Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

QUALITY ASSURANCE PROJECT PLAN:
SURVEY AND SAMPLING OF LOWER DUWAMISH WATERWAY SEEPS

FINAL

For submittal to:

The US Environmental Protection Agency
Region 10
Seattle, WA

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, WA

June 25, 2004

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TITLE AND APPROVAL PAGE
SURVEY AND SAMPLING OF LDW SEEPS
QUALITY ASSURANCE PROJECT PLAN

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Name Date

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Ecology Project Manager ______________________________ ______________

Name Date

Distribution List

This list identifies all individuals to receive a copy of the approved QA Project Plan, either in hard copy or electronic format, as well as any subsequent revisions.

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Joanna Florer, Windward Field Coordinator

Chemistry Laboratory Managers:

- Frank Colich (Frontier Geosciences, Inc.)
- Susan Dunnihoo (Analytical Resources, Inc.)

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- Jennie Goldberg, City of Seattle

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APPENDIX TABLES AND FIGURES

Acronyms

Acronym	Definition
%RSD	percent relative standard deviation
ARI	Analytical Resources, Inc.
ASTM	American Society for Testing and Materials
CAS	Chemical Abstracts Services
COC	chain of custody
CSC	confirmed and suspected contaminated sites
DQI	data quality indicator
DQO	data quality objective
EPA	US Environmental Protection Agency
FC	field coordinator
FEP	fluorinated ethylene propylene
Frontier	Frontier Geosciences, Inc.
GC-ECD	gas chromatograph-electron capture detection
GPC	gel permeation chromatography
GPS	global positioning system
HSP	health and safety plan
LCS	laboratory control sample
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
LIMS	laboratory information management system
MDL	method detection limit
MHHW	mean higher high water
MLLW	mean lower low water
NAD	North American datum

Acronym	Definition
NAPL	non-aqueous phase liquid
NTU	nephelometric turbidity unit
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PM	project manager
PSEP	Puget Sound Estuary Program
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RL	reporting limit
RM	river mile
RO	reverse osmosis
RPD	relative percent difference
SDG	sample delivery group
SMS	Washington State Sediment Management Standards
SQS	Sediment Quality Standards
SVOC	semivolatile organic compound
T-117	Terminal 117
TM	task manager
TOC	total organic carbon
TPH	total petroleum hydrocarbons
USACE	US Army Corps of Engineers
VOC	volatile organic compound
WAAS	Wide Area Augmentation System

1.0 Introduction

This quality assurance project plan (QAPP) describes the quality assurance (QA) objectives, methods, and procedures for conducting a reconnaissance survey and subsequent seep sampling in the Lower Duwamish Waterway (LDW) study area. These data will be used to support the source evaluation in the LDW remedial investigation (RI) as described in the Phase 2 work plan (Windward 2004). Section 3.1.4 of the Phase 2 work plan presented a preliminary study design for the seep survey, sampling, and chemical analyses to provide all stakeholders with a common understanding of the objectives, background, and general study design. This QAPP presents the study design, including details on project organization, field data collection, laboratory analysis, and data management.

US Environmental Protection Agency (EPA) guidance for QAPPs was followed in the preparation of this project plan (EPA 2002). This plan is organized into the following sections:

- Section 2 – project management
- Section 3 – data generation and acquisition
- Section 4 – assessment and oversight
- Section 5 – data validation and usability
- Section 6 – references

Appendix A is a health and safety plan (HSP) designed to protect on-site personnel from physical, chemical, and other hazards posed by the field sampling effort. Appendix B contains the locations where seeps will be sampled for chemical analyses and a summary of the rationale for seep selection. Appendix C contains a summary of existing seep data and comparisons of those data to Washington State water quality standards. Appendix D contains a list of all organic compounds[1] that will be analyzed, including laboratory method detection limits (MDLs) and reporting limits (RLs).

2.0 Project Management

This section describes the overall management of the project, including project organization, key personnel, problem definition and background, project description and summary, quality objectives and criteria, special training requirements and certification, and documents and record keeping.

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[1] The list of metals, including their MDLs and RLs, is located in Table 3-7.

2.1 PROJECT ORGANIZATION

The overall project organization and the individuals responsible for the various tasks required for the seep reconnaissance survey and seep sample collection and analysis are shown in Figure 2-1. Responsibilities of these individuals are described in the following sections.

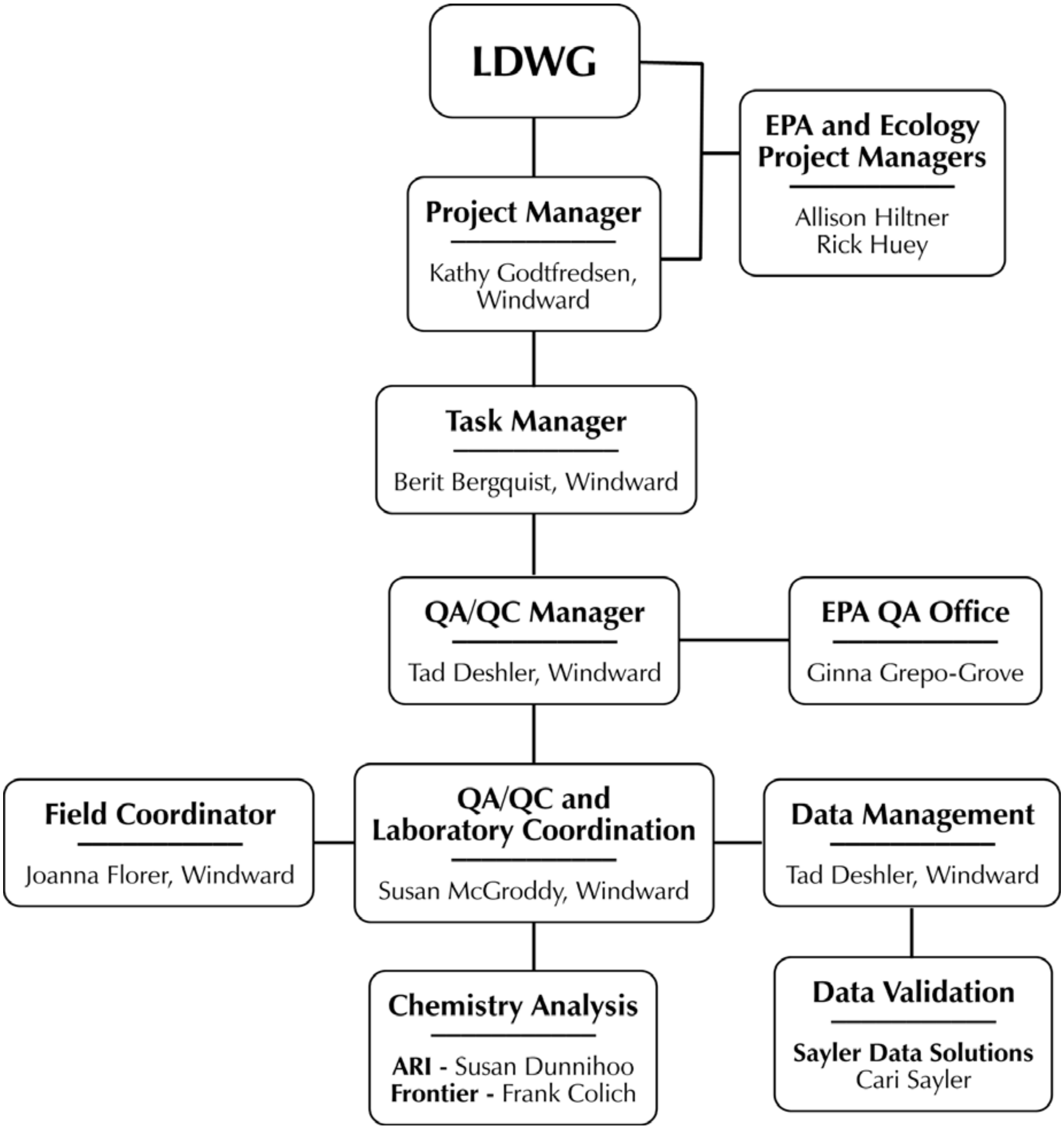

Figure 2-1. Project organization

2.1.1 Project management

The Lower Duwamish Waterway Group (LDWG), Allison Hiltner (the EPA Project Manager [PM]), and Rick Huey (the Washington Department of Ecology PM) will be involved in all aspects of this project, including discussion, review, and approval of the QAPP, and interpretation of the results of the investigation.

Kathy Godtfredsen will serve as the Windward PM. The PM is responsible for overall project coordination and provides oversight on planning and coordination, production of work plans, production of all project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. The PM is also responsible for coordinating with LDWG and EPA's and Ecology's PMs on schedule, deliverables, and other administrative details. The PM can be reached as follows:

Kathy Godtfredsen
Windward Environmental LLC
200 W. Mercer St., Suite 401
Seattle, WA 98119
Telephone: 206.577.1283
Facsimile: 206.217.0089
Email: kathyg@windwardenv.com

Berit Bergquist will serve as the Windward Task Manager (TM). The TM is responsible for project planning and coordination, production of work plans, production of all project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. The TM is responsible for communicating with the PM on progress of project tasks and any deviations from the QAPP. Significant deviations from the QAPP will be further reported to representatives of LDWG, EPA, and Ecology. The TM can be reached as follows:

Berit Bergquist
Windward Environmental LLC
200 W. Mercer St., Suite 401
Seattle, WA 98119
Telephone: 206.577.1291
Facsimile: 206.217.0089
Email: beritb@windwardenv.com

2.1.2 Field coordination

Joanna Florer will serve as the Windward Field Coordinator (FC). The FC is responsible for day-to-day technical oversight, and collecting and submitting environmental samples to the designated laboratories for chemical analyses. All field activities will be performed under the direction of the FC.

The FC will be responsible for all decisions concerning sample collection and for quality assurance/quality control (QA/QC) oversight, ensuring that appropriate protocols for sample collection, preservation, and holding times are observed. Deviations from this QAPP will be reported to the TM for consultation. The FC can be reached as follows:

Joanna Florer
Windward Environmental LLC
200 W. Mercer St., Suite 401
Seattle, WA 98119
Telephone: 206.577.1294
Facsimile: 206.217.0089
Email: joannaf@windwardenv.com

2.1.3 Quality assurance/quality control

Tad Deshler of Windward will oversee QA/QC for the project. As the QA/QC manager, he will provide oversight for both the field sampling and laboratory programs, and supervise data validation and project QA coordination.

The QA/QC manager can be reached as follows:

Tad Deshler
Windward Environmental LLC
200 W. Mercer St., Suite 401
Seattle, WA 98119
Telephone: 206.577.1285
Facsimile: 206.217.0089
Email: tad@windwardenv.com

The QA/QC manager will provide all necessary information to EPA's QA office so that EPA can independently evaluate data quality. Ginna Grepo-Grove will be EPA's QA office representative for this project. She can be reached as follows:

Ginna Grepo-Grove
US Environmental Protection Agency, Region 10
1200 6th Avenue
Seattle, WA 98101
Telephone: 206.553.1632
Email: grepo-grove.gina@epa.gov

Susan McGroddy will serve as Windward's QA/QC and laboratory coordinator. The QA/QC and laboratory coordinator will ensure that samples are collected and documented appropriately and will coordinate with the analytical laboratories to ensure that QAPP requirements are followed.

The QA/QC and laboratory coordinator can be reached as follows:

Susan McGroddy
Windward Environmental LLC
200 W. Mercer St., Suite 401
Seattle, WA 98119
Telephone: 206.577.1292

Facsimile: 206.217.0089
Email: susanm@windwardenv.com

Independent third-party data review and validation will be provided by Cari Sayler of Sayler Data Solutions. She can be reached as follows:

Cari Sayler
Sayler Data Solutions, Inc.
14257 93rd Court NE
Bothell, WA 98011
Telephone: 425.820.7504
Email: cari@saylerdata.com

2.1.4 Laboratory project management

Susan McGroddy of Windward will serve as the laboratory coordinator. Analytical Resources, Inc. (ARI) and Frontier Geosciences, Inc. (Frontier) will perform chemical analyses on the seep samples. Frontier will conduct analyses for metals and low-level mercury. ARI, the primary laboratory, will perform all other analyses. The laboratory PM at ARI can be reached as follows:

Susan Dunnihoo
Analytical Resources, Inc.
4611 S. 134th Place, Suite 100
Tukwila, WA 98168-3240
Telephone: 206.695.6207
Email: sue@arilabs.com

The laboratory PM at Frontier can be reached as follows:

Frank Colich
Frontier Geosciences, Inc.
414 Pontius Ave. N.
Seattle, WA 98109
Telephone: 206.622.6960
Email: frankc@frontiergeosciences.com

The analytical laboratories will accomplish the following:

- adhere to the methods outlined in this QAPP, including those methods referenced for each analytical procedure
- adhere to documentation, custody, and sample logbook procedures
- implement laboratory QA/QC procedures defined in this QAPP
- meet all reporting requirements
- deliver electronic data files as specified in this QAPP
- meet turnaround times for deliverables as described in the QAPP

- coordinate with EPA and the QA/QC contractor to perform laboratory and data audits

2.1.5 Data Management

Tad Deshler will oversee data management to ensure that analytical data are incorporated into the LDWG database with appropriate qualifiers following acceptance of the data validation. QA/QC of the database entries will ensure accuracy for use in Phase 2.

2.2 PROBLEM DEFINITION/BACKGROUND

The LDW Phase 1 RI (Windward 2003a) presents a summary of current LDW conditions using information gathered from previous studies. Based on the Phase 1 RI and the subsequent data needs memorandum (Windward 2003b), an evaluation of the potential for chemical discharge to the LDW through groundwater seeps was identified as a data need. To address this data need, it was determined in the Phase 2 work plan (Windward 2004) that seep samples would be collected at selected locations along the waterway and analyzed for various chemicals. The objective of the seep sampling plan as outlined in the Phase 2 RI work plan is to evaluate whether seep discharges below mean higher high water (MHHW) [2] and above mean lower low water (MLLW) may contribute to chemical loading to the LDW, either through dissolved phase, colloidal phase, or product phase. If results of chemical analyses of seep water indicate that seep discharges are contributing to chemical loading to the LDW, then additional seeps may be selected for sampling in the future either as part of the Phase 2 RI, as site-specific source evaluations, or as part of the source control work being conducted by the Lower Duwamish Source Control Work Group. The seep chemistry results will also be used to determine whether additional surface sediment samples are needed from seep areas.

Seep water chemical data have been collected at four sites along the LDW as part of other investigations conducted between 1995 and 2003 (Table 2-1).[3] These sites are Rhône-Poulenc, Boeing Plant 2, Terminal 117 (T-117), and Great Western International (Figure 2-2). A summary of seep data from these sites is presented in Appendix C, which includes comparisons of seep water concentrations to Washington State marine chronic water quality standards. The quality of these data, along with associated existing sediment data and the current understanding of potential sources in the area, were considered in determining whether the existing seep data were sufficient or whether additional data were needed in a particular area with existing seep data for the purposes of characterizing those seeps as potential sources of chemicals to the LDW. The seeps that have been sampled to date represent only a subset of the seeps

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[2] The Source Control Work Group is responsible for implementation plans for source characterization above MHHW.

[3] Seep water data were also collected at the Boeing Isaacson site at RM 3.7 east in 2000, but only one sample was collected and it was analyzed only for arsenic.

present along the LDW shoreline. Additional seeps may be present with the potential to transport chemicals to the LDW from groundwater. The following section provides an overview and schedule for the field sampling events to collect additional information involving seeps.

Table 2-1. Summary of previous seep sampling events

SITE	LOCATION	NUMBER OF SEEPS SAMPLED	DATE SAMPLED	DATA SOURCE	SAMPLING METHOD	ANALYTICAL METHODS AND ANALYTES	QA/QC
Boeing Plant 2	RM 2.9-3.6 east	18	3/23/95 – 7/12/95	Weston 1998	Capture of flow into sampling container	EPA 6010 (total and dissolved metals); EPA 8260 (VOCs); EPA 8270 (SVOCs and PAHs); WTPH-418.1 (total petroleum hydrocarbons)	Summary data validation was performed
Great Western International[a]	RM 2.3-2.4 east	6	4/28/94	Kavanagh 2004	na	EPA 8260 (VOCs)	na
		2	7/22/94	Kavanagh 2004	na	EPA 8260 (VOCs)	na
		8	11/04/94	Kavanagh 2004	na	EPA 8260 (VOCs)	na
		7	5/15/95	Kavanagh 2004	na	EPA 8260 (VOCs)	na
		7	10/27/95	Kavanagh 2004	na	EPA 8260 (VOCs)	na
		5	12/11/96	Kavanagh 2004	na	EPA 8260 (VOCs)	na
		4	11/04/97	Kavanagh 2004	na	EPA 8240A (VOCs)	Summary data validation was performed
		10	4/28/98	Kavanagh 2004	na	EPA 8260 (VOCs)	Summary data validation was performed
		9	11/06/98	Kavanagh 2004	na	EPA 8260B (VOCs)	Summary data validation was performed
		5	10/29/99	Kavanagh 2004	na	EPA 8260C (VOCs); EPA 8270C (SVOCs and PAHs); EPA 8270-SIM (pentachlorophenol)	Full data validation was performed
Rhône-Poulenc[b]	RM 4.0-4.2 east	7	3/23/95	Rhône-Poulenc 1996	PVC pipe was placed horizontally out from the bank and directed into the sample container; or a small hole was dug and a container was dipped into the hole and contents were transferred to the sample container	EPA 160.1 (TDS); EPA 415.1 (TOC); EPA 6010 (total metals); EPA 8240 (VOCs); EPA 8270 (SVOCs); EPA 8080 (pesticides/PCBs); EPA 8315A (formaldehyde);EPA 8150 (herbicides); EPA 8140 (organophosphorus pesticides); EPA 7197/218.4 (hexavalent chromium)	Data validation was partial, consisting of review of QC summary forms and noting any QC limit exceedances

SITE	LOCATION	NUMBER OF SEEPS SAMPLED	DATE SAMPLED	DATA SOURCE	SAMPLING METHOD	ANALYTICAL METHODS AND ANALYTES	QA/QC
T-117[c]	RM 3.5-3.7 east	3	12/23/03	Windward et al. 2004	Funnel with attached tubing was used to direct flow into sample container	EPA 6010B (metals); EPA 8082 (PCB Aroclors); EPA 415.1 (TOC); EPA 106.2 (TSS); EPA 7471 (mercury); EPA 8270 (SVOCs and PAHs)	Full data validation was performed

na – not available

RM – river mile

TSS – total suspended solids

[a] A total of ten seeps were sampled; some of the seeps were sampled on more than one date

