grouped into ranges for ease of use of the data. Reporting limits are always above the MDL.

Specialty Analytical can provide MDL information upon request for any analyte.

Frequency of Method Detection Limit Studies

MDL determinations, and evaluation of LOQ and Reporting Limits, are performed at:

1) Initial validation of a method in the laboratory, or upon validation of a specific instrument in the laboratory.

2) Upon validation of an analyst utilizing that instrument or performing a specific method.

3) Anytime there is a change in instrument sensitivity (normally defined as 35% change in sensitivity or response of an instrument).

4) At a minimum, annually for each instrument and method.

These determinations can be simultaneous, i.e., both an analyst and an instrument can be validated at once. MDL's must be determined on each instrument the method will be performed on.

Procedures to be followed for the determination of MDL's are found in 40 CFR part 138 App. B. This procedure specifies the level for spiking MDL's at, and allows accurate determination of signal/noise levels. This determination is critical to accurate determination of MDL's. Spiking concentrations that are too large will lead to artificially low MDL's due to higher precision at levels above the signal noise. This is one of the most common reasons for non-reproducible MDL determinations.

Spiking levels for MDL's should be 0.5-5X the calculated MDL, and should never exceed 10X the calculated MDL. Calculated MDL's exceeding the above guidelines need re-determinations prior to determinations of PQL or RL's.

Process for Performing Method Detection Limit Studies

1) Determine the required reporting limit - normally the regulatory defined limit.

2) Perform a minimum of 7 replicate analysis of blank matrix spiked at ½ to 1 of the required reporting limit.

3) Using provided spread sheet, input spike level, parameter, and values for results of replicate analysis.

4) Evaluate spreadsheet for outliers in results, using Grubs criteria.

5) Remove any outliers that are not part of the statistical variance , calculate the standard deviation, MDL, and LOQ.

6) Evaluate signal to noise ratio, verify that the level is in the noise range approved, and that the calculated MDL is not less than 10 times the spike level or greater than the spike amount. This is to verify appropriate spike levels.

7) If s/n is not reached, re-analyze minimum 7 replicates at lower spiking level.

8) If value check or standard deviation is too high, perform 7 replicate analysis at higher spike level.

9) When all criteria are met, calculate MDL from spreadsheet using the Standard Deviation times the student t value for proper number of replicate analysis.

10) Calculate LOQ as at least 2.5 times MDL as calculated above.

Process for Performing Method Detection Limit Studies continued...

11) Set reporting limits at or above the calculated LOQ.

12) In some cases, mostly for UST analysis, performing MDL determinations is not as important as precision studies at the reporting limits. In this case, performing the minimum 7 replicate analysis at the regulatory required reporting limit will replace the requirement for MDL determination by verifying precision and accuracy at the reporting limit. In no case will results be reported below this verified limit without performance of a MDL study.

CALIBRATION PROCEDURES

AND

STANDARD PREPARATION PROCEDURES

Calibration

Calibration is the standardization of a measurement or instrument by use of a standard or standards, or another instrument to adjust to any variances in accuracy of measurement.

Analytical Standards

Analytical Standards are utilized for calibration and preparation of quality control samples. These standards must be traceable to standard reference materials. Acceptable materials are:

1) EPA CRADA traceable materials.

2) NIST reference standards

3) Standards made by vendors traceable to one of the above.

If none of the above are available, duplicate analysis of standards prepared separately is acceptable.

All standards must be stored under conditions that provide the largest amount of protection from deterioration and change.

Traceability of the standards is established through statistical evaluation of the control sample, or analytical standard relative to NIST or CRADA reference materials.

Criteria for acceptability of a new standard solution is: Triplicate analysis of a standard yields a Relative Percent Difference (RPD) of less than 15% when quantified against a SRM from one of the above sources.

Expiration Dates of Standards

All standards obtained from commercial sources as well as SRM's are dated upon receipt. This will be written in indelible ink upon the container received, as well as any container the standard may be transferred to. This information will also be recorded in the standards logbook for that department. The expiration date of the standard is also noted and recorded as above. If no information as to expiration date is available, establishment of an expiration date based upon working knowledge of the standard is acceptable.

Standards must be protected from degradation, deterioration, and contamination by strict adherence to proper storage and handling procedures.

Stock and working standards are prepared fresh as required to maintain stability and are checked prior to every use for signs of contamination or deterioration (color formation, precipitation, concentration changes, additional peaks, leakage).

Expiration Dates of Standards continued

Standards prepared as stock or working standards are labeled with name of compound or mixture, concentration, solvent, date, preparer, and expiration date. This information will also be recorded in the working or stock standards log for that department. All requirements for storage of the primary standard
will be adhered to with the working or stock standard.

A LCS or check standard from a certified, independent source will be used to monitor for degradation or concentration changes. Results should fall within the 95% confidence limit of the given target range values.

Inorganic Standards

Stock standards shall conform to the expiration date of the commercial standard. These expiration dates are checked daily, and recorded on the daily bench sheet.

Working Standards are prepared at a minimum of every 6 months, when standards show signs of degradation, or when other factors require preparation.

Organic Standards

Liquid or Solid stock standard holding times are the manufacturers recommendation, or 6 months if no expiration date is available.

Commercially prepared standard holding time is the manufacturers recommendation, or 1 year if no expiration date is available.

Standard Preparation Equipment

Only Class A volumetric glassware, certified or calibrated pipets, and ACS grade solvents at a minimum, will be used for dilutions of primary standards.

Guidelines for Standard Preparation

1) Laboratory Technicians or Chemist experienced in calibration and use of analytical measurement tools are assigned to standard preparation.

2) Analytical reagent grade materials, in solution or neat, are utilized in the preparation of analytical and control standards. When possible, guaranteed assay materials with supporting documentation (chromatograms, assay results, etc.) are requested and filed with QAM.

3) Solvents utilized for dilution of standards are checked for contamination.

4) Analytical measuring tools (balances, pipettes, syringes, etc.) will be calibrated prior to use to assure accurate and acceptable measurements.

5) All data generated is documented immediately in the Lab Information Management System (LIMS) and

in standard preparation logbooks for the each department.

6) A sequential log number is assigned to the newly prepared standard. This number must be noted in the standard log, in preparation books, and on any storage vessels used for any aliquot.

7) Standards are analyzed prior to use on the instrument the standard is to be used on.

8) A standard obtained from another approved source is used as the traceability standard.

9) To maximize the precision of the result, both the new standard and the reference standard are analyzed on the same instrument, within the same batch, and as close in time as feasible.

10) Once the standard has passed QC evaluation, it is stored at the required temperature and condition until required for use.

Calibration Procedures

Calibration of instruments is performed using either Internal or External Standard Calibration. See glossary for definitions of calibration types. In each case, the following process occurs:

1) Calibration standards are prepared, as discussed above, to encompass the linear range of the instrument, or the working range for the analysis being performed. The low standard is at or below the reporting limit, unless defined in the method or SOP. Multiple points, covering the range selected, are analyzed. Calibration acceptance criteria are defined in each method or SOP, but typically require a 3 or 5 point calibration curve, which may include the blank for certain analysis. The curve must have a RSD better than or equal to that required in the method, or have a correlation coefficient (r) of 0.990 or greater (some analysis require 0.995 as defined in the SOP). If the RSD or r criteria are not met, the linear range is too large or re-calibration is required.

2) A second source, or a standard of known value, prepared or purchased from a source different from the calibration standards, must be analyzed. Its value must be within 20% of true value, or within the acceptance range given on the standard or within method acceptance criteria.

3) Continuing Calibration Verifications must be analyzed at the frequency required by the method or the SOP. At a minimum, one must be run prior to analyzing a sample batch, and must be re-analyzed in accordance with the method. With the exception of Internal Standard calibrations, they must be analyzed at the end of the run batch to verify instrument response stability. Internal Standard calibrations must be analyzed at least every 12 hours.

4) If CCV analysis does not meet method criteria, instrument maintenance may be performed. After maintenance, the CCV may be re-analyzed. If it fails to meet acceptance criteria again, the instrument must be calibrated again, and all samples analyzed from the last passing CCV must be re-analyzed.

QUALITY CONTROL SAMPLES

Quality Control Samples

Various types of quality control samples generated and used by Specialty Analytical in addition to samples submitted by clients are described in this section.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD is used to check for precision and accuracy. These are replicate portions of a sample spiked with a known amount of a compound (or compounds) of interest, that are taken through the entire analytical process (sample preparation, analysis, data reduction). These are performed on each matrix analyzed, and are performed at a frequency of 1 MS/MSD per analytical batch (10 or 20 samples, depending on the method). The sample analysis process and the spiked sample process differ only in the adding of known amounts of compounds to the replicate MS/MSD samples. The quantity of spike varies according to the linear range and detection limit of the method.

Should the native sample contain the compound of interest also, the concentration of that analyte in the native sample is subtracted from the value of the spiked sample, and the percent recovery (%R) is calculated using:

$$\%R = \frac{\text{(Spike Sample Result- Sample Result)}}{\text{Spike Added}} \times 100$$

The sample value may be outside the linear range of the instrument utilized in the analysis. In this instance, there is no way to determine the concentration of the analytes prior to spiking the samples. Due to dilution required to analyze the sample accurately and within the linear range of the instrument, the spike added may be diluted to below reporting limits. In this case, no information on spike recovery can be determined. In this case, the use of the Laboratory Control Standard (LCS or Blank Spike) is used to determine that the analytical process is in control and the data is flagged accordingly.

The calculated percent recoveries from the above calculation are used to assess the data precision as Relative Percent Difference (RPD). This is calculated using:

$$\%RSD = \frac{\text{(MS Result - MSD Result)}}{\text{Mean of MS and MSD Result}} \times 100$$

where MS and MSD Results are the % recoveries from the analysis.

In cases where the percent recoveries or RPD values fall outside acceptance limits, case narratives, data qualifier flags, or corrective actions may be required.

Method Blanks and Reagent Blanks

Method blanks are analyzed for each matrix type and batch of analytical samples (up to 20 samples). This must be prepared at the same time as the samples in the batch. An aliquot equal to the volume or weight of sample used in sample preparation is used for the method blank analysis. The method blank is treated identically to a sample, being taken through the same sample preparation and analysis. The method blank must be free of substances and interference at the reporting limit, or must have less than 10 times the contamination level found in the sample. Method blanks are typically run immediately after the CVS (CCC) standard to show system cleanliness and lack of carry-over on the instrument.

Holding Blanks

Holding blanks are aliquots of VOA free materials (normally water or methanol) that are stored in headspace free VOA vials in the refrigerator volatile samples are stored in. It is analyzed identically to samples to determine sample cross contamination during sample storage. Presence of volatile compounds (especially methylene chloride or acetone) indicate some migration of compounds through the septum seals of the VOA vials. Holding blanks are analyzed twice monthly as part of routine quality control, upon client request, or upon some indication of sample contamination discovered by the laboratory.

Calibration or System Blank

A calibration blank is used to establish the analytical curve “zero” point in some methods, taking background responses into account. It is identical to the matrix being analyzed for in the method. System blanks are utilized to check for system contamination, after standard analysis or high level samples have been analyzed to verify system cleanliness.

Laboratory Control Samples

Sometimes called a blank spike, the Laboratory Control Sample (LCS) is a standard of known concentration spiked into a consistent matrix (water or sand), prepared and analyzed identically to samples, and is part of the QC for an analytical batch. The spikes are compounds representing the analytes to be quantified by the method.