[b] Data are available only for detected chemicals (metals, bis(2-ethylhexyl)phthalate, and formaldehyde)

[c] One seep was re-sampled on 4/08/04

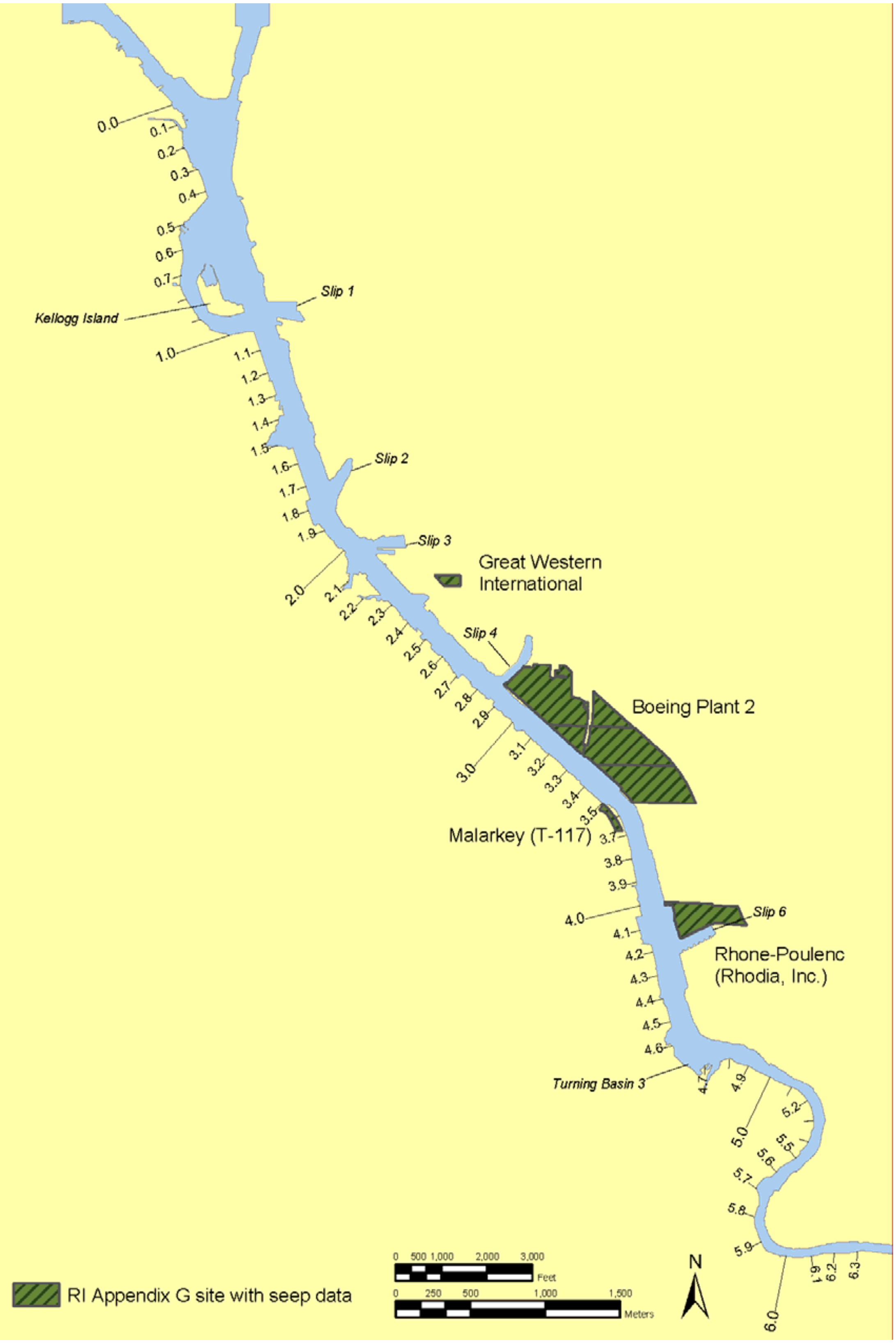

Figure 2-2. LDW seep survey area and sites with existing seep water data

2.3 PROJECT DESCRIPTION AND SCHEDULE

To meet the objective presented in Section 2.2, two field events will be conducted. First, a reconnaissance survey will be conducted to identify seeps, make observations of visual characteristics, and collect field measurements of conventional water quality parameters at as many seeps as possible during the survey period, including at least one major seep per area with high seepage.

The reconnaissance survey will be conducted from May 5 to 7, 2004. These survey dates were selected because of the negative tides that occur during this period. Surveying during these low tides will maximize the observable intertidal area and will ensure that tidal hydrostatic pressure has diminished to allow seep flows to reach maximum rates. The survey area includes all shoreline areas accessible by boat along the LDW from River Mile (RM) 0.0 to RM 5.0,[4] which is the upstream boundary of the area in which chemical concentrations in sediment in excess of the Washington State Sediment Quality Standards (SQS; WAC 173-204-310(1)(a)) have been previously measured, as summarized in the Phase 1 RI report (Figure 2-2).

During the reconnaissance survey, information will be collected at as many seeps as possible during the survey period. In an area where multiple seeps are flowing, one seep will be selected that is considered representative of conditions in that area. Selected seep locations will be recorded with a global positioning system (GPS) and marked with stakes. Characteristics to be observed at the staked seeps will include visual characteristics such as staining or discoloration, oily or other sheen, bacterial slime, odor, or the presence of waste material. Field measurements will include salinity, temperature, pH, dissolved oxygen, conductivity, and oxidation-reduction potential.[5] The flow rate also will be estimated. Video footage will be recorded and photographs will be taken at each staked seep location. These observations and field data will be used in a weight-of-evidence approach to identify a subset of target seeps for chemical analysis in consultation with EPA and Ecology at a meeting on May 25, 2004. Other information that will be considered in the weight-of-evidence approach includes potential upland sources and existing sediment, groundwater, and seep chemical data.

The second field event is scheduled for June 29 to July 2, 2004. The purpose of this field event is to collect water samples from selected seeps for chemical analyses. Seep water samples will be analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), organochlorine pesticides, polychlorinated biphenyls (PCBs) as Aroclors, and metals. For seeps potentially containing non-aqueous phase

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[4] Seeps within the T-117 early action area were not staked or assessed during the reconnaissance survey because seep water samples were recently collected prior to this QAPP and a full data validation was conducted (Windward et al. 2004).

[5] The ability to estimate flow rate and general water quality parameters at all seeps during the reconnaissance survey will depend on the nature of the seep and the sampling window available because of tidal constraints.

liquid (NAPL), total petroleum hydrocarbons (TPH) will also be analyzed (see Section 3.1.2). These data will be used to evaluate whether the selected seeps may be discharging chemicals to the LDW. These data also will be used to determine whether additional seep sampling is needed, and whether specific surface sediment sampling locations need to be identified in the surface sediment QAPP based on the seep water chemical data. The determination of whether additional sediment samples are required will be made through consultation with EPA and Ecology, and documented in the surface sediment QAPP.

Rainfall has been lower this spring than the most recent 16-year average (Figure 2-3). Thus, some stakeholders have expressed concern that some seeps may not be observed this spring because of the drier than normal conditions, particularly in February, March, and April. To assess this concern, available rainfall and groundwater level data from 1994-1995 and from this year were evaluated, as discussed below.

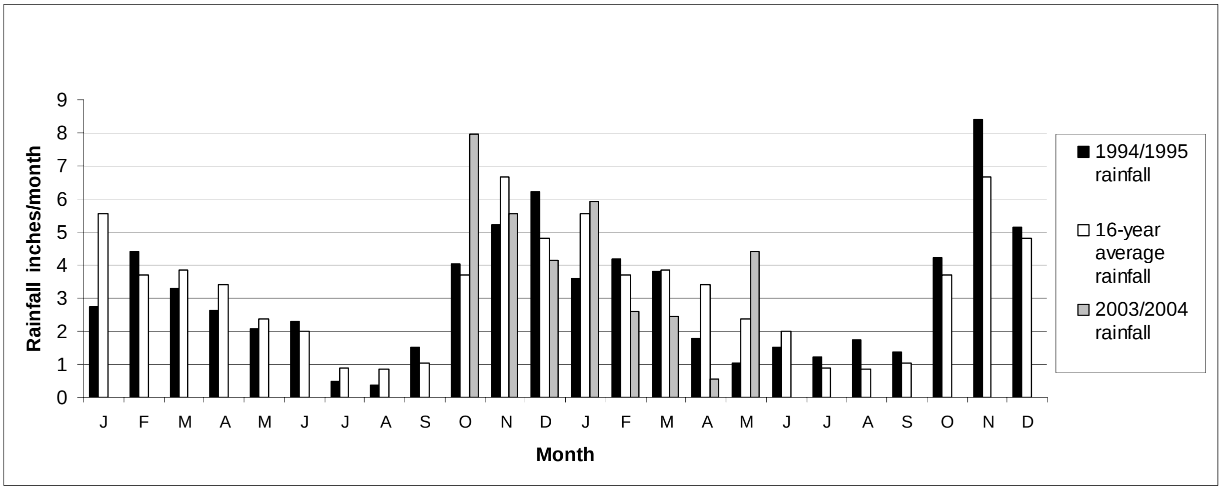

Figure 2-3. Monthly rainfall at Auburn, Washington in 1994/1995 and 2003/2004 relative to the 16-year average

Rainfall data for January 1994-December 1995, October 2003-May 2004, and the 16-year average from King County's rain gage in Auburn, are all presented in Figure 2-3. Rainfall was substantially higher than the 16-year average in October 2003 and May 2004,[6] but lower in February through April of 2004. Table 2-2 shows cumulative rainfall for February through April and October through May for 1994/1995, 2003/2004, and the 16-yr average. The cumulative rainfall from October 2003 through May 2004 was 0.5 in. lower than the 16-year average, whereas cumulative rainfall from October 1994 through May 1995 was 4.2 in. lower than the 16-year average.

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[6] May 2004 rainfall was almost twice the 16-year average rainfall for May.

Table 2-2. Cumulative rainfall (in.) at Auburn, Washington in 1994/1995 and 2003/2004 relative to the 16-year average

YEAR	FEBRUARY TO APRIL	OCTOBER TO MAY
1994/1995	11.0	29.9
2003/2004	5.6	33.6
16-year average	9.8	34.1

The seasonal variations in groundwater levels were evaluated using data from 1994 and 1995 collected as part of the Boeing Plant 2 Comprehensive Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI; Weston 1998). Two groundwater monitoring wells, from the northern (PL2 -270A) and southern (PL2-319A) portion of the facility, were selected for this analysis. These monitoring wells are located along the eastern edge of the Plant 2 facility where tidal effects are negligible. The RFI report presents the groundwater elevations for September 1994, March 1995, August 1995, and November 1995. As shown in Table 2-3, groundwater elevations varied by about 1.5-2.0 ft seasonally in each monitoring well. The groundwater elevations measured in March 2004 were 8-11 in. less than levels measured in March 1995.

Table 2-3. Groundwater elevations at Boeing Plant 2 monitoring wells

	GROUNDWATER ELEVATION (ft above MLLW)[a]				
MONITORING WELL	SEPTEMBER 1994	MARCH 1995	AUGUST 1995	NOVEMBER 1995	MARCH 2004
PL2-270A	7.9	9.4	8.0	8.7	8.6
PL2-319A	9.0	10.9	9.4	9.8	9.9

[a] Groundwater elevations were adjusted to MLLW by adding 6.1 ft to the NGVD 29 references used in the RFI report.

Most of the seeps observed during the reconnaissance survey were emerging in the mid-to-lower intertidal zone. Based on the groundwater elevations of 8.6 to 9.9 ft relative to MLLW measured in March 2004, and the relatively minor seasonal variations in groundwater elevation in 1994-1995, it is not expected that groundwater levels in May 2004 would have been so low that seeps within the intertidal zone would be dry. Therefore, it does not appear that the lower than normal rainfall this spring would have a significant effect on the ability to identify or sample seeps as outlined in this QAPP.

2.4 QUALITY OBJECTIVES AND CRITERIA FOR CHEMICAL MEASUREMENT DATA

The overall data quality objective (DQO) for this project is to develop and implement procedures that will ensure the collection of representative data of known, acceptable, and defensible quality. Parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity. These parameters are discussed in detail in Section 3.4. In addition, specific data quality indicators (DQIs) for each laboratory analysis and for field measurements are presented in Section 3.4.

2.5 SPECIAL TRAINING/CERTIFICATION

The Superfund Amendments and Reauthorization Act of 1986 required the Secretary of Labor to issue regulations through the Occupational Safety and Health Administration (OSHA) providing health and safety standards and guidelines for workers engaged in hazardous waste operations. Regulation 29CFR1910.120 requires 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.

2.6 DOCUMENTATION AND RECORDS

This section describes documentation and records kept during field activities and laboratory analysis. In addition, the data reduction process and contents of the data report are described.

2.6.1 Field observations

Field observations will occur during both the reconnaissance survey and the seep sample collection. All field activities will be recorded in a field logbook maintained by the FC. The logbook will provide a description of all field activities, conferences associated with field activities, field personnel, weather conditions, and a record of all modifications to the procedures and plans identified in this QAPP and the HSP (Appendix A). The field logbook will consist of bound, numbered pages. All entries will be made in indelible ink. The field logbook is intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the sampling period.

The following information will be recorded on the seep survey and sample collection forms (Forms 3 through 5) attached to the end of this QAPP:

- project name and task designation
- date and time of surveying or sample collection and name of person filling out form
- names of crew members
- weather conditions
- location ID number
- location GPS coordinates
- location bearings using object, distance, and direction from location
- description of the substrate which the seep flows through or onto
- qualitative description or quantitative measurement of seep flow rate

- seep observations (e.g., bacterial slime, oily or other sheen, staining, obvious smells, colored or milky discharge, density or viscosity differences, formation of precipitates, vegetation)
- general description of embankment substrate including indications of the possible presence of anthropogenic fill or waste material (e.g., bedding that directs seepage, fine-grained strata causing perched groundwater, buried channels, ditches or other discontinuities that facilitate groundwater seepage, evidence of ephemeral seep flows [gullies, drying vegetation])
- description of seep location relative to vertical changes in embankment or beach substrate
- photograph ID numbers
- conventional water quality parameter results
- a rough schematic diagram showing seep, stake, shoreline, object used for measurements, and other pertinent site features

Any deviations from the field procedures specified in this QAPP will be documented on the Protocol Modification Form (Form 1) attached to the end of this QAPP.

2.6.2 Laboratory records

Laboratories will be responsible for internal checks on sample handling and analytical data reporting, and will correct errors. Any corrective actions that are required by the laboratory will be documented on the Corrective Action Form (Form 2) attached to the end of this QAPP. Close communication will be maintained with the laboratories to resolve any QC problems in a timely manner. The laboratory data package will include the following:

- **Project narrative**: This summary, in the form of a cover letter, will present any problems encountered during any aspect of analysis. The summary will include, but not be limited to, discussion of quality control, sample shipment, sample storage, and analytical difficulties. Any problems encountered, actual or perceived, and their resolutions will be documented in as much detail as necessary. In addition, instrument operating conditions used for the analysis of each suite of analytes, and definitions of laboratory qualifiers, will be provided.
- **Records**: Legible copies of the chain-of-custody (COC) forms will be provided as part of the data package. This documentation will include the time of receipt and the condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory also will be documented.
- **Sample results**: Data packages will be submitted for both full and summary data validation. The full data validation packages will include all raw data. The summary 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 extraction/digestion
  - date and time of analysis
  - weight and/or volume used for analysis, including final dilution volumes or concentration factor for the sample
  - identification of the instruments used for analysis
  - method reporting and quantitation limits
  - all data qualifiers and their definitions

- **QA/QC summaries:** These summaries will contain the results of all QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results (see above). The laboratory will make no recovery or blank corrections. The required summaries are listed below; additional information may be requested.
  - Calibration data summary will contain the concentrations of the initial calibration and daily calibration standards and the date and time of analysis. The response factor, percent relative standard deviation (%RSD), percent difference, and retention time for each analyte will be listed, as appropriate. Results for standards to indicate instrument sensitivity will be reported.
  - Performance summary report for each instrument will contain a list of the samples for which the performance checks are applicable.
  - Internal standard area summary will report the internal standard areas, as appropriate.
  - Method blank analysis summary will report the method blank analysis associated with each sample and the concentrations of all compounds of interest identified in these blanks.
  - Surrogate spike recovery summary will report all surrogate spike recovery data for organic analyses. The names and concentrations of all compounds added, percent recoveries, and QC limits will be listed.
  - Matrix spike recovery summary will report the matrix spike or matrix spike/matrix spike duplicate recovery data for analyses, as appropriate. The names and concentrations of all compounds added, percent recoveries, and QC limits will be included in the data package. The relative percent differences (RPDs) for all matrix spike and matrix spike duplicate analyses will be reported.

  - Matrix duplicate summary will report the RPDs for all matrix duplicate analyses. The quality control limits for each compound or analyte will be listed.
  - Laboratory control analysis summary will report the results of the analyses of laboratory control samples. The QC limits for each compound or analyte will be included in the data package.
  - Relative retention time summary will report the relative retention times for the primary and confirmational columns of each analyte detected in the samples, as appropriate.
- **Original data:** Electronic copies of the original data generated by the laboratory will be provided, including the following:
  - sample refrigerator temperature logs
  - sample extraction/digestion, preparation, and cleanup logs
  - instrument specifications and analysis logs for all instruments used on days of calibration and analysis
  - reconstructed ion chromatograms for all samples, standards, blanks, calibrations, spikes, replicates, and laboratory control samples
  - final GC-ECD (gas chromatograph-electron capture detection) chromatograms used in the quantification of the sample
  - raw and enhanced spectra of detected compounds with associated best-match spectra for each sample
  - printouts and quantitation reports for each instrument used, including reports for all samples, standards, blanks, calibrations, spikes, and replicates
  - original data quantification reports for each sample

The contract laboratory for this project will submit data electronically, in Microsoft Excel® or delimited text format. Guidelines for electronic data deliverables for chemical data are as follows:

- Each row of data will contain only one analyte for a given sample. Therefore, one complete sample will require multiple rows.
- Each row will contain the following information at a minimum: Windward sample identifier, sample matrix, laboratory sample identifier (if used), date of sampling, date of laboratory analysis, laboratory method, analyte name, measured result, laboratory qualifiers, units, and measurement basis.
- If using a spreadsheet file to produce the electronic deliverable, the value representing the measured concentration or detection limit will be rounded to show the correct number of significant figures and will not contain any trailing digits that are hidden in the formatting.

- If using a database program to produce the electronic deliverable, the value representing the measured concentration or detection limit will be stored in a character field, or a field in addition to the numeric result field will be provided to define the correct number of significant figures.
- If a result for an analyte is below the detection limit, the laboratory qualifier will be U, and the value in the result column will be the sample-specific detection limit.
- Analytical results of laboratory samples for QA/QC will be included and clearly identified in the file with unique laboratory sample identifiers. Additional columns may be used to distinguish the sample type (e.g., matrix spike, matrix spike duplicate).
- If replicate analyses are conducted on a submitted field sample, the laboratory sample identifier must distinguish among the replicates.
- Wherever possible, all analytes and replicates for a given sample will be grouped together.

An example of the acceptable organization of the electronic deliverable for analytical chemical data is provided in Table 2-4.

Table 2-4. Example of acceptable organization of electronic deliverable for chemical data

FIELD NAME	REQUIRED OR OPTIONAL
Event name	required
Chain of custody ID	required
Laboratory sample ID	required
Matrix	required
Sample collection date/time	required
Requested analysis	required
Analyte	required
Chemical Abstracts Services (CAS) registry number	required
Date/time analyzed	required
Detection limit	required
Reporting limit	required
Reporting limit type	required
Sample result	required
Units	required
Significant figures	required
Laboratory qualifier	optional[a]
Analysis batch	required
True value/spiked amount	optional
Percent recovery	optional[a]
Upper limit	optional
Lower limit	optional
Analyst	required

FIELD NAME	REQUIRED OR OPTIONAL
Dilution	required
Extraction batch	required
Extraction date/time	required
Extraction method	required
Laboratory notes	optional[a]
Laboratory	required

[a] Required when available. Not all samples are qualified. Blanks and laboratory control samples (LCSs) have no percent moisture. Field samples have no percent recovery.

2.6.3 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 PM, the Windward PM, the Project QA/QC Coordinator, and independent reviewers. The data will be generated in a form amenable to review and evaluation. 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.

2.6.4 Data report

A data report will be prepared by Windward documenting all activities associated with the collection, handling, and analysis of samples. At a minimum, the following will be included in the data report:

- brief review of the study design and methods for both the reconnaissance survey and the seep water chemistry sampling and analyses
- data tables and maps summarizing the field events, including the following information:
    - seep locations identified in the reconnaissance survey and the seep water chemistry survey
    - seep water chemistry sampling locations
    - seep observations from the reconnaissance survey
    - conventional water quality parameter results from the reconnaissance survey and the seep water chemistry sampling event
    - summary of seep water chemistry results[7]
    - precipitation data from April 1, 2004 through July 2, 2004 from King County's Auburn rain gauge, or another appropriate local rain gauge

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[7] Field duplicate results will be reported as averages on maps and as individual results in data tables.

- deviations from the approved QAPP
- copies of field logs (appendix)
- data validation report (appendix)
- tables of all raw data (appendix)

Chemical data packages will be received from the laboratories within four weeks of the date the last sample was submitted. Chemical data will be validated within three weeks of receiving data packages from the respective laboratories. A draft data report, including electronic versions of the data, will be submitted to EPA and Ecology five weeks after receipt of the validated analytical results. A final data report will be submitted four weeks after receiving comments on the draft report.

3.0 Data Generation and Acquisition

This section describes the methods that will be used to conduct a seep reconnaissance survey and to collect seep water samples for chemical analyses. Elements include sampling design, seep surveying and sampling methods, sample handling and custody requirements, decontamination procedures, analytical methods, quality control, instrument/equipment testing, inspection and maintenance, instrument calibration, inspection/acceptance of supplies, and data management.

3.1 STUDY DESIGNS

This section presents the study designs for conducting a seep reconnaissance survey, identifying target seeps for chemical analyses, collecting seep samples, and performing chemical analyses.

3.1.1 Reconnaissance survey

During the reconnaissance survey, a list of seep observations and locations will be compiled. In addition, conventional water quality parameters will be measured at each seep, if feasible, as discussed in Section 2.3. The survey will be conducted May 5 to May 7, 2004 following agency approval of QAPP elements associated with the reconnaissance survey, as presented in this section and in Sections 2.1.1, 2.1.2, 2.6.1, and 3.2.1. Negative tides (i.e., below MLLW) occur on each of these survey dates. The survey will be conducted only during the time when tidal elevations are at or below +1 ft MLLW, which provides approximately 4.5 hours on May 5 (9:45 am to 2:15 pm), 5 hours on May 6 (10:15 am to 3:15 pm), and 5 hours on May 7 (11:00 am to 4:00 pm), for a total of 14.5 hours to conduct the reconnaissance survey (NOAA 2004).[8]

Two boats will be used for the reconnaissance survey. Seeps will be located by observing the shoreline from the first boat situated as close as possible to shore. In

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[8] Tidal information is based on tide tables. Actual water measurements cannot be made using in-water staff gauges located in the LDW because these gauges are out of the water at low tide.

addition, an attempt will be made by field personnel on the first boat to re-locate the seven major seeps identified by the City of Seattle during an outfall survey conducted in May and July of 2003, as shown in Figure 3-1. When a seep is selected, field personnel from the first boat will access the shoreline, mark with a stake the best general area of the seep for taking samples, establish the location with both GPS and compass bearings on fixed objects, and take photos and video footage. At marked seeps,[9] field personnel on the second boat will:

- estimate[10] flow rate
- collect seep water to measure conventional water quality parameters
- record seep observations (e.g., bacterial slime, oily or other sheen, staining, obvious smells, colored or milky discharge, density or viscosity differences, formation of precipitates, vegetation)
- document general embankment substrate, including the presence of possible waste material (e.g., bedding that directs seepage, fine-grained strata causing perched groundwater, buried channels, ditches or other discontinuities that facilitate groundwater seepage, evidence of ephemeral seep flows [gullies, drying vegetation])[11]

In addition, field personnel on the second boat will measure the conductivity, temperature, dissolved oxygen, pH, and salinity of LDW water (at both the surface and 1 m below the surface) at a frequency of approximately one location per river mile, as time allows.

All information collected during the reconnaissance survey, including a map of seep locations, will be submitted to the agencies on May 18, 2004. This information will then be used in the selection of seeps for sampling for chemical analyses, as described in the following section.

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[9] All marked seeps will be assessed by field personnel on the second boat only if time allows (see discussion in Section 3.2.1).

[10] Visual observations will be recorded and qualitative flow rate estimates will be made during the reconnaissance survey. A quantitative estimate of flow rate, relative to other seeps in the survey, will be made during the subsequent seep water chemistry sampling event at seeps where water samples are collected (see Section 3.2.2.4).

[11] Presence of anthropogenic materials within the soil, soil discoloration, or other unusual soil characteristics will be noted as possible indicators of anthropogenic fill or waste material.

Figure 3-1. Potential sources of groundwater contaminants to the Lower Duwamish Waterway that have been identified to date

Wind Ward environmental LLC

Prepared by SMS 3/11/04 Map 1274 updated by RAC 05/17/04 Map 1374
W:\Projects\00-08-06_Duwamish_RI\data\gis\Seep survey

3.1.1.1 Reconnaissance survey results

Results from the reconnaissance survey observations or measurements will be used in the process of selecting seeps to be sampled for chemical analyses. Copies of field seep forms, a map, and photos will be submitted to EPA and Ecology no later than May 18, 2004, so this material can be reviewed prior to the sampling location meeting on May 25, 2004. The following information will be provided:

- locations of all seeps observed
- observed characteristics at the seep
- the presence of anthropogenic fill or waste material
- estimated flow rate
- water quality parameters (e.g., conductivity)
- seep type (examples of some seep types might include linear seepage at base of embankment, point seepage at foot of beach, or seepage surrounding outfall pipe)

3.1.1.2 Potential sources

Among other considerations, the selection process for identifying which seeps should be sampled for chemical analyses will consider the following source information:[12]

- the location of a seep relative to any potential upland sources of chemicals in groundwater
- the nature and extent of upland contamination in the potential source area (if sufficient data are available)
- the known or potential presence of a hydrologic connection between the potential chemical source area and the seeps

Figure 3-1 shows potential sources of chemicals in groundwater, as identified in Appendix G of the Phase 1 RI (Windward 2003a), in the Source Control Work Group's source matrix (Flint 2003), and on Ecology's list of confirmed and suspected contaminated (CSC) sites.[13] Sites from the Source Control Work Group's source matrix were included on the map if the site is on the CSC list, or if any information presented in the source matrix indicated potential source issues of concern. These sites were mapped by determining the tax parcel associated with the address presented in the source matrix.

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[12] Note that the extent of available information is limited for potential upland sources and potential hydrogeologic connections. All source information available from the Source Control Work Group was incorporated into seep selection as part of the May 25, 2004 meeting.

[13] Additional areas of concern not identified in Figure 3-1, but noted by stakeholders, include Crowley Marine Services and the First Avenue South Property at the northeast corner of Slip 4.

3.1.1.3 Existing sediment, groundwater, and seep data

Existing sediment, groundwater, and seep data will be considered in the selection process to identify seeps for chemical analyses. Figure 3-1 shows locations with existing surface sediment chemical data used in Phase 1. Exceedances of Washington State Sediment Management Standards (SMS) at locations near seeps identified during the reconnaissance survey will be considered in selecting seeps for chemical analyses at the May 25, 2004 meeting.

Recent groundwater data were presented and evaluated in Appendix G of the Phase 1 RI (Windward 2003a) for 12 upland sites (Figure 3-1). These data will be used to evaluate the nature and extent of chemicals in groundwater, and the known or potential presence of a hydrologic connection between the potential chemical source area and the seeps. Thus, these data will also be considered in determining the need for chemical sampling at seeps that may be located downgradient from these 12 sites.

As discussed in Appendix G of the Phase 1 RI, seep data have been collected at four sites along the LDW as part of other investigations at Rhône-Poulenc, Boeing Plant 2, T-117, and Great Western International (Figure 3-1).[14] If these data are judged to be of sufficient scope and quality for use in Phase 2, additional seep data may not be needed at these locations. Important considerations for use of existing data include the sufficiency of analyte lists and the level of data validation, as summarized in Table 2-1. It is expected that additional seep data will not be needed at locations with fully validated data and acceptable documentation. A summary of the existing seep data and comparisons to Washington State marine water quality standards are presented in Appendix C of this QAPP. This information will be considered in the selection process for seeps to be sampled for chemical analyses, and will be discussed at the seep sampling decision meeting on May 25, 2004.

3.1.2 Seep water sample collection and chemical analyses

Seep water sampling for chemical analyses is scheduled to occur between June 29 and July 2, a period in which the lowest tides will be approximately 2 to 4 ft below MLLW. The sampling will be conducted only when tidal elevations are at or below +1 ft MLLW, resulting in approximately 3.25 hours on June 29 (7:00 am to 10:15 pm), 5.25 hours on June 30 (7:30 am to 12:15 pm), 5.25 hours on July 1 (8:00 am to 1:15 pm), and 5.25 hours on July 2 (8:45 am to 2:00 pm), for a total of 19 hours to conduct the seep water sampling (NOAA 2004).

Conventional water quality parameter measurements of seep water will be conducted in the field, including conductivity, turbidity, temperature, dissolved oxygen, pH, salinity, and oxidation-reduction potential, as described in Section 3.2.1.3. These conventional water quality parameters will also be measured in surface water of the

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[14] Seep water data were also collected at the Boeing Isaacson site at RM 3.7 east in 2000, but only one sample was collected and it was analyzed for arsenic only.

LDW, adjacent to a subset of the seeps sampled, at the surface and at a depth of 1 m below the surface.

Seep water samples will be collected and analyzed for conventional parameters (including turbidity), VOCs, SVOCs (including polycyclic aromatic hydrocarbons [PAHs] and 1,4-dioxane), PCB Aroclors, organochlorine pesticides, and metals.[15] TPH will also be analyzed in a subset of the seeps where NAPL may be present. NAPL is considered potentially present if a sheen or petroleum odor has been observed at a particular seep during the reconnaissance survey. Observations of potential NAPL presence during the seep reconnaissance are presented in Appendix B. The seep water samples that will be analyzed for TPH based on these observations are listed in Section 3.2.2.

Turbidity will be measured at each seep to determine whether a seep sample should be filtered prior to chemical analyses.[16] If the turbidity is greater than 5 nephelometric turbidity units (NTUs), then samples will be filtered prior to analysis because there would be reason to believe that the sampling method entrained sediment that is not present in undisturbed groundwater flow. Samples for SVOCs, PCBs, and organochlorine pesticide analyses will be filtered in the laboratory through a 1-µm glass fiber filter and samples for mercury will be filtered in the laboratory through a 1-µm polyethylsulfone filter to remove non-colloidal particles greater than 1 µm that may have been introduced into the seep water by the sampling method.[17] Samples for metals (except mercury) analyses will be filtered through a 0.45-µm nitrocellulose filter to represent the dissolved fraction for comparison to Washington State dissolved water quality standards.

If the turbidity of the seep sample is less than or equal to 5 NTU, both unfiltered and filtered samples will be analyzed to determine what particle size fraction is associated with the chemicals, with the exception of VOC samples, which will not be filtered regardless of turbidity. Groundwater can transport chemicals in the dissolved phase, associated with colloids (i.e., particles less than 1 µm in size), and sorbed to particles up to 2 µm (Vance 2004). Clay particles in surface sediment are defined as particles with a grain size less than 2 µm. Thus, particles that are greater than 1 µm but less than 2 µm could potentially be transported in groundwater and can be captured as entrained sediment during the seep water collection process. Therefore, information regarding unfiltered and filtered concentrations of chemicals, and information regarding nearby sediment quality, total suspended solids, and nearby potential

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[15] A complete list of metals is presented in Table 3-7, and a complete list of organic compounds is presented in Appendix D.

[16] Only total (unfiltered) samples will be analyzed for VOCs.

[17] A 0.45-µm filter size is used to define the dissolved fraction for comparison to dissolved water quality standards. Therefore, the seep water fractions filtered through a 1-µm filter are still considered "total" fractions for comparison to water quality standards for mercury and organic compounds, which represent total recoverable values.

groundwater sources, are all helpful in assessing the source of the contamination (i.e., groundwater or entrained sediment).

For samples collected from locations with the potential presence of NAPL, both the unfiltered sample and the filtered sample (1-µm glass fiber filter) will be analyzed for TPH, SVOCs, and PCBs. If seep water samples contain a visible NAPL phase, then an additional sample will be collected in the container type specified for TPH analysis. The NAPL will be separated from the water in the laboratory using a separatory funnel, and will be diluted and analyzed for TPH, SVOCs, and PCBs.

3.2 SAMPLING METHODS

All field activities will be performed under the direction of the Windward FC or other oversight personnel, as determined by LDWG, EPA, and Ecology.

3.2.1 Reconnaissance survey

On May 4, 2004, prior to conducting the reconnaissance survey, both east and west shorelines of the LDW from RM 0.0 to 5.0 will be observed by boat during a negative tide (0 ft MLLW or below) to note general location of seeps, a rough approximation of the number of seeps, and locations where seeps are at particularly low elevations. This information could be used to determine if prioritization by seep elevation is needed, and how the prioritization scheme would be designed to optimize the survey.

The reconnaissance survey will be conducted on May 5 to 7, 2004 by field crews in two boats beginning at RM 2.0 (1st Avenue bridge) on the east side of the LDW and moving to the south to RM 5.0. The west side of the waterway will then be surveyed moving to the north from RM 5.0 to RM 0.0, and then the remainder of the east side will be surveyed (i.e., RM 0.0 to RM 2.0). When a seep is located, field personnel from the first boat will access the shoreline to identify GPS coordinates, mark the best seep sampling location with a polyvinyl chloride (PVC) stake, take bearings, and sketch a rough schematic diagram of the seep's location relative to landmarks (Section 3.2.1.2). Field personnel from the second boat will then access the shoreline at locations with stakes to make visual observations (seep water characteristics, flow rate, and possible presence of waste material) and collect seep water for measurement of conventional water quality parameters.

The use of two boats will maximize efficiency of the survey, which needs to be completed within the 14.5 hours (over three days) available for sampling during water levels less than +1 ft MLLW, as discussed in Section 3.1.1. If seeps were equally spaced along each shoreline of the LDW, covering approximately 10 river miles, each river mile would have to be surveyed in about 90 minutes. If there are a large number of seeps within a particular segment of the LDW, it may take longer than 90 minutes per river mile to estimate flow rates and make water quality measurements at each seep. If this situation arises, prioritization of seeps for field data collection will be determined in consultation with the agency field representative present on the first boat. Field personnel on the first boat will be in communication with field personnel on the second boat to relay decisions made about which marked seeps to sample. In addition, a second Hydrolab will be brought on the survey, so personnel on the first boat can assist with Hydrolab measurements if they have extra time after marking and documenting seep locations. In addition to marking seeps for identification by the second boat during the reconnaissance survey, the stakes will serve to identify seep locations for possible seep water sample collection in late June/early July and to mark locations for possible surface sediment sampling at a later date, which will be identified as part of the surface sediment QAPP. In the event that a stake disappears between the time of the reconnaissance survey and subsequent seep water or surface sediment sampling, it will be possible to relocate the seep through: 1) GPS coordinates, 2) compass bearings on fixed objects that were recorded during the reconnaissance survey, and 3) information on the rough schematic diagram of the seep area. Collection of surface sediments at any of these locations will depend on the results of the seep survey and seep water chemical analyses, and will be determined in consultation with EPA and Ecology.