LCS’s provide information on the accuracy of the analytical batch, and establish the efficiency of the sample extraction, digestion (if part of the method), and analysis. The LCS is also used to verify matrix interference if MS/MSD recovery or precision control limits are exceeded, as it is usually an identical spike in concentration and analytes to the MS and MSD, but is not impacted by sample specific matrix effects.

Surrogate Spikes

For chromatographic analysis (GC, GC/MS, LC), surrogates are used to determine acceptable extraction and analysis efficiencies. Unlike spikes and LCS samples, surrogates are added to each sample in the analytical batch, and thus provide an extraction and instrumental analytical efficiency for each sample.

Surrogates are added prior to extraction of the sample, and are spiked directly upon the sample being analyzed. Surrogates are analyte compound substitutes, i.e. they are not specifically requested analytes of interest, and are normally not naturally occurring compounds. Surrogates should not interfere with the quantification and identification of the target compounds, and must be chemically similar to the compounds of interest.

Surrogate spike calculations for recovery are performed on all samples, blanks, LCS and MS/MSD.

Control limits are established for surrogates. Exceeding the control limits requires re-analysis to verify any matrix effects upon the surrogate, which may indicate effects upon the target compounds.

DOCUMENT CONTROL

AND

RECORDS MANAGEMENT

Documentation

The purpose of records management is to ensure all records for the laboratory are accountable and traceable, including COC records, logbooks, graphs, raw data, and other required items for verification of data. All documents are dated and a log is kept by the QAM to indicate the time period during which the procedure or document was in force.

Record Keeping

Documentation of client samples begins with Project Management, where samples are received, assigned unique laboratory numbers, and reconciles COC forms. Each shipment has a unique number (laboratory job number) that is carried throughout the sample analysis and reporting process. The information about sample receipt is contained in the Project Check In Log Book, which contains information on sample receipt, matrix, parameters, containers, and documentation.

Additional required information is contained in the instrument maintenance logs, standard logbooks, chemist's notebooks and bench sheets, and instrument run logs.

All sample and analytical data is retained for a minimum of five years.

Document Distribution

1) The QAM controls the QAP. Clients and all staff are issued a QAP. Document control numbers unique to each copy are included and a list of where the copies are located is kept by the QAM.

2) The QAM controls the SOPs. All staff are issued the appropriate SOPs. Document control numbers unique to each copy are included and a list of where the copies are located is kept by the QAM.

3) All copies are signed and dated by the Laboratory Director and QAM. Document control numbers are assigned to each copy and copies are tracked by revision number, location and date issued. The log is maintained by the QAM.

4) The QAP and SOPs are revised annually. All laboratory personnel are required to read the revisions. Signed documentation is placed in their training file. Clients that receive a QAP are sent all new revisions and are requested to return the acknowledgement of receipt of revision form.

Logbook Requirements

Requirements for logbooks used in the laboratory are as follows:

1) Bound logbooks with numbered pages are preferred over loose sheets. Sheets must be affixed to a logbook page, signed and dated both on the sheet and running onto the logbook.

2) Only assigned logbooks can be used for record keeping. Contract required logs will be maintained as part of contract requirement in project files.

3) All writing must be legible and in black ink. Corrections can only be made by drawing a single line through the entry, initialing and dating the change.

4) Complete information must be entered.

5) Any data invalidated must be noted as to the cause.

6) All data relevant to the information must be included. This may include reagent lots, preparation information, instrument conditions, etc.

7) When work is continued to another log, the number of the first log is entered on the first page of the second log.

NONCONFORMANCE
AND
CORRECTIVE ACTION

Out of control events

Out of control events are defined as any occurrence failing to meet pre-established criteria.

Nonconformance is a deficiency in characteristic, documentation, or procedure sufficient to make the quality indeterminate or unacceptable. An out of control event is a sub-category of non-conformance.

When either a nonconformance or out of control event occurs, it will be categorized as either a deficiency, or an observation.

Deficiencies are defined when a specific requirement of a program, process, or procedure has been violated.

Observations are defined when there is recognition of an activity or action that may be improved, but is not in violation of a specific requirement. Observations may degrade to a deficiency if not corrected.

Criteria for Out-Of-Control Events

Factors that affect data quality (failing calibration, improper sample storage, improper preservation of samples, failure to meet hold time, inadequate record keeping, etc.) require investigation and corrective actions. Some factors can be assessed through use of control charts. Control charts can yield information on trends, biases, and shifts in the operation of the analytical system.

The detection of one of these conditions is an indication the analytical system is out-of-control. The out-of-control value is placed on a control chart, circled, and documented through the use of a non-conformance form. The Laboratory Quality Assurance Manager and Laboratory Director are notified, and determine whether the incident is random, or reflects a process that is out-of-control.

Procedures for Corrective Action

When an out of control event occurs, the analyst will consult the SOP for proper corrective action. If corrective action is not possible (i.e. insufficient sample volume for reanalysis or suspect matrix interference) and the data is out of control or nonconforming, the analyst writes a case narrative describing the conditions of data analysis. A form is filled out and the situation is brought to the Laboratory Director's and QAM's attention. The QAM will determine the validity of the data and the Laboratory Director or Project Manager will contact the client to determine data is acceptable to the client or additional action is necessary (i.e. re-sampling). All conversations with the client are documented. A case narrative is written to describe the nonconformity and is included with the final report. All associated data must be flagged with a CN and all QC parameters that are out of control and associated with the data are flagged and included in the final report.

The QAM is responsible for documenting the actions taken in response to the nonconformity.

Under certain circumstances the Laboratory Director or the QAM may permit departures from the documented policies or procedures. These departures are documented by the QAM, Laboratory Director, or Project Management and communicated to the client via a report case narrative.

All corrective action procedure follow NELAP standards.

Procedures for Halting Analysis

When the analytical system is out-of-control corrective action processes are initiated by the analyst and

QAM.

If the problem is instrumental or specific to a particular batch analysis, any samples prepared after the event are re-processed after re-calibration, providing holding times are met.

If the batch or sample is still out-of-control after re-analysis, all method related activities are stopped. A detailed investigation to the causes is conducted, and any process problems are corrected. All actions taken are documented in the project file related to the sample(s).

Only after the corrective action is performed is the analysis placed on-line at the laboratory again.

Corrective Actions

Need for corrective actions come from several sources, equipment malfunction, failure of QA/QC checks, follow-up of performance or system audit findings, and QA non-compliance.

When instrumental or analytical methods fail QA/QC, the failure will be brought immediately to the attention of the QAM or the Laboratory Director. Corrective measures taken will depend on the analysis, the type of error, and the extent of the failure. If an analysis fails batch QA/QC (MS, LCS, Blank or duplicate) criteria and the batch cannot be reanalyzed (due to insufficient sample) or matrix interference is suspect all failures will be flagged as out of control and reported to the end data user.

Corrective actions can be extensive or simple. Each case requiring a corrective action will be determined on a specific basis.

Equipment malfunctions will be handled by segregating the equipment, until repairs can be performed, and precision and accuracy on the instrument restored.

Failure of performance audits will require Specialty Analytical to identify the problem in analysis or document traceability. Step by step analysis of the causes of the problem are instituted, and corrective actions are taken.

All incidents of QA failure and corrective actions will be documented fully. Any actions will be taken quickly, and the process will include actions to prevent re-occurrences of the event.

CONTROL CHARTING

Use of Quality Control Charts

Measurement system performance can be demonstrated by the measurement of homogeneous and stable control systems. The data compiled is plotted, and a control chart generated to indicate whether the system is providing process control. It is also used to notify the laboratory of developing method performance issues, by identifying systematic errors, drifts, or other problems.

Use of control charts are:

1) Provide graphical assessment of accuracy and precision for the measurement of each analyte.

2) Allow observations of recovery trends for individual analytes, and allow self-evaluation of analytical output.

3) Provide assessments of analytical capability of the technical staff.

A system must be verified as being in control, in order to be maintained in control. A system is not in control if it is observed to produce unexpected data more than once every 20-25 runs. Control limits usually become tighter once a process is under a controlled protocol.

Control Chart Types

Control charts that are used to monitor the performance of the methods are:

1) Surrogate Percent Recoveries

2) MS/MSD Recoveries per matrix type

3) LCS Percent Recoveries

Preparation of Control Charts

For methods which quality control acceptance limits are not specifically determined (either internally or by QAPjP), control charts are used to evaluate lab performance. Control charts, when used, will be prepared for each analysis and matrix type separately. The charts will consist of a centerline, two warning limits, and two control limits. This process is described in HAZWRAP DOE/HWP-65/R1 and EPA Handbook on Analytical Quality Control in Water and Wastewater Laboratories. Control charts require a minimum of 20 points to begin charting, so method recommended recoveries shall be used until sufficient data points have been gathered.

Interpretation of Control Charts

Representative concentrations of compounds as described in the method or SOP are spiked into the required percentage of samples (method required frequency for LCS and MS/MSD, all samples for surrogates when utilized). Recovery information is gathered for these points. The mean (x) and standard deviation (s) is calculated, and from this information warning and control limits are calculated. These are:

1) Warning limits are defined as x +/- 2s

2) Control limits are defined as x +/- 3s.

The %R of each surrogate recovery, MS/MSD recovery, or QC sample is plotted on a control chart and compared with the control and warning limits.

Control charts can also be used to evaluate data precision (RPD) on duplicate or spike duplicate samples. The calculations for warning and control limits are the same as above.

Any of the following incidents causes a out-of-control corrective action to be performed:

1) One or more points outside the control limit (3s).

2) Two or more consecutive points outside the warning limit (2s).

3) Seven or more consecutive points on same side of mean recovery bar (x), indicating data trends or shifts.

4) Cyclic or non-random patterns occurring in the data points plotted.

5) Runs of 6 or more points in the same direction.

DATA VALIDATION
AND
REPORTING

Laboratory Data

Technical staff will document sample preparation activities in prepared laboratory notebooks or bench sheets. These are the primary record of preparation activities in the laboratory, and for data reduction occurring after analysis. Data for GC/MS, GC, ICP, and LC methods are generated by stand-alone computer systems. Results from each analysis are transferred only to analytical forms specific to the particular analysis. Data is checked for accuracy and precision at the bench and instrument analyst level, by secondary review process, and by the Project Manager and Technical Reviewer prior to release of the data to the client. Data will be supported by the following to be valid:

1) Description of calibration

2) Description of instrument checks (noise levels, drift, and linearity).

3) Documentation of traceability of instrument standards, samples, and data

4) Documentation of analytical methodology and QC requirements.

5) Description of control taken to minimize and verify interference in the method (method blanks and LCS analysis for accuracy and precision).

6) Description of routine maintenance.

7) Documentation of sample preservation and transport.

Laboratory Data Validation and Data Reporting

Data validation is the process of reducing, reviewing, and accepting (or rejecting) data produced by the laboratory against a set of criteria. It is a systematic procedure of reviewing a body of data against the criteria to provide assurance of validity prior to use by a client or regulatory agency.

Data validation is performed by the analyst and a second, trained analyst, QAM, or Technical Director. A minimum of two reviews is required to validate a package. The Project Manager or Technical Reviewer will perform a data package review for completeness and consistency, and to assure compliance with customer deliverables requirements.

Validation is accomplished through routine audits of data collection and flow procedures, and by monitoring QC sample results. Data validation includes signed and dated entries on worksheets and in logbooks used for all samples, the use of sample tracking and numbering systems, and the use of quality control criteria to reject or accept data.