Prior to the reconnaissance survey field event, the following materials will be assembled:

- stainless-steel shovel
- phosphate-free detergent and scrub brush
- beaker for seep water field data collection
- Hydrolabs, with extra membranes for the dissolved oxygen probe
- field forms and field notebook with pens
- digital cameras and a ruler (for scale)
- binoculars
- cell phones for communicating between the boats
- flexible plastic sheeting
- video camera
- GPS unit
- PVC stakes with marker to identify location ID
- laser measuring device
- handheld compass
- gloves
- LDW maps including property boundaries
- access notification letter

3.2.1.1 Location and sample identification

Each seep located during the survey will be assigned a unique alphanumeric location ID number. The first three characters of the location ID are "LDW" to identify the Lower Duwamish Waterway project area. The next two characters are "SP" to identify the type of medium (i.e., seep) observed, followed by consecutive numbers, beginning with 01, to identify the specific location within the LDW area. For example, the location ID of the first seep surveyed would be LDW-SP-01. The sample ID number for the water quality parameters will consist of the location ID followed by the letter "R" to signify the reconnaissance survey, and then followed by the letter "a" or "b" to designate the duplicate measure. For example, the sample ID for the first water quality measurement at the first seep would be LDW-SP-01-R-a.

3.2.1.2 Location positioning

Seep location coordinates will be identified by a handheld Wide Area Augmentation System (WAAS)-enabled GPS unit. The GPS unit will receive GPS signals from satellites to produce positioning accuracy to within 3 meters. Washington State Plane coordinates North (NAD [North American Datum] 83) will be used for the horizontal datum. Each seep location also will be marked with a PVC stake driven into the sediment and extending no more than 2 to 3 in. above the sediment surface. Each stake will be marked. In addition, two bearings will be taken from the seep location, each noting the direction and distance from a permanent object using a hand-held compass and a laser measuring tape. Photographs of these objects also will be taken. The seep's location will also be roughly sketched to show the seep, stake, shoreline, object used for measurements, and other pertinent site features. Location positioning information will be recorded on the Seep Reconnaissance Survey Form A (Form 3 at the end of this QAPP).

3.2.1.3 Observations and measurements

Seep survey observations and measurements will be recorded on the Seep Reconnaissance Survey Forms B and C (Forms 4 and 5 at the end of this QAPP). At least one photograph will be taken of each seep, and video footage will be recorded at each seep. Seep water samples will be collected to measure conventional parameters in the field, using the most appropriate collection method for each seep. The water collection method will be based on best professional judgment in the field because flow rates and substrate types of seeps can vary. An agency representative will be present for agreement on the most appropriate method for each seep. Potential methods include:

- For an actively flowing seep from a moderately to steeply sloping embankment, a beaker will be placed directly under the flow.
- For other seeps where water cannot be collected directly under the flow, a pit will be excavated in the sediment and allowed to fill with seep water.

Care will be taken to minimize the entrainment of sediment into the collected seep water. Conventional water quality parameters will be measured using a Hydrolab Series 4a probe, which will be immersed into a beaker of seep water, if collected from an actively flowing seep, or directly into the pit where seep water will be flowing. The probe will be allowed to equilibrate before taking duplicate measurements of conductivity, temperature, dissolved oxygen, pH, salinity, and oxidation-reduction potential. Water quality measurements of LDW surface water will be made at approximately one location per river mile by lowering the Hydrolab probe into the LDW and recording measurements at both the surface and at 1 m below the surface. Because the priority of the survey is to collect seep water quality measurements, these LDW measurements may be collected just before or after the low tide period designated for surveying the seeps on each of the three survey days if time is a limiting factor. Flow rate estimates during the reconnaissance survey will be qualitative and described as either high flow (e.g., active flow), medium flow (e.g., smaller stream), or low flow (e.g., slight trickle).

3.2.2 Seep water sampling for chemical analyses

The locations where seeps will be sampled for chemical analyses are shown on Map B-1 and presented in Tables B-1 and B-2 in Appendix B. These locations were selected at the May 25, 2004 meeting with EPA and Ecology. Table B-1 in Appendix B presents water quality parameter results from the reconnaissance survey for each selected seep. Table B-1 also includes information used at the May 25, 2004 meeting in the weight-of-evidence approach for seep selection, such as proximity to potential sources, sediment quality data, and notable visual observations. Table B-2 presents the rationale for selecting each of the 18 seeps for additional sampling for chemical analyses.

Seep water sampling for chemical analyses at these 18 seeps will be conducted when tidal elevation is less than or equal to +1 ft MLLW on June 29, June 30, July 1, and July 2, resulting in a total available sampling time of 19 hours (see Section 3.1.2). The need to collect samples during low tide limits the amount of time available to collect each sample. The average time available to sample each of the 18 targeted seeps, including transit time, is approximately one hour. If it appears that sampling cannot be completed within the designated sampling period, some seeps that emerge at higher intertidal elevations may be sampled when water levels are above +1 ft MLLW. At least one member of the sampling team from the reconnaissance survey will be present during the seep water sampling event to ensure proper identification of seep locations and to provide observations on seep changes between events.

One seep water sample will be collected at each targeted location. If multiple seeps are flowing at a targeted location, then the seep with the highest perceived flow from visual observations will be sampled. If a seep that was targeted for chemical analyses is not flowing at the time of seep sampling, that seep cannot be sampled. However, if there is a flowing seep within approximately 10 m of the previously identified seep, then that flowing seep will be sampled. If no seeps are flowing within 10 m of the targeted seep, EPA and Ecology will be consulted to determine a course of action. The chemical analyses to be conducted for each selected seep are presented in Table 3-1. In addition to collecting seep samples for chemical analyses, conventional water quality measurements (Section 3.2.1.3) will be taken and flow rate information will be collected, as described below.

Table 3-1. Chemical analytes for seep water samples

	Unfiltered Fraction					Filtered Fraction			
Seep	VOCs	Metals	SVOCs, PCBs, and OC Pesticides	TOC	TPH	Metals	SVOCs, PCBs, and OC Pesticides	DOC	TPH
10	X	X[a]	X[a]	X[a]		X	X	X	
12	X	X[a]	X[a]	X[a]		X	X	X	
20	X	X[a]	X[a]	X[a]		X	X	X	
24	X	X[a]	X[a]	X[a]		X	X	X	
39	X	X[a]	X[a]	X[a]		X	X	X	
41[b]	X	X[a]	X[c]	X	X	X	X	X	X
48	X	X[a]	X[a]	X[a]		X	X	X	
53[b]	X	X[a]	X[c]	X	X	X	X	X	X
54[b]	X	X[a]	X[c]	X	X	X	X	X	X
61	X	X[a]	X[a]	X[a]		X	X	X	
62	X	X[a]	X[a]	X[a]		X	X	X	
64[b]	X	X[a]	X[c]	X	X	X	X	X	X
69	X	X[a]	X[a]	X[a]		X	X	X	
71	X	X[a]	X[a]	X[a]		X	X	X	
75	X	X[a]	X[a]	X[a]		X	X	X	
76	X	X[a]	X[a]	X[a]		X	X	X	
80	X	X[a]	X[a]	X[a]		X	X	X	
82	X	X[a]	X[a]	X[a]		X	X	X	

[a] Unfiltered fractions of these samples will be analyzed in addition to filtered samples only if turbidity is less than or equal to 5 NTU

[b] The laboratory will be notified prior to analyses of the samples that NAPL may be present in these samples, and will dilute as necessary or attempt to isolate the product phase.

[c] Unfiltered fraction of these samples will be analyzed for organochlorine pesticides only if turbidity is less than or equal to 5 NTU.

DOC – dissolved organic carbon

OC – organochlorine

TOC – total organic carbon

3.2.2.1 Location and sample identification

The location ID will generally be the same as the ID designated for that seep location during the reconnaissance survey. However, the sample ID will consist of the location

ID followed by the letter "C" to signify chemical sampling, rather than a letter "R" as used above for the reconnaissance survey. Field QA/QC samples will be assigned modified sample IDs as described below:

- Field replicates will be assigned the same sample ID as the sample collected at that seep, followed by "FR." For example, the field replicate collected from seep location 01 would be LDW-SP-01-C-FR.
- Rinsate blanks will be assigned the same sample ID as the sample collected at that seep, followed by "RB." For example, the rinsate blank collected at seep location 01 would be LDW-SP-01-C-RB.
- Identifiers for VOC trip blanks will contain the prefix "LDW-SP" followed by a unique numeric identifier, the letter "C," and the letters "TB" to designate trip blank. For example, the first trip blank submitted to the laboratory would be LDW-SP-C-TB-01.
- Atmospheric blanks (primarily to account for potential atmospheric mercury contamination) will be assigned the same sample ID as the sample collected at that seep, followed by "AB." For example, the atmospheric blank collected at seep location 01 would be LDW-SP-01-C-AB.

3.2.2.2 Location positioning

Seep locations identified for sampling based on the reconnaissance survey will be relocated by GPS and by the PVC stake previously placed during the reconnaissance survey. If the stake is missing, a handheld WAAS-enabled GPS unit will be used to reoccupy the coordinates recorded during the reconnaissance survey. The GPS unit will receive GPS signals from satellites to produce positioning accuracy to within 3 m. Washington State Plane coordinates North (NAD 83) will be used for the horizontal datum. The location bearings collected during the reconnaissance survey will be used for additional verification of a seep location if the stake is missing.

3.2.2.3 Seep sample collection

A Seep Sample Collection Form (see Form 5 at the end of this QAPP) will be completed for each seep location, as described in Section 2.6.1. At least one photograph will be taken of each seep.

The preferred method for collection of seep water samples is the use of stainless steel PushPoint mini-piezometers developed and sold by MHE Products.[18] A peristaltic pump will be used to withdraw seep water from the mini-piezometer through Teflon® and Masterflex tubing. The mini-piezometer will be placed in sediment at a location just upgradient from where the seep is emerging. Prior to placing the mini-piezometers upgradient of the seep, a pit will be excavated in the sediment at that

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[18] It will be necessary to install at least two mini-piezometers at each seep location to collect sufficient sample volume within the limited amount of time available for sampling at each site because of tidal constraints.

location with a shovel to assess whether the area is associated with active subsurface seep flow. The initial seep water pumped from the mini-piezometer will be turbid. Once the seep water runs clear (i.e., usually after about 50 mL of flow or 30 seconds of pumping), a turbidity measurement will be taken using a DRT-15CE turbidimeter (manufactured by HF Scientific).

If the turbidity is less than or equal to 5 NTU, mini-piezometers will be used to sample the seep if a sufficient volume of sample can be collected with the mini-piezometers. If turbidity is greater than 5 NTU, the turbidity will be measured using an alternative seep water sampling method, as described below, to determine whether the turbidity in the sample would be less than 5 NTU using this alternative method. If the turbidity is less than 5 NTU with the alternative method, the alternative method will be used to collect the sample. However, if the turbidity is greater than 5 NTU when samples are collected using either method, the sample will be collected using the mini-piezometer if a sufficient volume of sample can be collected. If sample volume becomes an issue, the alternative method will be used in place of the mini-piezometer.

The alternative seep water sampling method will be based on the judgment of the field personnel, considering flow rates and substrate type of the seep. An agency representative will be present for agreement on the most appropriate method for each seep. Care will be taken to minimize the entrainment of sediment into the collected seep water regardless of the collection method used. Potential alternative sampling methods include:

- Placement of an appropriate sampling container directly under an actively flowing seep from a moderate to steep sloping embankment
- Placement of a glass funnel, Teflon® sheeting, and/or Teflon® tubing, as appropriate, below seeps where water cannot be collected directly under the flow. Pre-assigned, pre-cleaned funnels, sheeting, and tubing will be used at each sampling location to avoid contamination from other locations. Sampling equipment will be pre-cleaned by Frontier, as described in EPA Method 1669 (EPA 1996).
- Excavating a pit in the sediment, lining the pit with a stainless steel bowl, allowing it to fill with seep water, and dipping a pre-cleaned glass beaker in the bowl to collect the seep water.

The VOC and TPH-gas range samples will be collected prior to collecting other samples. Mini-piezometers will be used to collect seep water samples for volatile analyses whenever possible using a pre-cleaned 50-mL syringe designed by MHE Products specifically for use with the PushPoint mini-piezometers. The seep water collected in the syringe will be dispensed into 40-mL sampling vials for volatile samples in the field, with care taken to avoid the entrapment of air bubbles into the sample. The sample vial will be filled (no headspace), and will be checked to ensure that no air bubbles are trapped in the vial. If an alternative sampling method is used, care will be taken to minimize disturbance of the seep water sample when directing it into the sample vials.

Samples for mercury analysis will be collected after measuring conventional parameters, according to guidelines in EPA Method 1669 for sampling metals at trace levels (EPA 1996).[19] The following steps will be taken to minimize sample contamination:

- All operations involving contact with the sample bottle, the inner Ziploc® bag containing the sample bottle, and transfer of the sample from the beaker to the sample bottle will be handled only by an individual designated as "clean hands"
- An individual designated as "dirty hands" is responsible for all activities that do not involve direct contact with the sample bottle or inner Ziploc® bag containing the sample bottle, such as opening the cooler or outer Ziploc® bag
- A third person will work with the individuals designated as "clean hands" and "dirty hands" to perform sample documentation as needed during sample collection
- Sampling personnel will wear clean, non-talc gloves when handling sampling equipment and sample containers associated with mercury analysis
- Samplers will be positioned downstream from the origin of seep flow
- Sample bottles will be rinsed three times with seep water before sample collection
- Sample collection will be conducted as quickly as possible to minimize exposure to airborne particulate matter
- Sample bottles will be double-bagged
- Equipment used for sample collection will be pre-cleaned and packaged by Frontier as described in EPA Method 1669 (EPA 1996) before use in the field
- Equipment blanks will be collected in the laboratory to verify the equipment cleaning process
- Atmospheric field blanks will be collected to check for airborne contamination of mercury, as described in Section 3.5.1

Following the sampling for mercury analysis, seep samples will be collected for analysis of arsenic, metals, PCBs as Aroclors/organochlorine pesticides, SVOCs, TPH, total suspended solids, total organic carbon, and dissolved organic carbon using

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[19] Method 1669 is intended as guidance for sampling water for trace metals. Frontier Geosciences was consulted regarding the appropriate procedures for sampling and analysis of mercury in LDW seep water, and best professional judgment was used in determining the methods for this QAPP. For example, although Method 1669 discusses the use of Tyvek suits and shoulder length gloves, it was concluded that these are not necessary for sampling LDW seeps.

appropriate sample containers as listed in Table 3-2. Samples for metals analysis will be filtered in the field by attaching an in-line disposable filter cartridge to the end of the Masterflex tubing, which runs through the peristaltic pump. The initial 25-50 mL of sample flushed through the filter will not be collected. If mini-piezometers are not used, seep water will be pumped from a glass beaker through the in-line filter to collect samples for metals analysis.

Table 3-2. Sample containers, preservation, and laboratory for analysis

PARAMETER	CONTAINER	PRESERVATION	LABORATORY
VOCs (unfiltered)	3 40-mL glass vial w/ septa cap	HNO_3 to pH<2, cool, 4°C[a]	ARI
Mercury (unfiltered)	250-mL FEP bottle	HCl or BrCl, cool, 4°C[b]	Frontier
Mercury (<1 µm)	250-mL FEP bottle	HCl or BrCl, cool, 4°C[b]	Frontier
Metals, including arsenic (unfiltered)	500-mL HDPE	HNO_3 to pH<2, cool, 4°C[a]	Frontier
Metals, including arsenic (<0.45 µm)	500-mL HDPE	HNO_3 to pH<2, cool, 4°C[a]	Frontier
SVOCs (unfiltered)	2 500-mL amber glass bottles	cool, 4°C, dark	ARI
SVOCs (<1 µm)	2 500-mL amber glass bottles	cool, 4°C, dark	ARI
Organochlorine pesticides and PCBs as Aroclors (unfiltered)	3 1-L amber glass bottle	cool, 4°C	ARI
Organochlorine pesticides and PCBs as Aroclors (<1 µm)	3 1-L amber glass bottle	cool, 4°C	ARI
Total organic carbon	250 mL HDPE bottle	H_2SO_4 to pH<2, cool, 4°C[a]	ARI
Dissolved organic carbon	250 mL HDPE bottle	H_2SO_4 to pH<2, cool, 4°C[b]	ARI
Total suspended solids	1-L HDPE	cool, 4°C	ARI
Total petroleum hydrocarbons-gasoline [c]	3 40-mL glass vial w/septa cap	HNO_3 to pH<2, cool, 4°C[a]	ARI
Total petroleum hydrocarbons-diesel extended range (unfiltered) [c]	2 500-mL amber glass bottles	cool, 4ºC	ARI
Total petroleum hydrocarbons-diesel extended range (<1 µm)[c]	2 500-mL amber glass bottles	cool, 4ºC	ARI

[a] Preservative will be added to bottles prior to field collection

[b] Preservative will be added to bottles in the laboratory

[c] Samples for TPH analyses will only be collected at seeps with potential NAPL (41, 53, 54, and 64)

HDPE – high-density polyethylene

FEP – fluorinated ethylene propylene

Conventional parameters will be measured in the field using a Hydrolab Series 4a probe, which will be immersed in a container of seep water. The probe will be allowed to equilibrate before taking measurements of conductivity, temperature, dissolved oxygen, pH, salinity, and oxidation-reduction potential. Duplicate measurements with two different Hydrolab instruments will be taken at the first and last seep sampled each day to assess Hydrolab performance. If measurements by the two Hydrolabs at the first seep differ by more than 20%, then readings will be taken with both instruments at all seep locations on that day.

3.2.2.4 Flow rate measurements

The flow rate will be measured at seeps where the flow of a single seep can be captured. Flow rate will be quantified using a stop-watch to measure the rate at which seep water flowing over a defined area fills a container of known volume. For seeps where it is not possible to capture the entire flow because of sheet flow or dispersion over rocks, the flow rate will be estimated based on visual observation. The flow rate measurements will enable a semi-quantitative comparison of flow rates among the seeps sampled in the LDW. These data will not be sufficient for and are not intended to be used to develop quantitative estimates of overall seep flow or groundwater discharge into the LDW.

3.2.2.5 Field equipment

The items needed in the field for chemical sampling of seep water are identified in Table 3-3. The FC will check that all equipment is included and in working order each day before sampling personnel go in the field. A rugged laptop computer complete with navigation software will accompany the FC at all times.

Table 3-3. Seep water sampling field equipment

FIELD EQUIPMENT	
QAPP	Glass and plastic funnels
Field sample collection forms	Teflon® and Masterflex tubing
Field notebooks (Rite in the Rain®)	Mini-piezometers
Chain-of-custody forms	Three peristaltic pumps
Pens, pencils, Sharpies	Glass beakers
GPS (w/ extra batteries)	Flexible Teflon® sheeting
Digital camera	Hydrolab
Cellular phone	Turbidity meter
Alconox® detergent and scrub brush	Extra membranes for Hydrolab DO probe
Coolers	Gloves
Ice (wet and/or dry)	Field notes from reconnaissance survey for seep locations
LDW maps including property boundaries	Rubber boots
Seep location coordinates	Raingear
Property access notification letters	Waders
Plywood	Stopwatch
Squirt bottle with distilled water	Reverse osmosis water
Bucket for decontamination	0.45-µm disposable inline filter cartridges
Distilled water	Syringes for VOC sampling

3.3 SAMPLE HANDLING AND CUSTODY

This section describes how individual samples will be processed, labeled, tracked, stored, and transported to the laboratory for analysis. In addition, this section describes decontamination procedures, disposal of field-generated wastes, sample custody procedures, and shipping requirements. Sample custody is a critical aspect of environmental investigations. Sample possession and handling must be traceable from the time of sample collection, through laboratory and data analysis, to delivery of the sample results to the recipient.

3.3.1 Sample handling procedures

The types of sample containers to be used, preservation, and sample volumes are summarized in Table 3-2. Preservative will be added to sample bottles prior to field sampling for all analytes except mercury (filtered and unfiltered) and dissolved organic carbon; for those analytes preservative will be added in the laboratory upon receipt of samples. Each jar will be sealed, completely labeled, and stored under appropriate conditions as outlined in Table 3-2. Labels will be filled out as completely as possible prior to the field event.

Sample labels will be waterproof and self-adhering. Each sample label will contain the project number, sample identification, preservation technique, analyses, date and time of collection, and initials of the person(s) preparing the sample. A completed sample label will be affixed to each sample container and covered with clear tape.

At ARI, each sample will be assigned a unique laboratory number using ARI's Laboratory Information Management System (LIMS). The LIMS is used to match the sample ID with a laboratory ID and to print bottle labels, which are affixed to each sample received at ARI. After the samples are labeled, a second person will confirm that the sample ID matches the laboratory ID. At Frontier, unique laboratory numbers will not be used; instead, the sample ID will be used for sample tracking. The laboratory will ensure that a sample-tracking record follows each sample through all stages of laboratory processing. The sample-tracking record must contain, at a minimum, the name/initials of responsible individuals performing the analyses, dates of sample extraction/preparation and analysis, and the type of analysis being performed.

All samples will be handled so as to prevent contamination or loss of any sample. Samples will be assigned a specific storage area within the laboratory and will be kept there until analyzed. The laboratory will not dispose of the environmental samples or sample extracts for this project until notified in writing by the Windward PM.

3.3.2 Decontamination procedures

The Hydrolab, turbidity meter, mini-piezometers, and stainless steel bowl will be decontaminated between stations following Puget Sound Estuary Program (PSEP) (PSEP 1997a) guidelines, as follows:

1. Rinse with LDW water until free of sediment
2. Wash with phosphate-free detergent
3. Rinse with distilled water

If the dissolved oxygen probe becomes oily, the membrane covering the probe will be replaced. During collection of seep water for chemical analyses, decontamination of funnels, tubing, sheeting, beakers, and syringes is not needed because pre-cleaned equipment will be used at each site.

Acid or solvent washes will not be used in the field because of safety considerations and problems associated with rinsate disposal and sample integrity. Specifically:

- Use of acids or organic solvents may pose a safety hazard to the field crew
- Disposal and spillage of acids and solvents during field activities pose an environmental concern
- Residues of solvents and acids on sampling equipment may affect sample integrity for chemical testing

Any sampling equipment that cannot be cleaned to the satisfaction of the FC will not be used for further sampling activity.

3.3.3 Field-generated waste disposal

Rinsate generated during equipment decontamination procedures will be returned to each sampling location after sampling is completed for that location. All disposable sampling materials and personal protective equipment used in sample processing, such as gloves and paper towels, will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies will be removed from the site by sampling personnel and placed in a normal refuse container for disposal as solid waste.

3.3.4 Sample custody procedures

Samples are considered to be in custody if they are: 1) in the custodian's (e.g., field or laboratory personnel's) possession or view, 2) retained in a secured place (under lock) with restricted access, or 3) placed in a container and secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s). Custody procedures will be used for all samples throughout the collection, transport, and analytical process, and for all data and data documentation whether in hard copy or electronic format. Custody procedures will be initiated during sample collection. A COC form will accompany samples to the analytical laboratory. Each person who has custody of the samples will sign the COC form and ensure that the samples are not left unattended unless properly secured. Minimum documentation of sample handling and custody will include:

- sample location, project name/task, and unique sample number
- sample collection date and time

- any special notations on sample characteristics or problems
- initials of the person collecting the sample
- date sample was sent to the laboratory
- shipping company name and waybill number

The FC will be responsible for all sample tracking and custody procedures for samples in the field and for final sample inventory, as well as for maintaining sample custody documentation. The FC will also complete COC forms prior to removing samples from the sampling area. At the end of each day, and prior to transfer, COC entries will be made for all samples. Information on the labels will be checked against sample log entries, and sample tracking forms and samples will be recounted. COC forms will accompany all samples. The COC forms will be signed at each point of transfer. Copies of all COC forms will be retained and included as appendices to data reports.

The laboratory will ensure that COC forms are properly signed upon receipt of the samples and will note questions or observations concerning sample integrity on the COC forms. The laboratory will contact the project QA/QC Coordinator immediately if discrepancies are discovered between the COC forms and the sample shipment upon receipt.

3.3.5 Shipping requirements and receipt

Sample coolers containing samples for chemical analyses will be hand-carried to ARI and Frontier at the end of each day. The temperature inside the cooler(s) will be checked upon receipt of the samples. The laboratory will specifically note any coolers that do not contain ice packs or that are not sufficiently cold (4°C ± 2°C) upon receipt.

3.4 ANALYTICAL METHODS REQUIREMENTS

This section discusses standard and alternative analytical methods, sample handling requirements, and data quality indicators for laboratory and field water quality analyses.

3.4.1 Analytical methods and laboratory sample handling

The methods of chemical analysis and associated laboratory sample handling requirements are identified in Table 3-4. In the laboratory, prior to chemical analyses, samples collected for fractions less than 1.0 µm will be filtered, as discussed in Section 3.1.2.[20] Samples will be filtered at the laboratory as soon as possible after samples are received and before preservatives are added. Also, the laboratory will be notified prior to chemical analyses if NAPL may be present in a sample.

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[20] Samples collected for fractions less than 0.45 µm will be filtered in the field.

Table 3-4. Laboratory analytical methods and sample handling requirements

PARAMETER	ANALYTICAL METHOD	FILTRATION [a]	SAMPLE PREPARATION METHOD	CLEANUP METHOD	HOLDING TIME	LABORATORY
VOCs	GC/MS (EPA 8260B)	none	EPA SW5030	none	14 days	ARI
Mercury	CVAF (EPA 1631E)	1.0-µm polyethylsulfone filter in the laboratory	EPA 1631E	EPA 1631E	90 days	Frontier
Arsenic	HG-AVS (EPA 206.3)	0.45-µm nitrocellulose filter in the field	EPA 206.3	none	6 months	Frontier
Metals	ICP-MS (EPA 200.8)	0.45-µm nitrocellulose filter in the field	1% HNO_3 closed vessel oven digest	none	6 months	Frontier
SVOCs[b]	GC/MS (EPA 8270C)	1.0-µm glass fiber filter in the laboratory	EPA 3510C or EPA 3520C	EPA 3640A (GPC) optional	7 days[c]	ARI
PCBs as Aroclors	GC/ECD (EPA 8082)[d]	1.0-µm glass fiber filter in the laboratory	EPA 3510C	EPA 3665A (acid) optional; EPA 3660B (sulfur) optional	7 days[c]	ARI
Organochlorine pesticides	GC/ECD (EPA 8081 Mod)[e]	1.0-µm glass fiber filter in the laboratory	EPA 3510C	EPA 3660B (sulfur) optional; EPA 3630C (silica) required	7 days[c]	ARI
Total organic carbon	Non-dispersive infrared combustion (EPA 415.1)	none	EPA 415.1	none	28 days	ARI
Dissolved organic carbon	Direct combustion (EPA 415.1)	1.0-µm glass fiber filter in the laboratory	EPA 415.1	none	28 days	ARI
Total suspended solids	EPA 160.2	none	EPA 160.2	none	7 days	ARI
Total petroleum hydrocarbons – gasoline	WDOE NWTPH-G	none	SW 5030	none	14 days	ARI
Total petroleum hydrocarbons – diesel extended range	WDOE NWTPH-Dx	1.0-µm glass fiber filter in the laboratory	SW 3545B or SW 3550B	SW 3630C and/or SW 3665A if requested	7 days	ARI

[a] Samples for mercury, SVOCs, PCBs, and organochlorine pesticide analyses will be filtered in the laboratory through a 1-µm filter to remove non-colloidal particles greater than 1 µm that may have been introduced into the seep water by the sampling method. Samples for metals (except mercury) analyses will be filtered in the field through a 0.45-µm filter to represent the dissolved fraction for comparison to Washington State dissolved water quality standards.

[b] Includes analysis of 1,4-dioxane; 1,4-dioxane will be added as a surrogate and recoveries will be reported

[c] Seven days until extraction; 40 days to analysis from time of extraction.

[d] If more than one Aroclor is detected in a sample, the laboratory will choose unique peaks to quantitate each individual Aroclor (i.e., a peak can only be used in the quantitation of one Aroclor).

[e] Extracts will be archived, and EPA will be provided with unvalidated data soon after receipt from the laboratory to assess whether any additional analyses are needed to meet project needs.

CVAF – cold vapor atomic fluorescence

Dx – diesel extended range

G – gasoline

GC/ECD – gas chromatography/electron capture detection

GC/MS – gas chromatography/mass spectrometry

GPC – gel permeation chromatography

HG-AFS – hydride generation atomic fluorescence spectrometry

ICP-MS – inductively coupled plasma mass spectrometry

NWTPH – Northwest total petroleum hydrocarbon

WDOE – Washington Department of Ecology

High salinity interferes with metals analysis (except mercury), so dilution of samples may be necessary to remove these interferences. Because chloride interferences may occur with arsenic analysis even at low salinities, arsenic will be analyzed using hydride-generation atomic fluorescence spectrometry.

3.4.2 Data quality indicators

The parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity. Table 3-5 lists specific DQIs for each laboratory analysis. Table 3-6 lists DQIs for each water quality parameter measured in the field. These parameters are discussed in more detail in the following sections. The complete list of organic compound analytes is presented in Appendix D; the complete list of metal analytes is presented in Table 3-7.

Table 3-5. Summary of DQIs for laboratory analyses

PARAMETER	UNITS	METHOD DETECTION LIMIT (SENSITIVITY)[a]	PRECISION[b]	ACCURACY[c]	COMPLETENESS
VOCs	µg/L	1.0	±30%	75-125%	95%
Mercury	ng/L	<0.15	±25%	75-125%	95%
Arsenic[d]	µg/L	1.5	±25%	75-125%	95%
Metals[d,e]	µg/L	0.4–5.0	±35%	75-125%	95%
SVOCs	µg/L	0.5–5.0	±30%	20-130%	95%
PCBs as Aroclors	µg/L	0.01	±30%	50-150%	95%
Organochlorine pesticides	µg/L	0.00035–0.03	±30%	50-150%	95%
Dissolved organic carbon	mg/L	1.5	±20%	75-125%	95%
Total organic carbon	mg/L	1.5	±20%	75-125%	95%
Total suspended solids	mg/L	1.0	±20%	75-125%	95%
Total petroleum hydrocarbons	mg/L	0.25	±30%	30-160%	95%
Total petroleum hydrocarbons – gasoline	mg/L	0.25	±30%	75-125%	95%
Total petroleum hydrocarbons – diesel extended range	mg/L	0.25-0.50	±30%	30-160%	95%

[a] These method detection limits are lower than Washington State marine chronic water quality standards, except for toxaphene, as presented in Section 3.4.2.6. Detection limits for toxaphene below water quality standards

are not achievable because toxaphene is a complex mixture containing multiple components resulting in reduced sensitivity. Method detection limits for specific metals are presented in Table 3-7 and presented in Appendix D for specific organic compounds.

[b] Precision is assessed by laboratory duplicate analyses (duplicate samples, matrix spike duplicates, LCS duplicates)

[c] Accuracy is assessed by the percent recoveries of matrix spike and laboratory control sample analyses

[d] Values presented assume a maximum dilution of 50x will be necessary to remove seawater interferences.

[e] Cadmium, chromium, copper, lead, nickel, silver, and zinc; detection limits vary for different metals, as presented in Table 3-7

Table 3-6. Summary of DQIs for water quality field analyses

PARAMETER	UNITS	PRECISION[a]	ACCURACY[b]	COMPLETENESS
Temperature	°C	20%	±0.10 °C	95%
Specific conductance	mS/cm	20%	± 1% of reading ±0.001 mS/cm	95%
pH	pH units	20%	±0.2 units	95%
Dissolved oxygen	mg/L	20%	±0.2 mg/L	95%
Oxidation reduction potential	mV	20%	±20 mV	95%
Salinity	ppt	20%	±0.2 ppt	95%
Turbidity	NTU	20%	±5% of range	95%

Note: Water quality measurements will be made using Hydrolab Series 4a, and turbidity will be measured using a DRT-15CE turbidimeter (manufactured by HF Scientific).

[a] Precision is assessed by duplicate field measurements.

[b] Accuracy is as reported for Hydrolab Series 4a instrument specifications.

3.4.2.1 Precision

Precision is the measure of the reproducibility among individual measurements of the same property, usually under similar conditions, such as multiple measurements of the same sample. Precision is assessed by performing multiple analyses on a sample and is expressed as an RPD when duplicate analyses are performed and as a % RSD when more than two analyses are performed on the same sample (e.g., duplicates). Precision is assessed by laboratory duplicate analyses (duplicate samples, matrix spike duplicates, LCS duplicates) for all parameters. Precision measurements can be affected by the nearness of a chemical concentration to the MDL, where the percent error (expressed as either %RSD or RPD) increases. The DQI for precision varies depending on the analyte (Table 3-5). The equations used to express precision are as follows:

$$\text{RPD} = \frac{(\text{measured conc} - \text{measured duplicate conc})}{(\text{measured conc} + \text{measured duplicate conc}) \div 2} \times 100$$

$$\%\text{RSD} = (\text{SD}/\text{D}_{\text{ave}}) \times 100$$

where:

$$\text{SD} = \sqrt{\left(\frac{\sum(\text{D}_\text{n} - \text{D}_{\text{ave}})^2}{(\text{n}-1)}\right)}$$

D = sample concentration
D_{ave} = average sample concentration
n = number of samples
SD = standard deviation

3.4.2.2 Accuracy

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Accuracy may be expressed as a percentage recovery for matrix spike and laboratory control sample analyses. The DQI for accuracy varies, depending on the analyte (Table 3-5). The equation used to express accuracy for spiked samples is as follows:

$$\text{Percent recovery} = \frac{\text{spike sample result} - \text{unspiked sample result}}{\text{amount of spike added}} \times 100$$

3.4.2.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition. The sampling approach was designed to address the specific objectives described in Section 2.2.

3.4.2.4 Comparability

Comparability expresses the confidence with which one data set can be evaluated in relation to another data set. Therefore, the sample collection and chemical and physical testing will adhere to the most recent PSEP QA/QC procedures (PSEP 1997b) and EPA and PSEP analysis protocols.

3.4.2.5 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:

$$\text{Completeness} = \frac{\text{number of valid measurements}}{\text{total number of data points planned}} \times 100$$

The DQI for completeness for all components of this project is 95%. 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.

3.4.2.6 Sensitivity

Analytical sensitivity is the minimum concentration of an analyte above which a data user can be reasonably confident that the analyte was reliably detected and quantified. For this study, the MDL will be used as the measure of sensitivity of each measurement process. These MDLs will be sufficient to obtain results below the Washington State marine chronic water quality standards for the protection of aquatic life, presented in Table 3-7, for all chemicals except toxaphene. Toxaphene detection limits below water quality criteria are not achievable because toxaphene is a complex mixture containing multiple components resulting in reduced sensitivity for this compound. The analytical laboratory will report results to the MDL. Detected concentrations between the MDL and reporting limit (RL) will be tagged with a "J" qualifier by the laboratory.

Table 3-7. Washington State marine chronic water quality standards for the protection of aquatic life compared to method detection limits (MDLs) and reporting limits (RLs)

ANALYTE	STATE MARINE CHRONIC WATER QUALITY STANDARD (µg/L)	METHOD	MDL[a] (µg/L)	RL[a] (µg/L)
Metals[b]				
Arsenic	36	SM3114-C	1.5	1.5
Cadmium	9.3	EPA 200.8	0.4	0.4
Chromium	50[c]	EPA 200.8	3.5	3.5
Copper	3.1	EPA 200.8	2.0	2.0
Lead	8.1	EPA 200.8	0.75	0.75
Mercury	0.025	EPA 1631E	<0.00015	0.00015
Nickel	8.2	EPA 200.8	2.0	2.0
Silver	1.9[d]	EPA 200.8	0.75	0.75
Zinc	81	EPA 200.8	5.0	5.0
Total PCBs (Aroclor sum)	0.03	EPA 8082	0.002-0.01[e]	0.01[e]
Organochlorine pesticides				
Aldrin	0.0019	EPA 8081	0.00084	0.001
Chlordane	0.004	EPA 8081	0.0002	0.001
4,4'-DDT	0.001	EPA 8081	0.0005	0.002
Dieldrin	0.0019	EPA 8081	0.00035	0.002
Endosulfan	0.0087	EPA 8081	0.0004	0.002
Endrin	0.0023	EPA 8081	0.0004	0.002
Heptachlor	0.0036	EPA 8081	0.0004	0.001
Toxaphene	0.0002	EPA 8081	0.03	0.1
SVOCs				
Pentachlorophenol	7.7	EPA 8270	2.0	5.0

[a] Frontier's RLs are equivalent to MDLs for metals; values presented assume a maximum dilution of 50x will be necessary for metals other than mercury to remove seawater interferences.

[b] Metals values represent the dissolved fraction except for the mercury value, which represents the total recoverable fraction.