The process consists of data editing, screening, checking, auditing, verification, certification, and review. Specialty Analytical will certify in writing that the data has been validated in accordance with defined laboratory processes.

Minimum Validation Requirements

1) A minimum 3 point calibration, not including the isoelectric point or calibration blank

2) Laboratory Control Samples/QC samples included for the analysis

3) One method blank per matrix and per concentration level for each batch or day

4) Matrix Spike/Matrix Spike Duplicate per concentration level and per matrix at the regulatory required frequency, or per batch.

Data checks used to validate precision and accuracy of parameters measured, and to support the representativeness, comparability, and completeness include:

1) Correlation coefficient of > or = 0.990, or a RSD of < 20% for the calibration curve.

2) Documentation of traceability of the instruments standards

3) Documentation of methodology (analytical and QC) from the SOP.

4) Routine maintenance performed

5) Documentation of sample transportation and preservation.

Review of QC Data

When an analytical data set is complete, the results will be reviewed to establish the validity of the data. General principles are:

1) Blank Evaluations - Review of method, instrument, and rinse blanks for background contamination.

2) Field/Trip Blank Evaluation - Review of field or trip blanks to check for background, instrument, carry-over or transport contamination.

3) Matrix Spike/Duplicate Evaluation - Review of precision and accuracy for the spike and duplicate results.

4) Calibration Standards Evaluation - Review to determine linearity, range, and verify sample values within calibration ranges.

5) Duplicate Sample Evaluation - Review of precision using RPD criteria for duplicates within set, if used in method.

6) LCS Evaluation - Results of LCS or Blank Spike are evaluated for % Recovery values, and compared with acceptance criteria.

7) Surrogate Spike Evaluation - Review of surrogate percent recovery to determine compliance with acceptance criteria.

Data Collection and Flow

Audits and review of data collection and flow will include:

1) Review of sample documents for completeness, with review by second analyst or technical reviewer.

2) Daily review of instrument logs, performance results, and analyst performance by QAM.

3) Daily review of performance indicators by analysts and QAM.

4) Random calculation checks at a minimum of 20%.

5) Review of all reports prior to and subsequent to data entry.

Data Review

During data review, data is compared to historical data, review of sample preparation and data from sample analysis is evaluated. Corrective actions are minimized by implementation of routine system controls. Analysts are provided with, and comply with, specific criteria for procedure, operation, and measurement systems.

Data review contains several levels. Analysts are responsible for initial data review, check compliance with QC criteria, and checking instrument calibration, blank reviews, review of raw data (including peak identification), and calculations of raw data. Analysts review 100% of data, whether hand or instrumental calculations are performed. Upon completion of this step, secondary review is performed at a minimum of 20%. This step emphasizes data acceptability relative to QC indicators and acceptance criteria, and on accuracy of data summaries. A final review is performed for data consistency and completeness.

AUDITS
QUALITY ASSURANCE
QUALITY CONTROL REPORTS

System Audits, Performance Audits, and QA/QC Reports

System and Performance Audits of Specialty Analytical will be performed on a periodic, on-going basis. These audits will be included in all Laboratory Audit files, and analyst specific information will be contained in the Analyst Certification/Training Files.

System Audits would include audits performed by outside agencies. These may include regulatory agencies, clients, or internal system audits. Internal system audits would be performed similarly to outside audits, but be performed by Laboratory Management. Each department will be audited at a minimum of yearly, and include Sample Management and Document control as well as analytical departments.

Performance Audits would include any Performance Evaluation Samples analyzed by Specialty Anaytical. These will be documented, and copies of relevant information will be included in Analyst Certification/Training Files. These will include, as a minimum, all Performance Evaluation Samples analyzed by the laboratory, including single-blind samples initiated by the Laboratory Quality Assurance Manager. They would also include all double-blind PE samples analyzed as part of maintenance of accreditation by regulatory agencies. Information on corrective actions should be included. All analysis performed by the laboratory, for which a PE sample can be obtained, will be analyzed on a twice-yearly basis. This information will be recorded in the annual QA/QC report, and relevant analyst training files.

QA/QC audits will summarize information on laboratory performance, and will contain relevant information from the above reports. They will also include periodic audits performed by Laboratory personnel, including departmental audits. They will include laboratory performance on PE samples, both internal and external, information on activities to improve precision and accuracy of the analysis, and summary information on regulatory and client audits. They should include responses to PE results exceeding acceptance limits, and responses to comments contained in internal and external audits. QA/QC audits will be performed at a minimum of annually. Any methods, which have been halted due to QA/QC issues, will be reviewed in a QA/QC report prior to validating the analysis again.

GLOSSARY

Accuracy. The degree of agreement of an analytical result with the true value. The accuracy of a result is affected by both systematic errors (i.e., bias) and random errors (i.e., imprecision). Some analysts improperly use accuracy to denote only systematic error. (See "bias" and "precision.")

Action limit. A control limit on a control chart, which, if exceeded, requires corrective action to be taken. Action limits are usually placed at +3 standard deviations from the expected or mean value. (See "Control Limit" and "Warning Limit" below.)

Analyte. That which is analyzed for in chemical, but not physical or biological, determinations.

Analytical error. The error, E, of an analytical result, R, is defined as:

$$E = R - T$$

where T is the true value.

Analytical Method. Written instructions describing an analytical procedure followed to obtain a numerical estimate of the concentration of a determinant (analyte) in a sample or samples.

Analytical Response. A numerical observation obtained when a sample is presented to a measurement sub-system (e.g., spectrophotometric measurement of the absorbance of a solution). The magnitude is related to the concentration of the determinant (analyte) in the sample.

Analytical Result. A numerical estimate of the concentration of a determinant (analyte) in a sample, obtained by carrying out once the procedure specified in an analytical method. A method may specify analysis of more than one portion of a sample to produce one analytical result. The result can also be thought of as the final value reported to the user.

Analytical System. A combination of analyst, analytical method, equipment, reagents, standards, laboratory facilities, any other components involved in carrying out an analytical procedure.

Batch. Usually a set of consecutive determinations (analyses) made without interruption. The results are usually calculated from the same calibration curve or factor. Also called a run. Maximum time between start of processing of the first and last sample in the batch is 24hrs

Bias. That part of inaccuracy of an analytical result caused by systematic error.

Blank. A sample used to estimate the analytical response attributable to all factors other than the determinant (analyte) in the sample. Blanks are analyzed identically to samples, but do not contain the determinant (analyte) (e.g., in water analyses, pure water would be analyzed to determine the blank). Some analysts use the term method blank with the same meaning given here.

Calibration Standards. Solution(s) of known analyte concentration, used in the calibration (standardization) procedure to determine the relationship between concentration and analytical response.

Certified Reference Material. A substance, one or more property values of which are certified by a technically valid procedure accompanied by or traceable to a material certificate or other document issued by a certifying body.

Check Standard. A solution of known concentration used to check the precision analyses (and bias due to

calibration). When used in conjunction with a control chart, the check standard is called a control standard.

Control Limit. A value on a control chart used to make decisions as to whether the results or control tests are acceptable. Two kinds of control limits are usually used: warning limits and action limits.

Criterion of Detection. The smallest concentration, which can be distinguished from a blank with no more than a 5% chance of reporting a false positive.

Data Quality Objectives. Qualitative and quantitative statements of the quality of data. Qualitative statements may be made concerning completeness, defensibility, representativeness, and accuracy, as well as other factors. Quantitative statements are usually made concerning acceptable bias and precision (which together, influence accuracy).

Degrees of Freedom. A whole number expressing the amount of information available for an estimate. The whole number is generally the number of independent results less the number of constraints. Constraints are what else needs to be estimated from the same set of results.

Determinant. That which is to be determined. Covers chemical, physical, biological, or other analytical determinations. (See "Analyte" above.)

External Standard Calibration. The use of independently prepared standards to determine the relationship between response and concentration, run separately from the sample(s). Also called external standardization.

Interference. Systematic error (bias) in the analytical result caused by the presence of a substance in the environmental sample (or added to the sample during analysis).

Internal Standardization. A calibration and analysis procedure in which the responses of analytes are determined relative to an internal standard(standards added to every sample). Two solutions-calibration and spiking-are required.

Isotope Dilution. An internal standardization procedure in which the internal standards are isotopically labeled analogs of target analytes. Isotope dilution techniques are characterized by very low bias due to calibration.

Laboratory Control Standard (LCS). See Check Standard.

Limit of Detection. The smallest concentration of an analyte for which there is at least a 95% chance the analyte, if present, will be detected (i.e., there is only a 5% chance of obtaining a false negative).

Matrix Spike/Matrix Spike Duplicate (MS/MSD). See Spike.

Percent Recovery. That percent of a known amount of material 'spiked" or added to a sample being analyzed which is reported at the end of the analysis. See "spike," "analytical recovery," and "physical recovery."

$$\% \text{ Recovery} = 100(R2 - Rl)/A$$

where R, is the result for the sample without the spike, and R2, the result for the spiked sample, and A is the equivalent concentration added in the spiked sample.

Population .The collection of all possible analytical results.

Precision. A qualitative term used to denote the scatter of results. Precision is said to improve as the scatter

among results becomes smaller. Random error is also referred to as imprecision. Usually measured as standard deviation.

Quality Assurance. The total integrated program for assuring the reliability of monitoring and measurement data.

Analytical Quality Control. The routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements.

Random error. Errors indicated when repeated analyses of identical portions of a homogeneous sample do not give identical results. Random results differ among themselves and are more or less scattered about some value. They are termed random because the sign and magnitude of the error of any particular result vary at random, and cannot be predicted with confidence.

Analytical Recovery. An estimate, usually expressed in percent, of an analytical result in comparison with a true or reference value for the analyte, (e.g., an analytical recovery of 95% for compound X means that the result was 95 percent of the true or reference value for X in the sample).

Physical Recovery. An estimate, usually expressed in percent of the amount of standard or analyte present at the final stage of analysis (e.g., final extract), compared with the amount present in the original sample. Physical recovery can be an indirect indication of analytical performance.

Reference Material. A material or substance, one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

Relative Percent Difference (RPD). The difference between duplicate results for analyses of a sample, relative to the mean value of those results and expressed as a percent.

RPD = 100(di - d2)/E(dl + d2)/2
= 200(d1 - d2)/(dl + d2)
where d1, is the result of the first analysis, and d2 the second.

Relative Standard Deviation (RSD). The standard deviation relative to the mean. Also called coefficient of variation." RSD is calculated as either s/x-bar or lOOs/x-bar. The latter is sometimes referred to a percent relative standard deviation, or %RSD. RSD indicates the magnitude of imprecision.

Spike. A known amount of analyte added to a sample for the purpose of judging, from the analytical percent recovery, whether there is bias due to interference present in the sample. Also referred to as fortification of the sample. See "percent recovery."

Standard. A solution of known concentration. There are two types of standards: (1) check (or control), and; (2) calibration.

SOP. A standard operating procedure, or detailed, written description of a procedure designed to systematize the performance of the procedure.

Standard Deviation A statistical constant which describes the width of the normal distribution or spread of

results. An actual standard deviation is denoted by "a" whereas an estimate of the standard deviation is denoted by "s". For "n" replicate results for a sample of known concentration, the estimate of the standard deviation (s) is:

$$\sqrt{\left[\sum (xi - \bar{x})2 / (n-1)\right]}$$

where "x" is a result and "x" is the mean of "n" results.