[c] Value for hexavalent chromium presented; value for trivalent chromium not available

[d] Chronic value not available; acute value presented

[e] Range of MDLs and RL for individual Aroclors

3.5 QUALITY ASSURANCE/QUALITY CONTROL

3.5.1 Field quality control samples

Although data validation guidelines have not been established for field quality control samples, the data resulting from the analysis of field QA/QC samples is useful in identifying possible problems resulting from sample collection or sample processing in the field. All field quality control samples will be documented in the field logbook and verified by the project QA/QC Coordinator or a designee.

Field QA/QC samples will be used to evaluate the efficiency of collection equipment cleaning procedures, and variability attributable to sample handling and atmospheric conditions. Four types of field QA/QC samples will be collected during each sampling event: 1) rinsate blanks for the sampling equipment, 2) field replicates, 3) trip blanks for VOCs, and 4) atmospheric field blanks for mercury. These sample types are further described below. Locations for collection of field QA/QC samples will be selected in the field by the FC.

3.5.1.1 Rinsate blanks

Rinsate blanks are used to assess whether and to what degree contamination is occurring in the field during sample collection. A rinsate blank will be created by rinsing the sample collection device (e.g., the mini-piezometers, funnels, tubing, or sheeting) with laboratory reverse-osmosis (RO) water. Rinsate samples will be collected in an appropriate clean jar for each analyte class (e.g., SVOCs). A minimum of one rinsate blank for every 20 samples collected using a sampling device will be submitted for chemical analysis, except for mercury. For mercury, a minimum of one rinsate blank per 10 samples will be collected. Rinsate blanks will be submitted to the laboratory in the same manner as the environmental samples and will be analyzed for the same analytes. If any chemicals of concern are detected in rinsate blanks, samples may be qualified or rejected depending on the magnitude of the detected concentration.

3.5.1.2 Field replicate samples

A minimum of one field replicate seep sample will be collected for every batch of 20 seep samples collected, except for mercury. For mercury, one field replicate sample will be collected for every batch of 10 seep samples in accordance with Method 1669 (EPA 1996). Replicate samples will be submitted for the same analyses as the seep samples to evaluate variability in the field.

3.5.1.3 Trip blanks

Trip blanks will be used to determine if VOCs are introduced to samples during holding, shipping, or storage prior to analysis. Trip blanks will consist of RO water sealed in a VOC sample container by the analytical laboratory. Trip blanks will be transported from the laboratory to the field and then returned to the laboratory unopened for analysis. One trip blank will be included in each cooler containing VOC samples.

3.5.1.4 Atmospheric blanks

Atmospheric blanks will be used to determine if airborne mercury is introduced to samples during collection. These field blanks will consist of a 250-mL fluorinated ethylene propylene (FEP) bottle filled with RO water. At the initiation of seep water sample collection the sample bottle lid will be removed, and will be replaced immediately after the mercury sample has been collected. One atmospheric field blank will be collected for each group of seep samples collected within a two-mi river section on the day those samples are collected.

3.5.1.5 Equipment blanks

Equipment blanks will be used to verify initial equipment cleaning of the mini-piezometer, funnels, tubing, and sheeting. These blanks will be prepared by running RO water through equipment at Frontier, collecting the sample, and analyzing for mercury. Three equipment blanks will be prepared; one for the mini-piezometer, one for funnels with attached tubing, and one for the Teflon® sheeting.

3.5.2 Chemical analyses

Before analyzing the samples, the laboratory must provide written protocols for the analytical methods to be used, calculate MDLs for each analyte in each matrix of interest, and establish an initial calibration curve for all analytes. The laboratory must demonstrate their continued proficiency by participation in interlaboratory comparison studies and through repeated analysis of certified reference materials, calibration checks, laboratory reagent blanks, and spiked samples.

3.5.2.1 Determination of MDLs

The MDL is defined as the lowest concentration of an analyte or compound that a method can detect in either a sample or a blank with 99% confidence. The laboratories determine MDLs using standard procedures outlined in 40CFR§136. In summary, seven replicate samples will be fortified at 1 to 5 times (but not to exceed 10 times) the expected MDL concentration. The MDL is then determined by calculating the standard deviation of the replicates and multiplying by a factor of 3.14.

3.5.2.2 Sample delivery group

Project- and/or method-specific quality control measures such as matrix spikes and matrix duplicates will be analyzed per sample delivery group (SDG) or sample batch. An SDG is defined as no more than 20 samples or a group of samples received at the laboratory within a two-week period. Although an SDG may span two weeks, all holding times specific to each analytical method will be met for each sample in the SDG.

3.5.2.3 Laboratory quality control criteria

The analyst will review results of QC analyses (described below) from each sample group immediately after a sample group has been analyzed. The QC sample results will then be evaluated to determine whether control limits have been exceeded. If control limits are exceeded in the sample group, the project QA/QC Coordinator will be contacted immediately, and corrective action, such as method modifications followed by reprocessing of the affected samples, will be initiated before processing a subsequent group of samples.

All primary chemical standards and standard solutions used in this project will be traceable to the National Institute of Standards and Technology, Environmental Resource Associates, National Research Council of Canada, or other documented, reliable, commercial sources. The accuracy of the standards will be verified by comparison with an independent standard. Laboratory QC standards are verified in a multitude of ways. Second-source calibration verifications are run (i.e., same standard, two different vendors) for calibrations. New working standard mixes (calibrations, spikes, etc.) are verified against the results of the original solution and must be within 10%. Newly purchased standards are verified against current data. Any impurities found in the standard will be documented. The following sections summarize the procedures that will be used to assess data quality throughout sample analysis. Table 3-8 summarizes the QC procedures to be performed by the laboratory. The associated control limits for precision and accuracy are summarized in Table 3-5.

Table 3-8. Laboratory quality control sample analysis summary

ANALYSIS TYPE	INITIAL CALIBRATION	CONTINUING CALIBRATION	MATRIX DUPLICATE OR REPLICATES	MATRIX SPIKES	MATRIX SPIKE DUPLICATES	METHOD BLANKS	SURROGATE SPIKES	LABORATORY CONTROL SAMPLES
VOCs	prior to analysis	daily	na	1 per batch or SDG	1 per batch or SDG	each batch or SDG	each sample	1 per batch or SDG
Mercury	daily	every 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	3 per 20 samples	na	1 per 20 samples
Arsenic	daily	every 10 samples	1 per 20 samples	1 per 20 samples	1 per 20 samples	3 per 20 samples	na	1 per 20 samples
Metals	daily	every 10 samples	1 per batch or SDG	1 per batch or SDG	na	1 per batch or SDG	na	1 per batch or SDG
SVOCs	prior to analysis	daily	na	1 per batch or SDG	1 per batch or SDG	each batch or SDG	each sample	1 per batch or SDG
PCBs as Aroclors	prior to analysis	daily	na	1 per batch or SDG	1 per batch or SDG	each batch or SDG	each sample[a]	1 per batch or SDG
Organo-chlorine pesticides[b]	prior to analysis	daily	na	1 per batch or SDG	1 per batch or SDG	each batch or SDG	each sample	1 per batch or SDG

ANALYSIS TYPE	INITIAL CALIBRATION	CONTINUING CALIBRATION	MATRIX DUPLICATE OR REPLICATES	MATRIX SPIKES	MATRIX SPIKE DUPLICATES	METHOD BLANKS	SURROGATE SPIKES	LABORATORY CONTROL SAMPLES
Total organic carbon	daily	every 10 samples	1 per 20 samples	1 per 20 samples	na	each batch or SDG	na	1 per 20 samples
Dissolved organic carbon	daily	every 10 samples	1 per 20 samples	1 per 20 samples	na	each batch or SDG	na	1 per 20 samples
Total suspended solids	na	na	1 per 20 samples	na	na	1 per 20 samples	na	na
Total petroleum hydrocarbons-gasoline	Prior to analysis	every 12 hours	na	1 per 20 samples	1 per 20 samples	Each batch or SDG	each sample	1 per batch or SDG
Total petroleum hydrocarbons – diesel extended range	prior to analysis	every 12 hours	1 per 20 samples	1 per 20 samples	1 per 20 samples	1 per batch or 20 samples	each sample	1 per batch or 20 samples

[a] 2,3,6,7-tetrachloroxanthene and decachlorobiphenyl will be used as surrogates for all Aroclor analyses

[b] Aroclor standards will be run as interference check samples for this analysis

na – not applicable

Matrix Replicates

Analytical replicates provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Analytical replicates are subsamples of the original sample that are prepared and analyzed as a separate sample, assuming sufficient sample matrix is available. A minimum of one replicate will be analyzed for each sample group or for every 20 samples, whichever is more frequent.

Matrix Spikes and Matrix Spike Duplicates

The analysis of matrix spike samples provides information on the extraction efficiency of the method on the sample matrix. By performing duplicate matrix spike analyses, information on the precision of the method is also provided for organic analyses. A minimum of one matrix spike and matrix spike duplicate will be analyzed for each sample group or for every 20 samples, whichever is more frequent, when possible.

Surrogate Spikes

All project samples analyzed for organic compounds will be spiked with appropriate surrogate compounds as defined in the analytical methods. Surrogate recoveries will be reported by the laboratories; however, no sample results will be corrected for recovery using these values.

Method Blanks

Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis. A minimum of one method blank will be analyzed for each extraction/digestion batch or for every 20 samples, whichever is more frequent.

Laboratory Control Samples

Laboratory control samples are analyzed as a measure of the accuracy of the analyses. LCS recoveries will be reported by the laboratories; however, no sample results will be corrected for recovery using these values.

Interference Check Samples

In order to identify specific organochlorine pesticides that may coelute with PCB congeners, single point mid-concentration PCB standards will be run with single-component pesticides in the initial calibration. The resulting data will be reviewed by data validators in order to assess potential coelution issues affecting the reported pesticide results.

3.6 FIELD INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Prior to each field event, measures will be taken to test, inspect, and maintain all field equipment. All equipment used, including the GPS unit, digital camera, and Hydrolab, will be tested for use before leaving for the field event.

The FC will be responsible for overseeing the testing, inspection, and maintenance of all field equipment. The laboratory PM will be responsible for ensuring that laboratory equipment testing, inspection, and maintenance requirements are met. The calibration methods used in calibrating the analytical instrumentation are described in the following section.

3.7 INSTRUMENT CALIBRATION AND FREQUENCY

Multipoint initial calibration will be performed on each instrument at the start of the project, after each major interruption to the analytical instrument, and when any continuing calibration does not meet the specified criteria. The number of points used in the initial calibration is defined in each analytical method. Continuing calibrations will be performed daily for organic analyses, every 10 samples for inorganic analyses, and with every sample batch for conventional parameters to ensure proper instrument performance. In addition, if an Aroclor is detected in a sample, then the standard for that Aroclor must be analyzed in the continuing calibration within 72 hrs of the original detection of the Aroclor. Gel permeation chromatography (GPC) calibration verifications will be performed at least once every 7 days and corresponding raw data will be submitted by the lab with the data package.

Field equipment will be calibrated according to the manufacturer's procedures presented in the user's manuals on each day of sampling prior to use in the field.

Calibration will be checked no less frequently than called for by the instrument manuals for the types of measurement being made and the conditions. Calibration information will be recorded in the field notebook. Equipment will be handled according to manufacturer's recommendations. Unusual or questionable readings will be noted and duplicate readings made. Precision will be assessed by comparing the results from duplicate measurements, as discussed in Section 3.2.2.3.

Calibration of analytical equipment used for chemical analysis includes instrument blanks or continuing calibration blanks, which provide information on the stability of the baseline established. Continuing calibration blanks will be analyzed immediately after the continuing calibration verification at a frequency of one blank for every 10 samples analyzed for inorganic analyses and one blank for every 12 hours for organic analyses. If the continuing calibration does not meet the specified criteria, the analysis must stop. Analysis may resume after corrective actions have been taken to meet the method specifications. All project samples analyzed by an instrument found to be out of compliance must be reanalyzed.

3.8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The field team leaders for each sampling effort will have a checklist of supplies required for each day in the field (see Section 3.2). The FC will gather and check these supplies daily for satisfactory conditions before each field event. Batteries used in the GPS unit and the digital camera will be checked daily and recharged as necessary. Sample containers will be inspected to ensure that they are the correct size and quantity and were not damaged in shipment.

3.9 DATA MANAGEMENT

All data will be recorded on field forms, which will be checked for missing information by the FC at the end of each field day. After sampling efforts are completed, all data from field forms will be entered into a Microsoft Excel® spreadsheet. A QC check will be done to ensure that all data were properly transferred from the field form to the spreadsheet (see Section 5.2). This spreadsheet will be kept on the Windward network drive, which is backed up daily. Field forms will be archived in the Windward library.

Analytical laboratories are expected to submit data in an electronic format as described in Section 2.6 and Table 2-4. The laboratory PM should contact the project QA/QC coordinator prior to data delivery to discuss specific format requirements.

A library of routines will be used to translate typical electronic output from laboratory analytical systems and to generate data analysis reports. The use of automated routines ensures that all data are consistently converted into the desired data structures and that operator time is kept to a minimum. In addition, routines and methods for quality checks will be used to ensure that such translations are correctly applied.

Written documentation will be used to clarify how field and laboratory duplicates and QA/QC samples were recorded in the data tables and to provide explanations of other issues that may arise. The data management task will include keeping accurate records of field and laboratory QA/QC samples so that project team members who use the data will have appropriate documentation. Data management files will be stored on a secure computer.

4.0 Assessment and Oversight

4.1 COMPLIANCE ASSESSMENTS AND RESPONSE ACTIONS

EPA, Ecology, or other management agencies may observe field activities during each sampling event, as needed. If situations arise where there is an inability to follow QAPP methods precisely, the Windward PM will determine the appropriate actions or consult EPA and Ecology if the issue is significant.

4.1.1 Compliance assessments

Laboratory and field performance assessments consist of on-site reviews (conducted by EPA) of QA systems and equipment for sampling, calibration, and measurement. EPA personnel may conduct a laboratory audit prior to sample analysis. Any pertinent laboratory audit reports will be made available to the project QA/QC coordinator upon request. All laboratories are required to have written procedures addressing internal QA/QC; these procedures will be submitted for review by the Project QA/QC coordinator to ensure compliance with the QAPP. All laboratories and QA/QC coordinators are required to ensure that all personnel engaged in sampling and analysis tasks have appropriate training.

4.1.2 Response actions for field sampling

The FC or a designee will be responsible for correcting equipment malfunctions throughout the field sampling effort and resolving situations in the field that may result in nonconformance or noncompliance with the QAPP. All corrective measures will be immediately documented in the field logbook, and Protocol Modification Forms will be completed (Form 1).

4.1.3 Corrective action for laboratory analyses

All laboratories are required to comply with the standard operating procedures previously submitted to the project QA/QC coordinator. The laboratory PM 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 Project QA/QC coordinator will be notified immediately if any QC sample exceeds the project-specified control limits (Table 3-5). The analyst will identify and correct the anomaly before continuing with the sample analysis. The laboratory PM will document the corrective action taken in a memorandum submitted to the project QA/QC coordinator within 5 days of the initial notification. A narrative describing the anomaly, the steps taken to identify and correct, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, re-extraction) will be submitted with the data package using a Corrective Action Form (Form 2).

4.2 REPORTS TO MANAGEMENT

Progress reports will be prepared by the FC for LDWG following each sampling event. The project QA/QC coordinator will also prepare progress reports for LDWG after the sampling is completed and the 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, as described in Section 2.6.4.

5.0 Data Validation and Usability

5.1 DATA VALIDATION

Data are not considered final until validated. Data validation will be conducted following EPA (1999, 2002) guidance.

The data validation process begins within the laboratory with the review and evaluation of data by supervisory personnel or QA specialists. The laboratory analyst is responsible for ensuring that the analytical data are correct and complete, that appropriate procedures have been followed, and that QC results are within the acceptable limits. The project QA/QC coordinator is responsible for ensuring that all analyses performed by the laboratories are correct, properly documented, and complete, and that they satisfy the project DQOs specified in this QAPP.

Independent third-party data review and summary validation of the analytical chemical data will be conducted by Cari Sayler of Sayler Data Solutions, Inc. A minimum of 20% or a single sample delivery group will undergo full data validation. Full data validation parameters include:

- quality control analysis frequencies
- analysis holding times
- laboratory blank contamination
- instrument calibration
- surrogate recoveries
- LCS recoveries
- matrix spike recoveries

- matrix spike/matrix spike duplicate RPDs
- compound identifications – verification of raw data with the reported results (10% of samples)
- compound quantitations – verification of calculations and reporting limits (10% of samples)
- instrument performance check using ion abundances
- internal standard areas and retention time shifts

If no discrepancies are found between reported results and raw data in the set that undergoes full data validation, then validation can proceed as a summary validation on the rest of the data using all of the QC forms submitted in the laboratory data package. Data verification and validation will be conducted in accordance with EPA Guidance (EPA QA/G8 2002), as well as the project's specified DQIs (Table 3-5), the technical specifications of the methods indicated in Table 3-5, and EPA (1999, 2002) guidance for organic and inorganic data review. The EPA PM may have EPA peer review the third-party validation or perform data assessment/validation on a percentage of the data.

All discrepancies and requests for additional, corrected data will be discussed with the laboratories prior to issuing the formal data validation report. All contacts with the laboratories will be documented in a communication report. Review procedures used and findings made during data validation will be documented on worksheets. Sayler Data Solutions will prepare a data validation report that will list the samples (using LDW sample numbers and corresponding laboratory numbers) and the suite of parameters evaluated, and will provide a brief discussion of each data validation parameter, focusing on exceedances, out-of-control QC results, and their effects on the quality of the data reported. Only validated data with appropriate qualifiers will be released for general use.

For some organic compounds (e.g., dichlorobenzene), results will be available from both Methods 8260 and 8270. For these compounds, the reported result will be selected based on the following guidelines:

1. If both results are non-detects, the lower reporting limit reported by ARI[21] will be selected.
2. If one result is not detected and the other detected, the detected result will be selected.
3. If both results are detections, the following additional criteria will be applied:
    a. If one result is off the calibration scale and one is on-scale, the on-scale result will be selected.

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[21] ARI does not report sample-specific MDLs with the sample results.

b. If internal standard areas are outside criteria, the better internal standard area result will be selected.

c. If both results meet all reporting criteria, the higher concentration result will be selected as most protective of the environment.

Sample results that are not selected as the best result to report will be qualified as rejected because of the availability of better results.

5.2 RECONCILIATION WITH DATA QUALITY OBJECTIVES

Data quality assessment will be conducted by the project QA/QC coordinator in consultation with EPA guidelines. The results of the third-party independent review and validation will be reviewed and cases in which the project DQOs were not met will be identified. The usability of the data will be determined in terms of the magnitude of the DQO exceedance.