For duplicate analyses of "in" pairs of unknown samples, the estimate of the standard deviation of the difference (d) for the two samples in each pair is:

$$\sqrt{[\sum p2 - (\sum p)2 / m(m-1)]}$$

For spike recoveries on “in" samples, the estimate of the standard deviation of the percent recovery (p) is:

$$\sqrt{[\sum p2 - (\sum p)2 / n(n-1)]}$$

Standard Reference Material (SRM). A sample of known concentration, also called a certified reference material, issued by the National Institute for Standards and Technology (NIST).

Statistical Sample. The results of one or more determinations from the sample population of all possible results.

Statistics. Certain single values computed from the results, which characterize the distribution of the results. Each statistic his its own frequency distribution which is defined by a particular mathematical function.

Surrogate Standard. A type of check standard added to each sample for certain types of analyses (e.g., trace organic), in a known amount and at the start of processing. The surrogate is not one of the target compounds for the analysis, and is not expected to be present in environmental samples, but should have analytical properties similar to those compounds.

Systematic Errors. Errors indicated by a tendency of results to be greater or smaller than the true value. Usually bias can be considered to be equivalent to systematic error.

Target Compound. A compound which is expected to be in an environmental sample or for which the analysis is being conducted.

Warning Limit. A control limit on a control chart, usually +2s distant from the expected or mean value. Action is required when results fall outside the warning limits too frequently. A single value outside a warning limit does not necessarily require action, but should alert one to a possible problem.

LIST of CURRENT METHODS

CONVENTIONAL METHODS

Alkalinity by EPA 310.1/2320B/310.2
Ammonia by EPA 350.1/SM4500-NH3 H
Chemical Oxygen Demand by EPA 410.4
Chloride by EPA 9253/9212/SM4500Cl- B
Chlorine, Residual by SM4500 Cl F
Conductivity by EPA 120.1
Cyanide by EPA 335.2
Dissolved Oxygen by EPA 360.1
Inorganic Anions by EPA 300.0/9056
Flashpoint by EPA 1010/ASTM D-93
Fluoride by ISE EPA 340.2/9214
Hardness by EPA 130.2
Calculated Hardness by SM 2340B
Hexavalent Chromium by EPA 7196A
Nitrate/Nitrite by EPA 353.2
Total Kjeldahl Nitrogen by EPA 351.2
Oil and Grease by EPA 9071A/9070
Oxidation-reduction potential by ASTM D1498
HEM/SGT_HEM by EPA 1664
Paint Filter Liquids Test by EPA 9095A
pH of Water by EPA 9040/150.1
pH of Soil by EPA 9045C
Phenolics, Total Recoverable by EPA 420.1
Phosphorus, total by EPA 365.2
Phosphorus, ortho by EPA 365.2
Phosphorus, ortho by EPA 365.1
Total Dissolved Solids by EPA 160.1
Total Suspended Solids by EPA 160.2
Total Solids by EPA 160.3
Volatile Solids by EPA 160.4
Settable Solids by EPA 160.5/SM2540F
Specific Conductance by EPA 9050A
SPLP Extraction by EPA 1312
Sulfate by EPA 375.4/9038/375.3
Sulfide by EPA 376.1
Sulfite by EPA 377.1
Tannin and Lignin by SM 5550B
TCLP Extraction by EPA 1311
Total Organic Carbon by EPA 415.1/9060
Total Organic Halogens by SM 5320B
Total Organic Halides by EPA 9020B
Total Halides by EPA 9076
Extractable Organic Halides by EPA 9023
Extractable Sulfides by EPA 9031
Turbidity by EPA 180.1
Water content, Karl Fischer by ASTM D4377

MICROBIOLOGY METHODS

Total Coliform by SM 9222B/9223B
Fecal Coliform by SM 9222D
Biochemical Oxygen Demand by EPA 405.1

METALS

ICP Metals by EPA 6010B/200.7
ICPMS Metals by EPA 6020/200.8
Mercury in solids by EPA 7471A/245.5
Mercury in water by EPA 7470A/245.2

ORGANICS

Semi-volatiles by EPA 8270C
Volatiles by EPA 8260B
PCBs by EPA 8082
Organochlorine Pesticides by EPA 8081A
BTEX by EPA 8021B
Volatile Petroleum Products by NWTPH-Gx

Semi-Volatile Petroleum Products by NWTPH-Dx
Petroleum Hydrocarbon ID by NWTPH-HCID
Glycols by EPA 8015B
Alcohols by EPA 8015B
PAHs by OAR GC/MS SIM
Semi-volatile organic by 40CFR 625
Organo Phosphorus Pesticides by EPA 8270D
Volatile organics by 40CFR 624
Chlorinated Herbicides by EPA 8151A
Semi-volatile organics by PMI 1671
Volatile organics by PMI 1666
Pesticides/PCB by 40CFR 608
EPH – Extractable Petroleum Hydrocarbons
VPH – Volatile Petroleum Hydrocarbons

Note: all analytes or methods may not be state certified. Consult current scope of accreditation.

Figure 1

Chain of Custody

CHAIN OF CUSTODY RECORD

Page___of___

Specialty Analytical
11711 SE Capps Road
Clackamas, OR 97015
Phone: 503-607-1331
Fax: 503-607-1336

Contact Person/Project Manager_____
Company_____
Address_____
_____
Phone_____ Fax_____
Project No._____ Project Name _____
Project Site Location OR_____ WA_____ Other_____
Invoice To _____ P.O. No. _____

Collected By:
Signature_____
Printed_____

Signature_____
Printed_____

Turn Around Time
☐ Normal 5-7 Business Days
☐ Rush _____
Specify
Rush Analyses Must Be Scheduled With The Lab In Advance

Analyses

For Laboratory Use
Lab Job No. _____
Shipped Via_____
Air Bill No. _____

Temperature On Receipt _____°C
Specialty Analytical Containers? Y / N
Specialty Analytical Trip Blanks? Y / N

Date	Time	Sample I.D.	Matrix	No. of Containers										Comments	Lab I.D.

Relinquished By: Company:	Date	Time	Received By: Company:	Relinquished By: Company:	Date	Time
Unless Reclaimed, Samples Will Be Disposed of 60 Days After Receipt. Samples held beyond 60 days subject to storage fee(s)				Received For Lab By:	Date	Time

Copies: White-Original Yellow-Project File Pink-Customer Copy

QUALITY ASSURANCE/QUALITY CONTROL MANUAL

FOR

AQUATIC TOXICOLOGY STUDIES

At

NORTHWESTERN AQUATIC SCIENCES
3814 YAQUINA BAY ROAD
P.O. BOX 1437
NEWPORT, OR 97365

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APPROVAL FOR IMPLEMENTATION:

Richard S. Caldwell 3/25/08

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Laboratory Director, Northwestern Aquatic Sciences, and
Technical Director, Aquatic Toxicology Laboratory

Linda K. Nemeth 3/25/08

Linda K. Nemeth, M.B.A. Date
Quality Assurance Officer

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I. POLICY STATEMENT

This manual summarizes the policies and operational procedures associated with Northwestern Aquatic Sciences and provides a detailed description of quality assurance and quality control (QA/QC) procedures for toxicity testing with marine and freshwater organisms at Northwestern Aquatic Sciences (NAS) in Newport, Oregon. These procedures address all aspects of toxicity testing that can potentially affect data quality and interpretation, including sample handling and storage of test materials, collection and conditioning of test organisms, test conditions and equipment, calibration of instruments, replication, reference toxicants, corrective action, record keeping and reporting, and data reduction. Further details on these policies and procedures are contained in SOPs, test protocols, and related documents.

NAS performs toxicity testing of environmental samples including marine and freshwater sediments, sediment pore waters, sediment elutriates, effluents, other products (chemical products, ores, mine tailings), and receiving waters. Test methods may be acute, chronic, or bioaccumulation methods all of which are based on published test methods.

NAS is accredited by the State of Washington Department of Ecology for bioassay (toxicity) testing. As part of this accreditation, NAS analyzes proficiency testing samples once a year from the DMR QA Program. NAS also maintains internal QC with the use of reference toxicant testing for every type of test and the use of control charts for references toxicant tests.

The technical and service requirements of all requests to provide testing are thoroughly evaluated by the Laboratory Director/QAO and Project Managers before commitments are made to accept the work. This includes a review of facilities and instrumentation, staffing, and any special QC or reporting requirements to ensure that testing can be performed within the expected schedule. All test methods are performed based on published reference methods such as U.S. Environmental Protection Agency (EPA), American Society for Testing Materials (ASTM), Environment Canada, and other officially published test methods or methods developed by NAS to meet specific client needs, such as for research purposes.

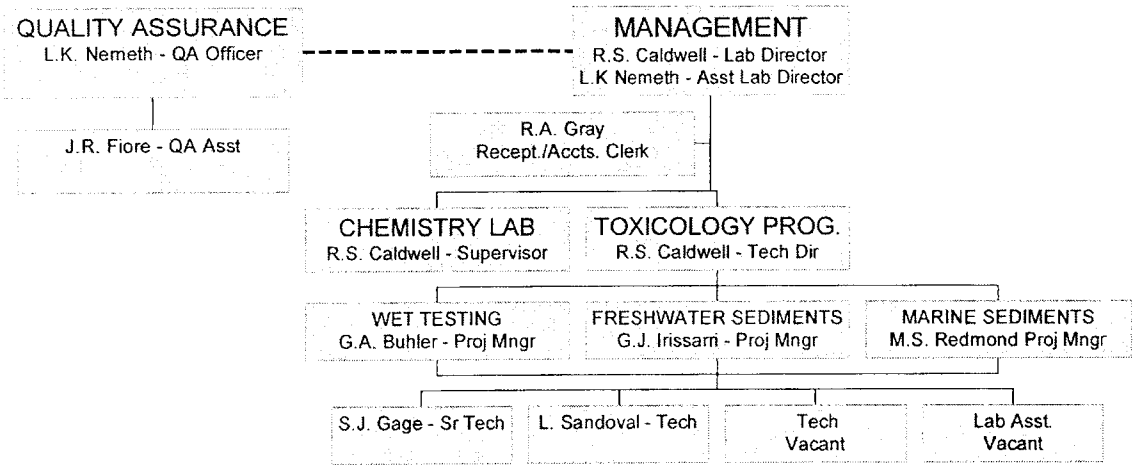
II. ORGANIZATION AND RESPONSIBILITIES

Northwestern Aquatic Sciences is an independent testing laboratory that provides aquatic toxicology testing throughout the United States and internationally, with emphasis on the Pacific Northwest. The overall operation is currently comprised of the aquatic toxicology laboratory with a chemistry support laboratory that is not an accredited entity at this time. There is an independent formal Quality Assurance program headed by the QA Officer. There is a small clerical staff that supports the laboratory program.

An organization chart for Northwestern Aquatic Sciences is shown below. The chart includes all individuals discussed below. Job descriptions for al individuals are maintained by the Assistant Laboratory Director.

A. ORGANIZATION CHART

NAS Organizational Chart
March 2008



B. LABORATORY DIRECTOR

The Laboratory Director is responsible for ensuring that:

- The responsibility, authority and interrelationships of all personnel who manage, perform, or verify work affecting the quality of tests are specified and documented, including a clear description of the lines of responsibility in the laboratory to ensure adequate supervision, and job descriptions for all positions.
- The minimum level of basic laboratory and other skills, education, and experience necessary for all laboratory positions are defined.
- All technical laboratory staff has demonstrated proficiency in the activities for which they are responsible.
- Training of personnel is kept up to date.
- All analytical and operational activities are documented.
- All personnel are adequately supervised.
- All sample acceptance criteria are verified, and samples are logged into the sample tracking system and properly labeled and stored.
- An annual management review of the quality system is performed.
- The quality of all data reported by the laboratory is documented.
- A proactive program for prevention and detection of improper, unethical, or illegal actions is in place.
- The laboratory has the appropriate resources and facilities to perform requested work.

- Corrective actions relating to findings from internal audits are completed.
- Appropriate persons-in-charge are designated in the absence of the Technical Director (Laboratory Supervisor) and QA officer.
- Supplies and any outside support services are of adequate quality to sustain confidence in the laboratory's tests.

C. QUALITY ASSURANCE (QA) OFFICER

As shown in the organization chart, the QA Officer is independent of direct job involvement and day-to-day operations, and has direct access to the Laboratory Director. The QA Officer:

- Remains independent from laboratory operations where QA oversight is provided.
- Evaluates data objectively and performs assessments independent of managerial influence.
- Is responsible for the quality system and its implementation.
- Serves as the focal point for QA/QC.
- Develops and maintains procedures for audits and data review.
- Maintains the quality manuals and keeps them current.
- Is responsible for the oversight and/or review of quality control data.
- Arranges for or conducts internal audits on the entire technical operation annually.
- Notifies laboratory management of deficiencies in the quality system.
- Monitors corrective actions.
- Ensures that the laboratory performs proficiency testing as required for certifications.
- Supervises assistants in the QA Unit.

D. TECHNICAL DIRECTOR

The Technical Director for the Aquatic Toxicology Program reports to the Laboratory Director and is responsible for:

- Certifying that personnel with appropriate educational and/or technical background perform all tests for which the laboratory is accredited
- Monitoring standards of performance in quality control and quality assurance;
- Monitoring the validity of the analyses performed and data generated in the laboratory to assure reliable data;
- Ensuring that sufficient numbers of qualified personnel are employed to supervise and perform the work of the laboratory; and
- Providing educational direction to laboratory staff.

E. TECHNICAL STAFF

Technical staff is responsible for sample analysis and identification of corrective actions. The staff report directly to the Laboratory Director. All personnel are responsible for complying with all quality assurance/quality control (QA/QC) requirements that pertain to their organizational/technical

function. As documented in the employee records, each technical staff member has the experience and education to adequately demonstrate knowledge of their particular function and a general knowledge of laboratory operations, analytical test methods, quality assurance/quality control procedures and records management.

Within the Toxicology Program, each individual project is managed by a specific Project Manager (PM), who specializes in work for that type of project. There are three PMs: WET Testing Project Manager, Freshwater Sediment Project Manager, and Marine Sediment Project Manager. Each project manager is responsible for the overall scheduling of the entire project, with each type of test assigned to one person to oversee as the Study Director. The Study Director supervises the conduct of the study or test, analyzes the data, and writes the report and then gives it to the QA unit for data verification and review. After corrections and QA approval, the report goes to the Project Manager for review, revision, and approval. The final step is for the report to go to the Laboratory Director for final review and approval.

F. TRAINING

Each employee has read, understood, and is using the latest version of the laboratory's protocols and SOPs Most training with toxicology testing is conducted as hands on training with the person being trained working side-by-side with an experienced person. Additional training in the form of reading assignments, seminars, and workshops are also provided as appropriate. Training records (e.g., continuing education, participation in technical conferences, internal training activities) are kept with Human Resource files.

III. SAMPLING, HANDLING AND STORAGE OF TEST MATERIALS

Test materials may include, but are not limited to, marine and freshwater sediments, sediment pore waters, sediment elutriates, effluents, other products (chemical products, ores, mine tailings), and receiving waters. General guidelines are given below for sampling and handling of test materials. SOPs and protocols should be consulted for more specific information regarding collection, volume requirements, container specifications, preservation techniques, and storage conditions.

A. SAMPLING

Sampling for most projects at NAS is performed by the client, and samples are shipped to NAS. Sampling requirements will be specific to the types of test materials and the specific study design in effect. Effluents may be grab or 24-hr composite samples and should be taken from the sampling point specified in the NPDES discharge permit. Grab samples are commonly taken for receiving waters. Sediment samples may be taken using various coring devices or surface samplers such as a Smith-McIntyre grab. Sediment sampling locations are specified in a written sampling plan.

Sampling implements should be made of non-contaminating materials (e.g. stainless steel, plastic, etc.) and properly cleaned for the type of analyses to be performed. Sample containers may be glass or

plastic (polyethylene or polypropylene) bottles, or disposable cubitainers. Samples should completely fill the storage container leaving no air space.

All samples should have the following information recorded on the sample container label: sample location, test to be performed, date and time of collection, initials of persons collecting the sample, and special remarks if appropriate. Since most samples are not collected by NAS personnel, this is not under NAS control most of the time. At a minimum, the sample container usually has a sample number, date and time of collection, and initials of persons collecting the sample.

When sampling involves a large number of samples and/or detailed records are required by the sampling plan, a field notebook is used in which are recorded the dates, locations, and procedures used for collecting samples as well as any other necessary data. The notebook should be hardbound and all entries are made in waterproof ink.

B. SHIPPING

Shipping is normally by overnight express service (e.g. Federal Express, UPS, Greyhound) and should be scheduled to avoid weekend delivery when possible. Although Saturday delivery by UPS is available, other weekend delivery is not readily available in Newport. Under certain circumstances, however, special arrangements can be made. Shipping containers must be strong and insulated (e.g. plastic ice chests, Styrofoam-insulated corrugated boxes). Samples are shipped on ice (cold packs). Samples should be shipped under chain-of-custody.

C. HANDLING, PRESERVATION AND STORAGE

Upon receipt at the laboratory, samples are immediately logged in by the designated sample custodian (See Section III.C.) Each sample is given a unique sample number with numbers listed consecutively in the sample logbook. The logbook includes all laboratory samples including those not a part of the Aquatic Toxicology Program. Data logged at the time of receipt include the sample number, the sample description, the analysis required, the date and time of collection, the initials of the person collecting the sample, the date and time of receipt at the laboratory, and the initials of the person logging the sample. Upon completion of the analysis, the date and time of analysis, initials of the analyst, sample disposition, date of disposition and initials of the person responsible for the ultimate sample disposition are recorded in the logbook. Samples are stored in designated refrigerators or in a lockable refrigerated (4°C) cold-room. Sediment samples may be stored under nitrogen if required for prolonged storage.

D. HOLDING TIMES

Samples for bioassays are used within prescribed time limits from the date of collection depending on the type of sample and the regulations governing that particular study (e.g. Puget Sound Estuary Program, California State Water Resources Control Board, Washington Department of Ecology,

Oregon Department of Environmental Quality, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, etc.). In general, effluents and receiving waters are tested within 36 hours of the completion of the collection period, and sediments are tested within 14 days of collection. Sediments for bioassays should be stored at 4°C, never frozen or dried. Sediments for certain types of bioassay testing (e.g., Army Corps of Engineers DMMO) may be stored under nitrogen for 6 to 8 weeks. Alternatively, sediments for some projects may be collected and put into containers with no headspace rather than under nitrogen. If the sample holding time for test materials for a project has been or is about to be exceeded, the client is contacted for instructions on whether to proceed. For some projects, the samples are already more than two weeks old when received.

E. SAMPLE ACCEPTANCE/REJECTION

Samples may be deemed unacceptable if: 1) the sample is received after the allowed holding time has elapsed (or so late that a test cannot be started within the time limits); 2) the sample is not properly labeled and identifiable; or 3) the sample container arrived broken or the sample container has had its chain-of-custody seal broken. In the event that one of these events occurs, the client is contacted and informed that the sample is unacceptable and given the options of resampling and resubmitting a sample, having the test run with that sample but with a disclaimer attached for that sample, or dropping that sample from the analysis group.

IV. CHAIN-OF-CUSTODY PROCEDURES

All samples received by Northwestern Aquatic Sciences should be sent under chain-of-custody. A written chain-of custody procedure is available for use upon request. The purpose of this procedure is to maintain an accurate written record that can be used to trace the possession of the sample from the moment of its collection through its final analysis. In addition, this procedure insures that the samples are handled only by authorized and properly trained personnel.

A. GUIDELINES FOR SAMPLE COLLECTION

Each sample should be collected according to the established guidelines for the type of sample and the sampling location. Each sample must have a label attached to it containing the information specified in Section II.A. The sample collector is responsible for the care and custody of the samples until they are transferred to the appropriate laboratory or given to an assigned custodian.

B. TRANSFER OF CUSTODY

When turning over possession of samples, the transferor and the transferee sign, date, and record the time on the chain-of-custody sheet. This record sheet allows the transfer of a group of samples at a time. If the samples arrive at the laboratory when the designated personnel are not there to receive

them, the samples must be put into a secure location and the transfer conducted when the appropriate personnel are present.

C. LABORATORY CUSTODY PROCEDURES

Samples are to be handled by a minimum number of people. For each project the designated sample custodian is the Project Manager (PM) assigned to that particular study. The PM may designate an alternate sample custodian to act in the PM's absence. Samples may be stored in designated refrigerators or stored in a locked cold-storage room at 4°C. Samples are discarded only under the direction of the Project Manager when it is certain that all tests have been properly performed and recorded.

V. DILUTION WATER

The dilution water used in toxicity tests will depend on the type of test, the objectives of the study, and logistical constraints. Individual test protocols and method manuals should be consulted for the proper dilution water to use and the proper pretreatment if any.

In general, marine tests employ Yaquina Bay seawater as the dilution water. Where salinity adjustment is called for, combinations of seawater, seawater brine and/or laboratory deionized water (Milli-Q) may be employed. In some instances artificial sea salts may also be used.

Most freshwater effluent testing is done with either receiving water collected upstream from the effluent outfall or synthetic water made from Milli-Q water and reagent grade chemicals.

In the case of sediment tests for discharge of dredge materials into disposal site waters, water from a reference sediment collection site may be used, depending on the objectives.

VI. TEST ORGANISMS

Test organisms that can be field collected by NAS include amphipods (*Rhepoxynius abronius* and *Eohaustorius estuarius*), clams (*Macoma nasuta*), worms (*Nephtyes caecoides*), shrimp (*Crangon franciscorum* and *Lissocrangon stylirostris*), Dungeness crab juveniles (*Cancer magister*), bay mussels (*Mytilus edulis*), and California or sea mussels (*Mytilus californianus*). Such organisms can be taxonomically identified from appropriate texts by staff members or taxonomists can be consulted at Oregon State University's Hatfield Marine Science Center in Newport, OR.

Many test organisms are purchased from commercial suppliers. Routinely purchased test organisms include blue mussel (*Mytilus* spp.), Pacific oyster (*Crassostrea gigas*), fathead minnow (*Pimephales promelas*), inland silverside (*Menidia beryllina*), sheepshead minnow (*Cyprinodon variegatus*), topsmelt (*Atherinops affinis*) mysid shrimp (*Mysidopsis bahia* and *Holmesimysis costata*), rainbow

trout (*Oncorhynchus mykiss*), amphipods (*Ampelisca abdita*, *Leptocheirus plumulosus*, and *Hyalella azteca*), and juvenile polychaetes (*Neanthes* sp.).

NAS has adequate facilities for culturing both freshwater and marine organisms. Cultured species change in response to test needs. NAS currently maintains cultures of various organisms including the cladocerans *Daphnia magna*, *Daphnia pulex*, and *Ceriodaphnia dubia*, the freshwater amphipod, *Hyalella azteca* and the midge, *Chironomus tentans*.