6.0 References

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Data Collection Forms

FORM 1. PROTOCOL MODIFICATION FORM

Project Name and Number: ______________________

Material to be Sampled: ______________________

Measurement Parameter: ______________________

Standard Procedure for Field Collection & Laboratory Analysis (cite reference):

Reason for Change in Field Procedure or Analysis Variation: ______________________

Variation from Field or Analytical Procedure: ______________________

Special Equipment, Materials or Personnel Required: ______________________

Initiator's Name: ______________________ Date: __________

Project Officer: ______________________ Date: __________

QA Officer: ______________________ Date: __________

FORM 2. CORRECTIVE ACTION FORM

Project Name and Number: ______________________________

Sample Dates Involved: ______________________________

Measurement Parameter: ______________________________

____

____

Acceptable Data Range: ______________________________

____

____

Problem Areas Requiring Corrective Action: ______________________________

____

____

Measures Required to Correct Problem: ______________________________

____

____

Means of Detecting Problems and Verifying Correction: ______________________________

____

____

Initiator's Name: ______________________________ Date: ____________

Project Officer: ______________________________ Date: ____________

QA Officer: ______________________________ Date: ____________

FORM 3. SEEP RECONNAISSANCE SURVEY FORM A

Project Name: ______________________ **Project Task:** ______________________

Date: ______________________ **Crew:** ______________________

Weather: ______________________ **Photo no.** ______________________

Name of person filling out form: ______________________

Location ID:	**Time:**	**Photo #:**	
GPS Coordinates:	**Easting (x):**	**Northing (y)**	
Bearing 1:	**Object description:**	**Distance:**	**Compass direction**
Bearing 2:	**Object description:**	**Distance:**	**Compass direction**
Comments/sketch:			

Location ID:	**Time:**	**Photo #:**	
GPS Coordinates:	**Easting (x):**	**Northing (y)**	
Bearing 1:	**Object description:**	**Distance:**	**Compass direction**
Bearing 2:	**Object description:**	**Distance:**	**Compass direction**
Comments/sketch:			

FORM 4. SEEP RECONNAISSANCE SURVEY FORM B

Project Name: ____________________ **Project Task:** ____________________

Date: ____________________ **Crew:** ____________________

Weather: ____________________ **Photo no.** ____________________

Name of person filling out form: ____________________

Location ID:	**Easting (x):**	**Northing (y)**	**Time:**

Qualitative description of flow rate

Temp	**SpC**	**DO**	**pH**	**ORP**	**Turbidity**	**Salinity**
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3

Comments:

Location ID:	**Easting (x):**	**Northing (y)**	**Time:**

Qualitative description of flow rate

Temp	**SpC**	**DO**	**pH**	**ORP**	**Turbidity**	**Salinity**
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3

Comments:

Location ID:	**Easting (x):**	**Northing (y)**	**Time:**

Qualitative description of flow rate

Temp	**SpC**	**DO**	**pH**	**ORP**	**Turbidity**	**Salinity**
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3

Comments:

FORM 5. SEEP RECONNAISSANCE SURVEY FORM C

Project Name: ________________________ **Project Task:** ________________________

Date: ________________________ **Name of person filling out form:** ________________________

Seep number:	**Photo number:**
Substrate description (e.g., rock, soil, cobble, gravel, sand, silt, clay):	
Seep observations (e.g., sheen, bacterial slime, staining, odor, waste material, colored discharge, precipitates, vegetation):	
Description of embankment that seep flows from and general seep characteristics:	
Seep location relative to vertical changes in embankment or beach substrate:	

Seep number:	**Photo number:**
Substrate description (e.g., rock, soil, cobble, gravel, sand, silt, clay):	
Seep observations (e.g., sheen, bacterial slime, staining, odor, waste material, colored discharge, precipitates, vegetation):	
Description of embankment that seep flows from and general seep characteristics:	
Seep location relative to vertical changes in embankment or beach substrate:	

Seep number:	**Photo number:**
Substrate description (e.g., rock, soil, cobble, gravel, sand, silt, clay):	
Seep observations (e.g., sheen, bacterial slime, staining, odor, waste material, colored discharge, precipitates, vegetation):	
Description of embankment that seep flows from and general seep characteristics:	
Seep location relative to vertical changes in embankment or beach substrate:	

FORM 6. SEEP WATER COLLECTION FORM

Project Name: ______________________ **Project Task:** ______________________

Date: ______________________ **Crew:** ______________________

Weather: ______________________ **Photo no.** ______________________

Location ID:		**Easting (x):**		**Northing (y):**		**Time:**
Sample collection method:						
Flow rate collection method:						
Volume of container:						
Time to fill container:						
Calculated flow rate:						
Temp	**SpC**	**DO**	**pH**	**ORP**	**Turbidity**	**Salinity**
1	1	1	1	1	1	1
2	2	2	2	2	2	2
Comments:						

Substrate description (e.g., rock, soil, cobble, gravel, sand, silt, clay)	
Seep observations (e.g., sheen, bacterial slime, staining, odor, waste material, colored discharge, precipitates, vegetation):	
Description of embankment that seep flows from and general seep characteristics:	
Seep location relative to vertical changes in embankment or beach substrate:	

APPENDIX A. HEALTH AND SAFETY PLAN

By their signature, the undersigned certify that this Health and Safety Plan (HSP) is approved and that it will be used to govern health and safety aspects of fieldwork described in the Quality Assurance Project Plan to which it is attached.

Name Windward Project Manager	Date
Name Corporate Health and Safety Manager	Date
Name Field Coordinator/Health and Safety Officer	Date

Acronyms

CPR	cardiopulmonary resuscitation
CSO	combined sewer overflow
EPA	US Environmental Protection Agency
FC	field coordinator
HSM	Project Health and Safety Manager
HSO	Field Health and Safety Officer
HSP	health and safety plan
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyls
PFD	personal flotation device
PPE	personal protective equipment
TBT	tributyltin

A.1.0 Introduction

This site-specific health and safety plan (HSP) describes safe working practices for conducting field activities at potentially hazardous sites and for handling potentially hazardous materials/waste products. This HSP covers elements as specified in 29 CFR 1910§120. The procedures and guidelines contained in this plan are based on generally recognized health and safety practices. Any changes or revisions to this plan will be made by a written amendment, which will become a permanent part of this plan. The goal of the HSP is to establish procedures for safe working practices for all field personnel.

This HSP addresses all activities associated with collection and handling of seep water samples in the Lower Duwamish Waterway (LDW). During site work, this HSP will be implemented by the Field Coordinator (FC), who is also the designated site Health and Safety Officer (HSO), in cooperation with Windward's Corporate Health and Safety Manager (HSM) and Windward's Project Manager (PM).

All personnel involved in fieldwork on this project are required to comply with this HSP. The contents of this HSP reflect anticipation of the types of activities to be performed, knowledge of the physical characteristics of the site, and consideration of preliminary chemical data from previous investigations at the site. The HSP may be revised based on new information and/or changed conditions during site activities. Revisions will be documented in the project records.

Observers for the reconnaissance survey or seep water sampling event who are not field personnel will be given a safety briefing by the HSO on physical and chemical hazards. Observers will be advised of chemicals that may be present at the site and where those chemicals may be located. In addition, appropriate attire and any precautions necessary while walking along the shoreline will be discussed.

A.2.0 Site Description and Project Scope

A.2.1 SITE DESCRIPTION

The sampling area is in the LDW (see Figure 3-1 in the attached QAPP). The area is affected by tidal fluctuations. The QAPP to which this HSP is attached provides complete details of the sampling program. The following section summarizes the types of work that will be performed during field activities.

A.2.2 SCOPE AND DURATION OF WORK

Specific tasks to be performed are as follows:

- A reconnaissance survey will conducted by boat in from May 5 to May 7, 2004 to identify locations of seeps throughout the LDW. For each seep location identified, field personnel will access the shoreline for closer inspection, photo documentation, and field measurement of water quality parameters.

- Water samples will be collected from select seep locations for chemical analysis from June 30, 2004 to July 2, 2004. Seep locations will accessed by land or water. Collection methods may include excavating a pit in the sediment to collect seep water discharging from intertidal areas with shallow slopes.

A.3.0 Health and Safety Personnel

Key health and safety personnel and their responsibilities are described below. These individuals are responsible for the implementation of this HSP.

Task Manager: The TM has overall responsibility for the successful outcome of the project. The TM will ensure that adequate resources and budget are provided for the health and safety staff to carry out their responsibilities during fieldwork. The TM, in consultation with the HSM, makes final decisions concerning implementation of the HSP.

Field Coordinator/Health and Safety Officer: Because of the limited scope and duration of fieldwork, the Field Coordinator (FC) and Health and Safety Officer (HSO) will be the same person. The FC/HSO will direct field sampling activities, coordinate the technical components of the field program with health and safety components, and ensure that work is performed according to the QAPP.

The FC/HSO will implement this HSP at the work location and will be responsible for all health and safety activities and the delegation of duties to a health and safety technician in the field, if appropriate. The FC/HSO also has stop-work authority, to be used if there is an imminent safety hazard or potentially dangerous situation. The FC/HSO or his designee shall be present during sampling and operations.

Windward's Corporate Health and Safety Manager: The HSM has overall responsibility for preparation, approval, and revisions of this HSP. The HSM will not necessarily be present during fieldwork, but will be readily available, if required, for consultation regarding health and safety issues during fieldwork.

Field Crew: All field crew members must be familiar with and comply with the information in this HSP. They also have the responsibility to report any potentially unsafe or hazardous conditions to the FC/HSO immediately.

A.4.0 Hazard Evaluation and Control Measures

This section covers potential physical and chemical hazards that may be associated with the proposed project activities, and presents control measures for addressing these hazards. The activity hazard analysis, Section A.4.3, 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 HSP.

A.4.1 PHYSICAL HAZARDS

For this project, it is anticipated that physical hazards will present a greater risk of injury than chemical hazards. Physical hazards are identified and discussed below.

A.4.1.1 Slips, trips, and falls

As with all fieldwork sites, caution should be exercised to prevent slips, trips, and falls on slick or uneven surfaces. In particular, care should be used in rainy conditions, on the shoreline, and when getting on or off the boat to access the shoreline. Debris, including slick rocks, pieces of wood or pilings, vegetation, and other objects, are found along the shoreline throughout the LDW. Before sampling activities begin, there will be a training session for all field personnel on the physical hazards to be aware of both on the boat and on shore.

Slips can be minimized by wearing boots with good tread, made of material that does not become overly slippery when wet. Trips are always a hazard on the uneven deck of a boat, in a cluttered work area, or in the intertidal zone where uneven substrate is common. Personnel will keep work areas as free as possible from items that interfere with walking. Falls may be avoided by working as far from exposed edges as possible, by erecting railings, and by using fall protection when working on elevated platforms. For this project, no work is anticipated that would present a fall hazard.

A.4.1.2 Sampling equipment

All sampling equipment, including GPS, Hydrolab, and digital and video cameras, will be used onshore. The sampling methodologies are not anticipated to be labor intensive; however, care will be taken to ensure safe use of all equipment. Before field activities begin, there will be a training session for all field personnel in use of sampling equipment.

A.4.1.3 Falling overboard

Access to seeps onshore will be from a boat. As with any work from a floating platform, there is a chance of falling overboard. Personal flotation devices (PFDs) will be worn by all field personnel in the boat.

A.4.1.4 Manual lifting

Equipment and samples must be lifted and carried. 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 will be used.

A.4.1.5 Heat stress, hypothermia, or frostbite

Sampling operations and conditions that might result in the occurrence of heat stress, hypothermia, or frostbite are not anticipated. The sampling will occur during the time of year when extreme weather conditions are not expected to occur.

A.4.1.6 Weather

In general, field team members will be equipped for the normal range of weather conditions. The FC/HSO 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.

In the event of heavy rain, field team members will not sample near a flowing CSO because of potentially high levels of fecal coliform bacteria.

A.4.1.7 Sharp objects

Sampling operations might result in exposure of field personnel to sharp objects on top of or buried within the sediment. If encountered, field personnel should not touch these objects. Also, field personnel should not dig in the sediment by hand.

A.4.2 VESSEL HAZARDS

Because of the high volumes of vessel and barge traffic on the LDW, precautions and safe boating practices will be implemented to ensure that the field boat does not interrupt vessel traffic. As practical, the field boat will stay out of the navigation channel. Additional potential vessel emergency hazards and responses are listed in Table A-1.

Table A-1 Potential Vessel Emergency Hazards and Responses

POTENTIAL EMERGENCY HAZARD	RESPONSE
Fire or Explosion	If manageable, attempt to put out a small fire with a fire extinguisher. Otherwise, call the Coast Guard or 911 and evacuate the area (by rescue boat or swimming) and meet at a designated area. The FC/HSO will take roll call to make sure everyone evacuated safely. Emergency meeting places will be determined in the field during the daily safety briefing.
Medical Emergency/Personal Injury	At least one person with current first aid-CPR training will be aboard the vessel at all times. This person will attempt to assess the nature and severity of the injury, call 911 immediately, and apply CPR if necessary. Stop work and wait for medical personnel to arrive. Fill out a site accident report.

POTENTIAL EMERGENCY HAZARD	RESPONSE
Person Overboard	All persons aboard the sampling vessel will wear a personal flotation device at all time. Have one person keep an eye on the person and shout the distance (boat lengths) and direction (o'clock) of the person from the vessel. Stop work and use the vessel to retrieve the person in the water.
Sinking Vessel	Call the Coast Guard immediately. If possible, wait for a rescue boat to arrive to evacuate vessel personnel. See fire/explosion section for emergency evacuation procedures. The FC/HSO will take a roll call to make sure everyone is present.
Lack of Visibility	If the navigation visibility or personal safety is compromised because of smoke, fog, or other unanticipated hazards, stop work immediately. The vessel operator and FC/HSO will assess the hazard and, if necessary, send out periodic horn blasts to mark vessel location to other vessels potentially in the area, move to a secure location (i.e., berth), and wait for the visibility to clear.
Loss of Power	Stop work and call Coast Guard for assistance. Use oars to move vessel towards the shoreline. Vessel personnel should watch for potential collision hazards and notify vessel operator if hazards exist. Secure vessel to a berth, dock, or mooring as soon as possible.
Collision	Stop work and call Coast Guard for assistance. The FC/HSO and vessel operator will assess damage and potential hazards. If necessary, vessel will be evacuated and secured until repairs can be made.

A.4.3 CHEMICAL HAZARDS

Previous investigations have shown that some chemical substances are present at higher-than-background concentrations in the sampling area. Potential exposure to sample media could occur through contact with intertidal sediments and seep water. For the purposes of discussing potential exposure to substances in sediments, the chemicals of concern are metals, tributyltin (TBT), petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs).

A.4.3.1 Exposure routes

Potential routes of chemical exposure include inhalation, dermal contact, and ingestion. 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 A.6.

Inhalation —Inhalation is not expected to be an important route of exposure.

Dermal exposure — Dermal exposure to hazardous substances associated with sediments, surface water, or equipment decontamination will be controlled by the use of PPE and by adherence to detailed sampling and decontamination procedures.

Ingestion — Ingestion is not considered a major route of exposure for this project. Accidental ingestion of surface water is possible. However, careful handling of equipment and containers aboard the boat should prevent the occurrence of water splashing or spilling during sample collection and handling activities.

A.4.3.2 Description of chemical hazards

Metals and tributyltin — Exposure to metals may occur via ingestion or skin contact. As mentioned above, neither is likely as an exposure route. Metal fumes or metal-contaminated dust will not be encountered during field and sample handling activities. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for passage of any of the metals into the body. Field procedures require immediate washing of sediments from exposed skin.

Petroleum hydrocarbons and PAHs — Exposure to petroleum hydrocarbons and PAHs may occur via ingestion or skin contact. The most important human health exposure pathway for this group of chemicals, inhalation, is not expected to occur at this site. Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure, but these effects have not been seen in people. Some PAHs may reasonably be expected to be carcinogens. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for passage of any of these compounds into the body. Field procedures require immediate washing of sediments from exposed skin.

Polychlorinated biphenyls — Prolonged skin contact with PCBs may cause acne-like symptoms known as chloracne. Irritation to eyes, nose, and throat may also occur. Acute and chronic exposure can damage the liver, and cause symptoms of edema, jaundice, anorexia, nausea, abdominal pains, and fatigue. PCBs are a suspected human carcinogen. Skin absorption may substantially contribute to the uptake of PCBs. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for passage of any of the compounds into the body. Field procedures require immediate washing of sediments from exposed skin.

A.4.4 ACTIVITY HAZARD ANALYSIS

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

Table A-2 presents the activity hazard analysis for the seep surveying and sampling activities.

Table A-2. Activity hazard analysis

ACTIVITY	HAZARD	CONTROL
Accessing shoreline from boat	Slips, trips, or falls	Use care in boarding and departing the vessel. Wear PFD. Be cognizant of obstacles on shore.
Seep water sampling	Skin contact with contaminated sediment or seep water; contact with sharp objects	Wear modified Level D PPE. Do not dig in sediment with hands. Do not touch sharp objects is found.

A.5.0 Work Zones

During sampling and sample handling activities, work zones will be established to identify where sample collection and processing are actively occurring. The intent of the work zone is to limit the migration of sample material out of the work zone and to restrict access to active work areas by defining work zone boundaries.

A.5.1 WORK ZONE

The work zone onshore will encompass the area where sample collection and handling activities are performed. On the beach, the FC/HSO will delineate the work zone as a particular area. Only persons with appropriate training, PPE, and authorization from the FC/HSO will be allowed to enter the work zone while work is in progress.

A.5.2 DECONTAMINATION STATION

A decontamination station will be set up at the end of a work day for personnel to clean soiled boots. The station will have the buckets, brushes, soapy water, rinse water, or wipes necessary to clean boots, PPE, or other equipment. Plastic bags will be provided for expendable and disposable materials.

Decontamination of the boat will also be completed at the end of each work day. Cockpit and crew areas will be rinsed down with LDW water to minimize accumulation of sediment.

A.6.0 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:

- Do not climb over or under obstacles of questionable stability.
- Do not eat, drink, smoke, or perform other hand-to-mouth transfers in the work zone.
- Work only in well-lighted spaces.
- Never enter a confined space without the proper training, permits, and equipment.