A record is kept with information on the collection and care of test organisms. The location and date of each collection is recorded along with the species and number of organisms collected, field conditions (e.g., temperature and salinity), initials of persons collecting organisms, and any other pertinent information.

Organisms are transported to the laboratory and held in the laboratory under standard conditions as outlined in the SOPs for collections. Water quality data is kept on separate bench sheets. These data sheets are regularly transferred to a binder for all water quality data on organisms. Organisms are fed according to SOPs and protocols.

VII. FACILITIES, EQUIPMENT, AND ENVIRONMENTAL CONTROL

A. NEWPORT AQUATIC TOXICOLOGY LABORATORY

Northwestern Aquatic Sciences operates aquatic toxicology laboratory facilities in Newport, OR. The facilities include over 5000 ft^2 of offices, wet and dry biological laboratories, refrigerated and frozen storage, an analytical laboratory equipped for GC/MS and other analyses, and storage areas located on a 1.2-acre site adjacent to Yaquina Bay. NAS' Yaquina Bay location gives it direct access to high quality seawater, which may be filtered and UV sterilized as required. The laboratory is also supplied with oil-free compressed air, dechlorinated fresh water, and Milli-Q™ deionized water. All bioassay water is supplied to the laboratory through non-toxic PVC or polyethylene pipe. Temperature-controlled rooms or fiberglass-lined water tables are available for organism maintenance or for the constant temperature control of test containers. Adequate electrical power, circulating water pumps, and heating and refrigeration equipment is available for maximum flexibility and support of aquatic studies.

Test vessels include glass aquaria ranging in size from 3.5 to 60 liters and borosilicate glass beakers ranging in size from 30 ml to 1000 ml. Special glassware is available for flow-through bioassays. Adequate electrical power, circulating water pumps, and heating and refrigeration equipment is available for maximum flexibility and support of aquatic studies and toxicity tests. Continuous flow Mount-Brungs proportional dilutors are available for use in short- and long-term continuous flow bioassays with toxic chemicals or complex wastes.

Instrumentation is available for measurement of conventional water quality parameters (i.e., dissolved oxygen, salinity, conductivity, pH, temperature, hardness, alkalinity, ammonia-N, and sulfide).

Supporting laboratory space and equipment are available such as balances, ovens, inverted and compound microscopes, and a refrigerated centrifuge. The laboratory includes 4°C space for sample chilling and storage.

In addition, NAS has over 500 square feet of modern office space equipped with FAX, internet access, copy machines and a small reference library for support in the toxicity testing program. Offices are equipped to provide everything needed for data reduction and analysis, technical report writing, and other common laboratory and consulting support functions. Networked microcomputers are available for word processing, data analysis and data management. NAS currently has the following software available for data analysis: Microsoft EXCEL 2000, Biostat (U.S. Army Corps of Engineers, Seattle District), ToxCalc v.5.0.23N (Tidepool Scientific), and CETIS software, also by Tidepool Scientific. Efficient literature searching and retrieval is provided through in-house capabilities, as well as access to the Oregon State University library.

B. ENVIRONMENTAL CONTROL

Temperature control of bioassay and culture chambers is achieved by using constant temperature rooms and by immersion of containers in water baths. There are four walk-in temperature-controlled rooms available, each with separate temperature and photoperiod control. Additional testing space is available in the form of temperature-controlled water baths. Water baths are circulated using submersible pumps or by employing a cascading principle for water movement to minimize temperature gradients and stratification. Chilling is accomplished with Blue M portable chillers. Heating employs either stainless steel or Vycor heaters controlled by YSI Model 63RC thermister controllers. Temperature control is easily within the ±1°C limit specified in most bioassay test protocols. Aeration is provided using oil-free air compressors. The laboratory lights are under photoperiod control.

VIII. CALIBRATION PROCEDURES AND FREQUENCY

Analytical measurements routinely used in aquatic toxicology consist of water quality (e.g. temperature, salinity, conductivity, pH, etc.), and weight and volume measurements. Instruments used are properly and frequently calibrated to ensure accurate and reliable measurements. A brief description of the calibration procedures for these instruments is given in this section. All measuring operations and testing equipment having an effect on the accuracy or validity of tests are calibrated and/or verified before putting into use and on a continuing basis.

Calibration frequency and procedures for balances, pH meters, thermometers, and other support equipment are included as part of the procedure manual and/or in standard operating procedures.

A. TRACEABILITY OF CALIBRATION

Wherever applicable, calibration of analytical support equipment and instruments is traceable to national standards of measurement.

B. REFERENCE STANDARDS

Reference standards of measurement (such as Class S or equivalent weights or traceable thermometers) are used for calibration only. Reference standards are subjected to in-service checks between calibrations and verifications. Northwestern Aquatic Sciences maintains a contract with Quality Control Services, Portland, Oregon for regular calibration of reference thermometers (every three years), Class S weights, and laboratory balances (annually).

Standards and other reagents are labeled when received. The label includes receipt date, date opened, and expiration date. Normally reagents expire one year after opening unless otherwise indicated.

C. WATER QUALITY

Temperature is measured to the nearest degree Centigrade using digital or mercury thermometers,. Laboratory thermometers are calibrated annually against a certified Standard Thermometer traceable to National Institute of Standards and Technology (NIST) standards.

Salinity is measured to the nearest 0.5 part per thousand (ppt) using a hand-held temperature-compensated refractometer. The refractometer is zeroed before use and after approximately every twenty measurements.

All pH measurements are made to the nearest 0.1 pH unit using Orion SA250 pH meters and probes. The meters and probes are maintained according to factory specifications. The instrument is calibrated before each day of use with standard buffer solutions that bracket the pH range of the samples (pH 7.0 and 10.0 for seawater samples and pH 7.0 and 4.0 buffers for freshwater samples unless the pH of the samples is expected to be above 7.0). Documentation of satisfactory operation is recorded daily when in use.

Dissolved oxygen is measured to the nearest 0.1 ppm using YSI Model 51B dissolved oxygen meters and probes. The instruments are maintained according to factory specifications and calibrated before each day of use using water-saturated air or air-saturated water as specified in the manufacturer's instructions. Documentation of satisfactory operation is recorded daily when in use.

Specific conductance is measured in umhos/cm using YSI Model 33 S-C-T Meters or an ICM Conductivity Meter. The instruments are maintained according to factory specifications. Operating conditions of the meters (electronic balance and battery condition) are checked prior to each use as specified by the manufacturer. Documentation of satisfactory operation is recorded monthly based on calibration against a NIST traceable standard.

Water hardness and alkalinity are measured in freshwater test solutions using Hach test kits accurate to within 10 mg/L as $CaCO_3$. The kits are based on EPA methods 130.2 and 310.1, respectively, except that the alkalinity measurement employs a chemical indicator rather than an electrometrically determined endpoint of pH 4.5. Measurements are expressed as mg/L of $CaCO_3$. Sulfide and total ammonia-N are also measured when required. The method used for the measurement of total ammonia-N is based on the salicylate colorimetric method of Hach Chemical Co. and was adapted from Clin. Chim. Acta., 14: 403 (1966). The method used for the measurement of dissolved sulfide is the methylene blue colorimetric method based on SM 4500-S^{2-} (Standard Methods 1995, 19th edition) but substituting Hach reagents for color development for those specified in SM 4500-S^{2-}.

D. WEIGHTS AND VOLUMES

Reference toxicants are weighed using an analytical balance accurate to the nearest 0.1 mg. Balances are checked before and after each use using weights traceable to NIST standards. Balances are serviced annually by QC Services, Portland, OR. Effluent and reference toxicant dilutions are made using Class A volumetric flasks and pipettes and graduated cylinders.

IX. TEST ACCEPTABILITY

Test acceptance criteria are specific to the type of toxicity test being performed. The actual test protocol should be consulted in each case. In general, mean mortality in dilution water controls cannot exceed 10-30% in effluent, sediment or reference toxicant tests, depending upon the type of test. Water temperature and other water quality parameters also have criteria for test acceptability which are defined in each test protocol. An individual test may be conditionally acceptable if temperature, DO, and other specified conditions fall outside specifications, depending on the degree of departure and the objectives of the tests. The acceptability of the test will ultimately depend on the best professional judgment of the investigator. Any deviations from test specifications are to be noted when reporting data from the test.

A. DOCUMENTING LABORATORY PERFORMANCE

Reference toxicant tests are used to demonstrate satisfactory laboratory performance. Reference toxicant tests for most test methods are conducted simultaneously with unknown sample toxicity tests. A few test methods have reference toxicant tests run on each batch of animals rather than concurrently with project tests. Control charts are constructed to monitor the performance of bioassay test results using reference toxicants. These charts are used to demonstrate satisfactory laboratory performance. See Section X , D for the use and construction of control charts to evaluate and document laboratory performance.

B. ACCEPTABILITY OF TEST ORGANISMS

In general, test organisms are considered acceptable if: 1) all organisms are from a single group spawned/hatched/released or field-collected at the same time from the same location; 2) their survival in the control of a test using its standard dilution water or control sediment is at least 80 or 90%; and 3) the toxicity values obtained from a reference toxicant test fall within the established intervals on the laboratory's control chart for that reference toxicant/organism combination. Actual individual test protocols should be consulted for individual test acceptability criteria since they are specific each type of test.

C. ACCEPTABILITY OF PHYSICAL/CHEMICAL PROPERTIES OF TEST SOLUTIONS

Conventional water quality parameters (e.g., temperature, dissolved oxygen, pH, salinity or conductivity, alkalinity, hardness, sulfide, and ammonia-N) are measured in at least one replicate of each sample or test concentration at the beginning and end of a test at a minimum for most tests. The specific requirements are listed in individual test protocols. These data are recorded on the raw data sheets for that particular test and the raw data sheets become part of the archived file for that project.

In general, test temperature measurements should be within 1°C of the designated temperature. Dissolved oxygen should not fall below a specified level (usually a percentage of saturation or specific mg/L); if it does, aeration must then be employed (or increased, if already employed). The pH of test materials may need to be adjusted prior to testing depending on the type of test and organism employed. Also depending on the type of test, ammonia and sulfide may need to be monitored at the beginning and end of a test at a minimum and possibly during a test to evaluate their contribution to any test effect.

D. BRINE CONTROLS/SALT CONTROLS

Brine controls should be included in tests that use hypersaline brine to adjust the salinity of effluent dilutions. Brine controls are made using the same volume of brine as is used in the highest effluent concentration. Brines produced by freezing natural seawater are preferable to brines made by evaporation or by addition of commercial sea salt formulations, although any of these methods may be used. SOPs are available for brine preparation and for brine volume calculations.

Control and brine control results are compared using a t-test or ANOVA. The effluent toxicity test is acceptable if there is no significant difference at the $p=0.05$ level. It may be advisable to test the organism's response to specific brines before attempting their use in a full effluent toxicity test.

Similarly, salt controls are used when sea salts have been used to adjust the salinity of effluents. Salt controls are prepared by using the same amount of sea salts as is used in the highest effluent concentration.

X. LABORATORY DOCUMENTATION

Quality assurance programs are dependent on timely and accurate record keeping. Documentation of QA checks and procedures provide proof of performance and a reference to guide future work. This section describes the types of records to be kept and assigns responsibility for record keeping. The laboratory maintains a signature/initial log of all laboratory staff so that personnel initialing any work can be identified.

A. TEST METHODS AND STANDARD OPERATING PROCEDURES (SOPs)

SOPs are documents that contain detailed information on the requirements for the correct performance of laboratory and other procedures. NAS maintains a master list of SOPs that reflect its current and former programs, as well as allowing for growth. The QAO and Lab Director are responsible for developing, writing, and approving SOPs. The types of SOPs at NAS include administrative sops, QA sops, general data sops, microbiology sops, chemistry sops, and toxicology sops. Within the toxicology sops there are currently eight categories of SOPs:

- Laboratory Equipment, Supplies and Materials
- General Laboratory Practices
- QC Program
- Test Methods - WET Testing
- Test Methods - Freshwater Sediment
- Test Methods - Marine Sediment
- Animal Culture and Collection Methods
- Data Analysis, Management, and Reporting

The SOPs at NAS are considered proprietary and not to be given out. For each test method, there is a test protocol that is followed and appended to the final report. The test protocols may be provided to the client for review and/or signature prior to starting a project.

There are three controlled copies of all officially approved SOPs: QA, laboratory, and NAS library. All SOPs are approved by the QA Officer before being implemented. The distribution of current SOPs and archiving of outdated ones is controlled through the QA Officer. Each SOP has a cover sheet with its SOP number, inception date, current revision date, title, file name, references, distribution list, revision summary, and dates and signatures of the Laboratory Director/Technical Director and QAO.

B. LABORATORY BENCH SHEETS

Laboratory bench sheets are used to document information from many routine laboratory operations. For example bench sheets are used to collect required data for all bioassay tests. Other examples of the use of bench sheets include: 1) the collection of culture data; 2) recording data for test animal collections; and 3) laboratory systems operations. Bench sheets are used to insure that the information

is recorded in a complete and organized manner and that the test or other procedure can be reconstructed, if necessary.

All entries to laboratory bench sheets are made in black water-proof ink. No erasures are made on the original data sheets. Corrections are made by crossing one line through the incorrect entry and writing the correct entry, an explanation for the correction, the date, and the initials of the person correcting the error. Error correction codes may be used in explaining corrections.

C. LABORATORY NOTEBOOKS

Laboratory notebooks are used to document information that cannot easily be recorded on bench sheets. Laboratory notebooks are typically maintained for sample logbooks, reagent logbooks, and project notebooks for the collection of data not suitable for bench sheets. Each page in a laboratory notebook is initialed and dated as information is entered. Notebook pages are numbered prior to use. Notebook entries and corrections are made as with bench sheets (see Section IX. B.).

D. CONTROL CHARTS

Control charts are constructed to monitor the performance of bioassay test results using reference toxicants. These charts are used to demonstrate satisfactory laboratory performance. Control charts are prepared for each reference toxicant, test species, test condition, and endpoint combination, and successive toxicity values are plotted and examined to determine if the results are within prescribed limits. A minimum of five reference toxicant tests is needed for constructing a control chart. After two years or a minimum of 20 data points, the control chart is maintained using only the 20 most recent points. The mean and upper and lower control limits ($\pm$ 2 S) are recalculated with each successive test result. If the toxicity value from a given test with a reference toxicant does not fall in the expected range, this is not an automatic cause for rejection of the effluent or sediment test. Chance alone would cause one in 20 tests to fall outside the limits at the $P_{0.05}$ probability level. If more than one out of 20 reference toxicant test fall outside the control limits, the source of the variability is investigated, corrective actions are taken to reduce the variability and another reference toxicant test is performed as soon as possible. If the cause of the outlier can be documented, the outlier should be excluded from future calculations of the control limits. If two or more consecutive tests fall outside the control limits, the results must be explained and the reference toxicant test repeated.

E. PROJECT FILES

A project file is created for each project handled within the laboratory. The project file contains all documents associated with the project. This includes correspondence from the client, chain-of-custody records, raw data, test protocols, bench sheets, copies of laboratory notebook entries pertaining to the project, and a copy of the final report. When a project is complete, all records are passed to the QA Officer who inventories the file, checks for completeness, and puts the file into document archive.

F. CONFIDENTIALITY

Often during the course of business, NAS is privy to data or information that is considered confidential or proprietary to our clients. Such information includes results of their tests, origin of their samples, the fact that we are working with them, any procedures or processes that they conduct or investigate, any information about them or their business, our own laboratory procedures, and clients. All such information must be kept strictly confidential. The information should only be discussed with people designated as technical contacts or purchasing agents for the particular project or corporate officers for the clients' company. The information should not be discussed with anyone else, even people within a client's company not designated as a contact, without written permission from the client.

Access to laboratory records and data is limited to laboratory personnel except with the permission of the QA Officer or Laboratory Director.

Where clients require transmission of test results by telephone, telex, facsimile or other electronic or electromagnetic means, staff will ensure confidentiality is preserved

XI. REPORTING OF TEST RESULTS

The final report of the test results should include all of the following standard information at a minimum: name and identification of the test including a reference to the test protocol; the names of the investigator(s) and laboratory; information on the sample(s) including date of receipt, the type of sample, storage information and any chain-of-custody records; information on the test or dilution water; detailed information about the test organisms including source and acclimation or culture conditions; a description of the experimental design and test chambers and other test conditions including water quality; information about any aeration that may have been required; definition of the effect criteria and other observations; responses, if any, in the control treatment; tabulation and statistical analysis of measured responses; a description of the statistical methods used; any unusual information about the test or deviations from procedures; the results of associated reference toxicant tests.

XII. PERFORMANCE AND SYSTEM AUDITS

NAS participates in available federal and state accreditation and performance audit programs that subject the laboratory to stringent system and performance audits. A system audit is a review of laboratory operations conducted to verify that the laboratory has the necessary facilities, equipment, staff, and procedures in place to generate acceptable data. A performance audit verifies the ability of the laboratory to provide accurate toxicity test results using samples submitted by the auditing agency.

NAS is currently accredited for toxicity testing with the State of Washington (Lab Accreditation No.C1238). The State of Oregon does not currently require accreditation for toxicology laboratories

although they have started to implement NELAC on a voluntary basis. NAS has participated in the EPA DMR Performance Evaluation of aquatic toxicology laboratories since 1991. NAS has also qualified by performance evaluation testing to participate in Effluent Toxicity Characterization Program studies for the San Francisco Bay Region, California Regional Water Quality Control Board, and has participated in several interlaboratory testing projects.

NAS performs biennial internal audits of the aquatic toxicology laboratory and is occasionally required by specific projects to be audited by the client or a third party QA consultant.

XIII. CORRECTIVE ACTION

When errors, deficiencies, or out-of-control situations exist, the QA Program provides systematic procedures, called "Corrective Actions," to resolve problems and restore proper functioning to the analytical system.

Laboratory personnel are alerted that corrective actions may be necessary if:

1. Annual Performance Evaluation test results are unacceptable;
2. Control organism performance (survival, growth, etc.) does not meet acceptance criteria;
3. Reference toxicant test results exceed control chart limits;
4. Deficiencies are detected during routine QA reviews; or
5. Inquiries concerning data quality are received from clients.

Corrective action procedures are often handled at the bench level by the project toxicologist through review of the records of test water quality, test organism acclimation or culture conditions, preparation of test solutions and other applicable test records. If the problem persists or cannot be identified, the matter is referred to the project manager, laboratory supervisor, and/or QA Officer for further investigation. Once resolved, full documentation of the corrective action procedure, should be described in a formal Corrective Action Report and filed with the QA unit. Corrective action documentation is routinely reviewed by management. Further information on corrective action is available in SOPs.

IVX. REFERENCES

ASTM. 2001. Annual book of ASTM standards. Section 11: Water and environmental technology, Vol. 11.05. Biological Effects and Environmental Fate; Biotechnology Pesticides. American Society of Testing and Materials, Philadelphia, PA,.

California State Water Resources Control Board. 1990. Marine toxicity test quality assurance and quality control. 15pp.

Clin. Chim. Acta., 14: 403 (1966).

Moore, D.W., Dillon, T.M., Word, J.Q., and Ward, J.A. 1994. Quality assurance/quality control (QA/QC) guidance for laboratory dredged material bioassays; Results of QA/QC workshop held May 26-27, 1993, in Seattle, Washington, Misc. Paper D-94-3, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Puget Sound Estuary Program. 1995. Recommended guidelines for conducting laboratory bioassays on Puget Sound sediments. Prepared for: U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, WA and Puget Sound Water Quality Authority, Olympia, WA.

Standard Methods. 1995 (19th edition). Methods 4500-S^{2-} A, B, D, F, & H. Introduction, Separation of Soluble and Insoluble Sulfides, Methylene Blue Method, Iodometric Method, and Calculation of Un-ionized Hydrogen Sulfide.

US EPA. 1991. Evaluation of dredged material proposed for ocean disposal: testing manual. U.S. Environmental Protection Agency, Office of Marine and Estuarine Protection, Washington, D.C. and Department of The Army, U.S. Army Corps of Engineers, Washington, D.C. EPA-503/8-91/001.

US EPA. 1995. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to west coast marine and estuarine organisms. U.S. Environmental Protection Agency, National Exposure Research Laboratory, Office of Research and Development, Cincinnati, Ohio, EPA/600/R-95-136.

US EPA. 1998. Evaluation of dredged material proposed for discharge in waters of the U.S. - testing manual: Inland testing manual. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, D.C. and Department of The Army, U.S. Army Corps of Engineers, Washington, D.C., EPA-823-B-98-004.

US EPA. 2002. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. U.S. Environmental Protection Agency, Office of Water. EPA-821-R-02-014.

US EPA. 2002. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms. Fourth Edition. U.S. Environmental Protection Agency, Office of Water. EPA-821-R-02-013.

US EPA. 2002. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. Fifth Edition. U.S. Environmental Protection Agency, Office of Water, EPA-821-R-02-012.

APPENDIX B
FOCUSED PRG LIST

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Table 1 - Near Final **EPA List of Focused PRGs** for the FS from 4 March, 10 March, and 17 March 2010 Meetings with LWG Meeting Notes.

Chemical	Line of Evidence	Va				litional 10 and 17 March LWG Notes
Metals						
Arsenic	Eco Benthic - PEL SQG	17	mg/kg	No FPM SQG exists	Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Arsenic	Background DW UPL	3.97	mg/kg		Site-wide hilltop	
Cadmium	FPM High SQG	3.51	mg/kg		Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Chromium	Eco Benthic - PEL SQG	90	mg/kg	No FPM SQG exists	Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Copper	Eco Benthic - PEC SQG	149	mg/kg	This is lower than the FPM low SQG of 493 mg/kg	Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Copper	Eco Benthic - FPM High SQG	562	mg/kg	Including both FPM and PEC is inconsistent with other decisions for most chemicals	Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Lead	Eco Benthic - PEL SQG	91.3	mg/kg	No FPM SQG exists	Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Mercury	Eco Benthic - FPM High SQG	0.41	mg/kg		Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Nickel	Eco Benthic - PEL SQG	36	mg/kg	No FPM SQG exists	Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Silver	Eco Benthic - FPM High SQG	1.72	mg/kg		Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
TBT	Eco - Fish Dietary Assessment - Small Mouth Bass	5.93	mg/kg-OC	Covers all other TBT PRGs except sculpin below.	1 RM	
TBT	Eco - Fish Dietary Assessment - Sculpin	3.78	mg/kg-OC	Weak Line of Evidence	AOPC development - point by point, BERA - 1/10th rivermile	EPA would like to retain this PRG but acknowledges that there are uncertainties regarding sculpin exposure in deeper non-nearshore areas that can be discussed in the FS. EPA was unclear how the large additional area included outside the current localized AOPC boundaries should be handled in the FS (i.e., expansion of localized AOPCs or part of site-wide AOPC). EPA also agreed that the LWG can evaluate data density and quality issues in the FS.
Zinc	Eco Benthic - PEL SQG	315	mg/kg	No FPM SQG exists	Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
PAHs						
B(a)p	HH Clam Consumption, High Consumption Rate 18 g/day, 10^-5	5.9	mg/kg-OC	Weak Line of Evidence	1 RM, excluding navigation channel, (E and W separate)	EPA considered making alternative water depth or consumption exposure assumptions but prefers using assumptions consistent with the risk assessment.
B(a)pEq	HH Tribal Fisher In-water Direct Contact 10^-6 (cPAH)	423	µg/kg	Cut off at AOPC lines per EPAs June 2009 AOPC development rules	1/2 RM, excluding navigation channel, (E and W separate)	EPA indicated that cutting areas at the AOPC boundary lines is not a rigid rule and the LWG should understand that the future boundary lines might vary somewhat based on the distribution of the chemical concentrations. The exact methods for the LWG to determine these variations is unclear.

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Table 1 - Near Final **EPA List of Focused PRGs** for the FS from 4 March, 10 March, and 17 March 2010 Meetings with LWG Meeting Notes.

Chemical	Line of Evidence	Value	Units	Notes	Exposure Area	Additional 10 and 17 March LWG Notes
B(a)pEq	HH HF Fisher Beach Sediment Direct Contact 10^-6 (cPAH)	162	µg/kg		Beach Type	EPA considered whether this PRG would be part of the site-wide AOPC or not. They decided that because BaP clam consumption PRG above highlights this same area, that there is no additional area created and this BaP beach PRG should be included as part of the localized AOPCs.
Total LPAHs	Eco Benthic - FPM High SQG	9300	µg/kg		Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Total PAHs	Eco Benthic - PEC SQG	22800	µg/kg	No FPM SQG exists	Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
SVOCs						
4-methylphenol	Eco Benthic - FPM High SQG	96	µg/kg	Issues of High Non-Detect and/or High Non-Detect Frequencies	Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Benzyl Alcohol	Eco Benthic - FPM High SQG	36	µg/kg		Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Carbazole	Eco Benthic - FPM High SQG	1100	µg/kg		Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Phenol	Eco Benthic - FPM High SQG	120	µg/kg		Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Phthalates						
Diethyl Phthalate	Eco Benthic - FPM Low SQG	120	µg/kg	EPA said use FPM high, but one does not exist, so FPM Low is shown	Point by Point	EPA would prefer is some more relevant chemical or phthalate were provided by the FPM model. EPA indicated that the chemical list available from the FPM model should be further considered in the FS comprehensive benthic approach.*
PCBs						
Total PCBs	HH Adult Fish Consumption - Small Mouth Bass - Low IR - 10^-4	29.5	µg/kg	Cut off at AOPC lines per EPAs June 2009 AOPC development rules	1 RM	EPA indicated that cutting areas at the AOPC boundary lines is not a rigid rule and the LWG should understand that the future boundary lines might vary somewhat based on the distribution of the chemical concentrations. The exact methods for the LWG to determine these variations is unclear.
Total PCBs	Background DW UPL	17	µg/kg	Cut off at AOPC lines per EPAs June 2009 AOPC development rules	Sitewide Hilltop	EPA indicated that cutting areas at the AOPC boundary lines is not a rigid rule and the LWG should understand that the future boundary lines might vary somewhat based on the distribution of the chemical concentrations. The exact methods for the LWG to determine these variations is unclear.
Total PCBs	Eco Benthic - FPM High SQG	500	µg/kg		Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Dioxin Furans						
2,3,4,7,8 PCDF	Eco Bird Dietary Assessment - Sandpiper Worms	0.0541	µg/kg		Beach Type	Sandpiper PRGs should be mapped to sand piper beaches. (Not wide shoreline seidments in general).

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Chemical	Line of Evidence	Value	Units	Notes	Exposure Area	Additional 10 and 17 March LWG Notes
2,3,4,7,8 PCDF	HH Adult Fish Consumption, Small Mouth Bass Low IR, 10^-4	0.00106	µg/kg		1 RM	EPA agreed to move the 10^-5 PRG to the site-wide AOPC, but would like to continue to look at the 10^-4 PRG within the localized AOPCs.
2,3,4,7,8 PCDF	Eco - Mink Multi-Species Diet	0.056	µg/kg		1 RM	
Pesticides						
Total Chlordane	HH Fish Consumption - Large Home Range Single Species High IR, Low BA 10^-6	1.87	µg/kg		Study Area	
delta-HCH	Eco Benthic - FPM High SQG	2.35	µg/kg		Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Aldrin	HH Fish Consumption - Large Home Range Single Species High IR, Low BA 10^-6	0.84	µg/kg		Study Area	Given that a very small area maps out for PRG that is totally covered by other PRGs, the LWG may want to consider accepting this PRG.
Dieldrin	Eco Benthic - FPM High SQG	21.5	µg/kg		Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Endrin	Eco Benthic - FPM High SQG	20.8	µg/kg		Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Endrin Ketone	Eco Benthic - FPM High SQG	8.5	µg/kg		Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Gamma HCH	Eco Benthic - PEL SQG	1.38	µg/kg	Issues of high Non-Detect (923 of 1106 samples in BERA dataset were non-detect). No FPM SQG exists	Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Sum DDD	Eco Benthic - PEC SQG	28	µg/kg	No FPM SQG exists	Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Sum DDE	Eco Benthic - PEC SQG	31.3	µg/kg	No FPM SQG exists	Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Sum DDE	HH Adult Fish Consumption, Small Mouth Bass Low IR, 10^-5	8.8	µg/kg		1 RM	
Sum DDT	Eco Benthic - PEC SQG	62.9	µg/kg	No FPM SQG exists	Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*
Total DDX	Eco Benthic - FPM High SQG	218	µg/kg		Point by Point	Benthic SQG that will be further evaluated in comprehensive benthic approach.*

*EPA has not yet fully agreed to allow LWG to embark upon the comprehensive benthic approach to mapping areas of benthic toxicity.

PRGs where there is disagreement between LWG and EPA and have significant impact on the current AOPC boundaries.

PRGs referenced in EPA's AOPC Development Rules, June 2009

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Table 2 - Near Final **EPA List PRGs that Have Been Moved to the Site-Wide AOPC** for the FS from 4 March, 10 March, and 17 March 2010 Meetings with LWG Meeting Notes.

Chemical	Line of Evidence	Value	Units	Notes	Exposure Area	Additional 10 and 17 March LWG Notes
PAHs						
B(a)p	Background DW UPL	15.32	ug/kg	EPA using background as surrogate to cover widespread PAH concentrations.	Site-wide hilltop	EPA agreed that this would be part of the site-wide AOPC.
2,3,4,7,8 PCDF	HH Adult Fish Consumption, Small Mouth Bass Low IR, 10^-5	0.00106	µg/kg	Causes large additional area at a risk level inconsistent with decisions on similar PRGs.	1 RM	EPA agreed that this PRG could be moved to the site-wide AOPC concept.
2,3,4,7,8 PCDF	Background DW UPL	0.0005	µg/kg	Causes large additional area at a risk level inconsistent with decisions on similar PRGs.	Site-wide hilltop	EPA agreed that this PRG could be moved to the site-wide AOPC concept.
Pesticides						
Dieldrin	Bioaccumulation or Background value	TBD	TBD		TBD	EPA indicated that Dieldrin background value should become part of the site-wide AOPC. Background is a surrogate for a bioaccumulation-based PRG.
SumDDE	Background DW UPL	1.72	µg/kg	Unclear why this would be mapped outside AOPC boundaries but total PCBs would not.	Sitewide Hilltop	EPA agreed that mapped by this PRG outside current AOPC boundaries would be added to the site-wide AOPC concept (similar to current approach on total PCB background PRG).

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Table 3 - Near Final **EPA List of PRGs That Are No Longer Proposed for Use.**

Chemical	Line of Evidence	Value	Units	Notes	Exposure Area	Additional 10 and 17 March LWG Notes
Metals						
Mercury	Background DW UPL	0.0532	mg/kg	EPA contemplated using background as surrogate for absence of mercury fish	Site-wide hilltop	EPA decided that it was not reasonable to remediate mercury to background levels and removed this potential PRG from the list.

*EPA has not yet fully agreed to allow LWG to embark upon the comprehensive benthic approach to mapping areas of benthic toxicity.

APPENDIX C
DRAFT DATA SCREENING FIGURES (ARCGIS CD FORMAT)

CLARIFICATION OF DRAFT DATA SCREENING FIGURES

EPA's May 4, 2010, comments on the *Draft Project Area Identification Report and Data Gaps QAPP* regarding the screening levels were discussed during the June 3, 2010, monthly coordination meeting held between NW Natural, Siltronic, EPA, and DEQ. During this discussion, EPA stated that pending comments on the Portland Harbor Site Risk Assessment would affect the screening levels required for use in this Final AIR. In addition, NW Natural and DEQ are currently negotiating the upland risk assessment for the Gasco site, which may also affect the screening levels.

To facilitate incorporation of these pending screening level changes into the data screening of the existing data set, EPA approved postponement of the revised data screening until the Portland Harbor Site Risk Assessment comments are available and the upland risk assessment negotiations are complete. Because the results of the revised data screening will not affect delineation of the proposed initial Project Area and data gaps sampling, EPA also approved submittal of this Final AIR and the attached Final Data Gaps QAPP (Appendix A) without revision to the existing data screening. The screening levels and all associated tables will be revised once pending comments on the Portland Harbor Site Risk Assessment are received and the upland risk assessment negotiations are complete.

HOW TO USE GIS LAYERS

An ESRI ArcReader is required to view the GIS layers included in Appendix C of this Final AIR. This software can be downloaded at the following Web site:
http://www.esri.com/software/arcgis/arcreader/download.html

Once the files are opened, any of the individual layers can be turned on and off by checking and unchecking the boxes. To see what layers are available to view, click on the "+/-" button next to the name of the layer. It is also possible to zoom in and zoom out of the document by clicking on the magnifying glass icon in the toolbar.

APPENDIX D
DRAFT DATA TABLES (ON CD)

Clarification of Draft Data Tables

EPA's May 4, 2010, comments on the *Draft Project Area Identification Report and Data Gaps QAPP* regarding the screening levels were discussed during the June 3, 2010, monthly coordination meeting held between NW Natural, Siltronic, EPA, and DEQ. During this discussion, EPA stated that pending comments on the Portland Harbor Site Risk Assessment would affect the screening levels required for use in this Final AIR. In addition, NW Natural and DEQ are currently negotiating the upland risk assessment for the Gasco site, which may also affect the screening levels.

To facilitate incorporation of these pending screening level changes into the data screening of the existing data set, EPA approved postponement of the revised data screening until the Portland Harbor Site Risk Assessment comments are available and the upland risk assessment negotiations are complete. Because the results of the revised data screening will not affect delineation of the proposed initial Project Area and data gaps sampling, EPA also approved submittal of this Final AIR and the attached Final Data Gaps QAPP (Appendix A) without revision to the existing data screening. The screening levels and all associated tables will be revised once pending comments on the Portland Harbor Site Risk Assessment are received and the upland risk assessment negotiations are complete.

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APPENDIX D-1
DATA SUMMARY TABLES

APPENDIX D-2
EXISTING DATA SCREENING TABLES