- Make eye contact with equipment operators when moving within the range of their equipment.
- Be aware of the movements of shipboard equipment when not in the operator's range of vision.
- Get immediate first aid for all cuts, scratches, abrasions, or other minor injuries.
- Use the established sampling and decontamination procedures.
- Always use the buddy system.
- Be alert to your own and other workers' physical condition.
- Report all accidents, no matter how minor, to the FC/HSO.
- Do not do anything dangerous or unwise even if ordered by a supervisor.

A.7.0 Personal Protective Equipment and Safety Equipment

Appropriate PPE will be worn as protection against potential hazards. In addition, a PFD will be required when working aboard the boat. Prior to donning PPE, the field crew will inspect their PPE for any defects that might render the equipment ineffective.

Fieldwork will be conducted in Level D or modified Level D PPE, as discussed below in Sections A.7.1 and A.7.2. Situations requiring PPE beyond modified Level D are not anticipated. Should the FC/HSO determine that PPE beyond modified Level D is necessary, the HSM will be notified and an alternative selected.

A.7.1 LEVEL D PERSONAL PROTECTIVE EQUIPMENT

Workers performing general activities in which skin contact with contaminated materials is unlikely will wear Level D PPE. Level D PPE includes the following:

- Cotton overalls or laboratory coats
- Chemical-resistant steel-toed boots
- Chemical-resistant gloves
- Safety glasses

A.7.2 MODIFIED LEVEL D PERSONAL PROTECTIVE EQUIPMENT

Workers performing activities where skin contact with contaminated materials is possible and in which inhalation risks are not expected will be required to wear 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:

- Impermeable outer garb such as rain gear

- Chemical-resistant steel-toed boots
- Chemical-resistant outer gloves

A.7.3 SAFETY EQUIPMENT

In addition to PPE that will be worn by shipboard personnel, basic emergency and first aid equipment will also be provided. Equipment for the field team will include:

- A copy of this HSP
- First aid kit adequate for the number of personnel
- Emergency eyewash

The FC/HSO will ensure that the safety equipment is aboard. Equipment will be checked daily to ensure its readiness for use.

A.8.0 Monitoring Procedures for Site Activities

A monitoring program that addresses the potential site hazards will be maintained. For this project, air, dust, and noise monitoring will not be necessary. No VOCs have been identified among the expected contaminants, the sampled media will be wet and will not pose a dust hazard, and none of the equipment emits high-amplitude (>85 dBA) sound. For this project, the monitoring program will consist of all workers monitoring themselves and their co-workers for signs that might indicate physical stress or illness.

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
- Symptoms of heat stress
- 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
- Shivering
- Blue lips or fingernails

If any of these conditions develop, work shall be halted immediately and the affected person(s) 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 direct result of sample collection or handling activities, procedures will be modified to address the problem.

A.9.0 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 buckets
- Rinse buckets
- Long-handled scrub brushes
- Clean water sprayers
- Paper towels
- Plastic garbage bags
- Alconox® or similar decontamination solution

A.9.1 MINIMIZATION OF CONTAMINATION

The first step in addressing contamination is to prevent or minimize exposure to existing contaminated materials and the spread of those materials. During field activities, the FC/HSO will enforce the following measures:

Personnel:

- Do not walk through areas of obvious or known contamination
- Do not handle, touch, or smell contaminated materials directly
- Make sure PPE has no cuts or tears prior to use
- Fasten all closures on outer clothing, covering with tape if necessary
- 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 boat:

- 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
- Rinse boots in LDW water before entering the boat

A.9.2 PERSONNEL DECONTAMINATION

The FC/HSO will ensure that all site personnel are familiar with personnel decontamination procedures. Personnel will perform decontamination procedures, as appropriate, before eating lunch, taking a break, or before leaving the work location. Following is a description of these procedures.

Decontamination procedure:

1. If outer suit is heavily soiled, rinse it off
2. Wash and rinse outer gloves and boots with water
3. Remove outer gloves; inspect and discard if damaged
4. Wash hands if taking a break
5. Don necessary PPE before returning to work

Dispose of soiled, expendable PPE before leaving for the day

A.9.3 SAMPLING EQUIPMENT DECONTAMINATION

The shovel used to dig pits for seep water collection will be decontaminated before each use by rinsing with LDW water, washing with detergent such as Alconox, and then rinsed with LDW water. Frontier will provide precleaned and decontaminated glass beakers and stainless steel bowls for seep water collection. Dedicated precleaned beakers and bowls will be used at each new seep location; decontamination of these materials will not be conducted in the field.

A.9.4 VESSEL DECONTAMINATION

Prior to returning to the boat after sampling, personnel will rinse their boots with LDW water to minimize the amount of sediment accumulating in the boat. At the end of each sampling day, the vessel will be rinsed with LDW water to remove sediment from cockpit and crew areas.

A.10.0 Disposal of Contaminated Materials

All disposable sampling materials and PPE, such as disposable coveralls, gloves, and paper towels used in sample processing, will be placed in heavyweight garbage bags. Filled garbage bags will be placed in a normal refuse container for disposal as solid waste.

A.11.0 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 hazardous concentrations of contaminants will be encountered in sampled material, so training will consist of site-specific instruction for all personnel and oversight of inexperienced personnel by an experienced person for one working day. The following sections describe the training requirements for this fieldwork.

A.11.1 PROJECT-SPECIFIC TRAINING

In addition to HAZWOPER training, as described in Section 2.5 of the QAPP, field personnel will undergo training specifically for this project. All personnel must read this HSP and be familiar with its contents before beginning work. They shall acknowledge reading the HSP by signing the field team HSP review form contained in Attachment A1. The form will be kept in the project files.

The boat captain and FC/HSO will also be required to have the US Coast Guard Auxiliary Boating Safely certification. The Boat captain or a designee will provide project-specific training prior to the first day of fieldwork and whenever new workers or agency observers arrive. Field personnel will not be allowed to begin work until project-specific training is completed and documented by the FC/HSO. Training will address the HSP and all health and safety issues and procedures pertinent to field operations. Training will include, but not be limited to, the following topics:

- Activities with the potential for chemical exposure
- Activities that pose physical hazards, and actions to control the hazard
- 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

- Vessel evacuation and emergency procedures

A.11.2 DAILY SAFETY BRIEFINGS

The FC/HSO or a designee and the boat captain will present safety briefings before the start of each day's activities. These safety briefings will outline the activities expected for the day, update work practices and hazards, address any specific concerns associated with the work location, and review emergency procedures and routes. The FC/HSO or designee will document safety briefings in the logbook.

A.11.3 FIRST AID AND CPR

At least one member of the field team must have first-aid and cardiopulmonary resuscitation (CPR) training. Documentation of which individuals possess first-aid and CPR training will be kept in the project health and safety files.

A.12.0 Medical Surveillance

A medical surveillance program conforming to the provisions of 29 CFR 1910§120(f) is not necessary for field team members because they do not meet any of the four criteria outlined in the regulations for implementation of a medical surveillance program:

- Employees who are or may be exposed to hazardous substances or health hazards at or above permissible exposure levels for 30 days or more per year (1910.120(f)(2)(I)
- Employees who must wear a respirator for 30 days or more per year (1910.120(f)(2)(ii))
- Employees who are injured or become ill as a result of possible overexposures involving hazardous substances or health hazards from an emergency response or hazardous waste operation (1910.120(f)(2)(iii))
- Employees who are members of HAZMAT teams (1910.120(f)(2)(iv)).

As described in Section A.8, employees will monitor themselves and each other for any deleterious changes in their physical or mental condition during the performance of all field activities.

A.13.0 Reporting and Record Keeping

Each member of the field crew will sign the HSP review form (see Attachment A1). If necessary, accident/incident report forms and OSHA Form 200s will be completed by the FC/HSO.

The FC/HSO or a designee will maintain a health and safety field logbook that records health- and safety-related details of the project. Alternatively, entries may be made in the field logbook, in which case a separate health and safety logbook will not be required. The logbook must be bound and the pages must be numbered consecutively. Entries will be made with indelible blue ink. At a minimum, each day's entries must include the following information:

- Project name or location
- Names of all personnel onboard
- 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.

A.14.0 Emergency Response Plan

As a result of the hazards onboard and the conditions under which operations will be conducted, 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. Field personnel 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 identify the onboard 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 to a hospital from any sampling location.

A.14.1 PRE-EMERGENCY PREPARATION

Before the start of field activities, the FC/HSO will ensure that preparation has been made in anticipation of emergencies. Preparatory actions include the following:

- Meeting with the FC/HSO and equipment handlers concerning the emergency procedures in the event that a person is injured.

- A training session given by the FC/HSO 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 in the HSP and ensuring that a copy of the HSP accompanies the field team.

A.14.2 PROJECT EMERGENCY COORDINATOR

The FC/HSO will serve as the Project Emergency Coordinator in the event of an emergency. She will designate her replacement for times when she is not onboard or is not serving as the Project Emergency Coordinator. The designation will be noted in the logbook. The Project Emergency Coordinator will be notified immediately when an emergency is recognized. The Project Emergency Coordinator 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 Project Emergency Coordinator will notify the HSM and the Windward PM as soon as possible after initiating an emergency response action. The Windward PM will have responsibility for notifying the client.

A.14.3 EMERGENCY RESPONSE CONTACTS

All onboard personnel must know whom to notify in the event of an emergency situation, even though the FC/HSO has primary responsibility for notification. Table A-3 lists the names and phone numbers for emergency response services and individuals.

Table A-3. Emergency response contacts

CONTACT	TELEPHONE NUMBER
Emergency Numbers	
Ambulance	911
Police	911
Fire	911
Harborview Medical Center	(206) 323-3074
Emergency Responders	
U.S. Coast Guard	
Emergency General information	(206) 286-5400 (206) 442-5295 UHF Channel 16

CONTACT	TELEPHONE NUMBER
National Response Center	(800) 424-8802
EPA	(908) 321-6660
Washington State Department of Ecology – Northwest Region Spill Response (24-hour emergency line)	(206) 649-7000
Emergency Contacts	
Project Task Manager	
Berit Bergquist	(206) 577-1291
Corporate Health and Safety Manager	
Tad Deshler	(206) 577-1285
Field Coordinator/ Field Health and Safety Officer	Site cellular telephone:
Joanna Florer	(206) 954-1780

A.14.4 RECOGNITION OF EMERGENCY SITUATIONS

Emergency situations will generally be recognizable by observation. 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.

A.14.5 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.

A.14.6 FIRE

Field personnel will attempt to control only small fires, should they occur. If an explosion appears likely, personnel will follow evacuation procedures specified during the training session. If a fire cannot be controlled with a fire extinguisher on board that is part of the required safety equipment, personnel will either withdraw from the vicinity of the fire or evacuate the boat as specified in the training session.

A.14.7 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 Project Emergency Coordinator of the incident, the name of the individual, the location, and the nature of the injury

The Project Emergency Coordinator will immediately do the following:

- Notify the boat 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 a life-threatening emergency occurs, i.e., injury where death is imminent without immediate treatment, the FC/HSO or boat captain will call 911 and arrange to meet the Medic One unit at the nearest accessible dock. Otherwise, for emergency injuries that are not life-threatening (i.e., broken bones, minor lacerations, etc.) the Project Emergency Coordinator will follow the procedures outlined above and proceed to the Harbor Island Marina or to an alternative location of her choice if that would be more expedient.
- Notify the HSM and the Windward PM.

If the Project Emergency Coordinator determines that emergency response is not necessary, she 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 A.14.10.

If a worker leaves the boat to seek medical attention, another worker should accompany them 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 Project Emergency Coordinator.

The Project Emergency Coordinator will have responsibility for completing all accident/incident field reports, OSHA Form 200s, and other required follow-up forms.

A.14.8 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.

A.14.8.1 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
- After initial response actions have been taken, seek appropriate medical attention

A.14.8.2 Inhalation

- Move victim to fresh air
- Seek appropriate medical attention

A.14.8.3 Ingestion

- Seek appropriate medical attention

A.14.8.4 Puncture wound or laceration

- Seek appropriate medical attention

A.14.9 SPILLS AND SPILL CONTAINMENT

No bulk chemicals or other materials subject to spillage are expected to be used during this project. Accordingly, no spill containment procedure is required for this project.

A.14.10 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:

Harborview Medical Center
325 Ninth Ave.
Seattle, WA
(206) 323-3074

Directions from the vicinity of LDW to Harborview Medical Center are as follows:

- Dock the vessel at the 1st Ave S boat launch
- Drive east on S River Street
- Turn left on Occidental Ave S
- Turn left on E Marginal Way S
- Turn right on S Michigan Street
- Look for entrance ramps to I-5 Northbound
- Head north on I-5
- Take the James Street exit
- Head east on James Street to 9th Avenue
- Turn right on 9th Avenue
- Emergency entrance will be two blocks south on the right

ATTACHMENT A1. FIELD TEAM HEALTH AND SAFETY PLAN REVIEW

I have read a copy of the Health and Safety Plan, which covers field activities that will be conducted to investigate potentially contaminated areas in the LDW. I understand the health and safety requirements of the project, which are detailed in this Health and Safety Plan.

Signature Date

Signature Date

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APPENDIX B. SEEP WATER SAMPLING LOCATIONS

This appendix presents the seep locations that were selected for chemical analyses of seep water at the seep selection meeting with EPA and Ecology on May 25, 2004. Eighteen locations were chosen for seep water collection and chemical analyses, and are shown in Figure B-1. Table B-1 presents water quality parameter results from the reconnaissance survey for each selected seep, along with additional information used at the May 25, 2004 meeting in the weight-of-evidence approach for seep selection, such as proximity to potential sources, sediment quality data, and notable visual observations. Table B-2 summarizes the rationale for selecting each seep.

Figure B-1. Locations of seeps for analysis of seep water chemistry

Windward environmental LLC

Prepared by CEJ 06/01/04 Map 1391
W:\Projects\00-08-06_Duwamish_RI\data\gis\Seep survey

Table B-1. Available information used in weight-of-evidence approach for selecting seeps to sample.

Seep	Location	Proximity to Potential Source	Sediment Quality for Samples within 100 ft	Notable Field Observations or Other Comments	Qualitative Flow Rate	Temperature (°C)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	pH	Oxidation-Reduction Potential (mV)	Salinity (ppt)
10	RM 2.8E; Slip 4	potential historical source	1 sample with PCBs >CSL, 3 samples with multiple chemicals >CSL/ML	filamentous algae	medium-high	14.74	15,040	7.80	na	93	11.1
12	RM 2.8E	adjacent to Crowley Marine Services	1 sample with PCBs >SQS and ≤CSL; 1 sample with multiple chemicals >CSL/ML	slimy surface at seep; drums on pallets and concrete surface above embankment; adjacent to Crowley Marine Services	high	12.22	31,257	4.76	na	250	26.5
20	RM 3.7E	adjacent to Jorgensen	1 sample with PCBs >SQS and ≤CSL; 1 sample with multiple chemicals >SQS and ≤CSL	light sheen observed in LDW water along Jorgensen property – no sheen observed in seep or its intertidal vicinity	medium	15.60	14,680	5.53	na	176	10.6
24	RM 4.2E; Slip 6	adjacent to Boeing Developmental Center; potential historical source[a]	2 samples with multiple chemicals >CSL/ML	slime at seep location	medium-low	16.04	20,920	7.31	na	724	15.4
39	RM 4.3W	potential upland dredge spoils	1 sample with PCBs >SQS and ≤CSL	adjacent to Delta Marine	high	15.67	8,304	2.04	6.93	159	5.7
41	RM 4.0W	no potential source identified in vicinity	no sediment data	light sheen at seep	high	19.35	18,553	1.86	6.68	89	12.5
48	RM 3.0W	no potential source identified in vicinity	1 sample with PCBs >CSL	public access location (South Park)	high	13.93	20,529	2.88	7.92	181	16.0
53	RM 2.2W	adjacent to Swan Bay Holdings	no sediment data	black liquid oozing from seep; TPH odor	low	12.63	20,494	1.90	6.95	34	16.5
54	RM 2.2W	adjacent to Swan Bay Holdings	no sediment data	grey foam at seep; construction and metal debris along shore	low	12.83	9,814	2.18	6.72	138	7.4

SEEP	LOCATION	PROXIMITY TO POTENTIAL SOURCE	SEDIMENT QUALITY FOR SAMPLES WITHIN 100 FT	NOTABLE FIELD OBSERVATIONS OR OTHER COMMENTS	QUALITATIVE FLOW RATE	TEMPERATURE (°C)	SPECIFIC CONDUCTIVITY (µS/cm)	DISSOLVED OXYGEN (mg/L)	pH	OXIDATION-REDUCTION POTENTIAL (mV)	SALINITY (ppt)
61	RM 1.5W	adjacent to Glacier NW (near former Reichhold plant)	no sediment data	dark yellow seep water; sulfide odor	medium-high	13.02	11,390	1.35	6.92	96	8.6
62	RM 1.4W	adjacent to Glacier NW (near former Reichhold plant)	1 sample with PCBs >SQS and ≤CSL; 1 sample with detected dioxin/furans	na	low	12.87	15,394	2.39	6.95	212	12.0
64	RM 1.0W	no potential source identified in vicinity	no sediment data	light brownish yellow seep water; adjacent to Lafarge Corporation; sheen present at seep	medium	12.17	18,395	1.67	6.49	154	14.8
69	RM 0.5E	Central Painting, McFarland Property, and Birmingham Steel within 500 m	1 sample with PCBs >SQS and ≤CSL; 2 samples with multiple chemicals >SQS/SL and ≤CSL/ML	adjacent to restoration area; public access location	medium-low	17.13	26,850	3.41	8.29	176	19.7
71	RM 0.2W	approximately 50 m north of Birmingham Steel	no sediment data	public access area	medium-low	13.75	21,033	2.71	6.75	187	16.5
75	RM 0.8E	within 250 m of T-108/Chiyoda; potential gasoline source in adjacent groundwater	2 samples with no detects	restoration area; pale yellow seep water	medium-low	12.66	14,946	1.74	6.52	140	11.7
76	RM 1.0E: Slip 1	no potential source identified in vicinity	1 sample with PCBs >SQS and ≤CSL; 1 sample with multiple chemicals >CSL/ML	abundant metal debris on the bank; light yellow seep water	low	13.71	16,134	2.01	6.1	174	12.3
80	RM 1.6E	adjacent to James Hardie Gypsum; downgradient from Philip Services	1 sample with multiple chemicals >CSL/ML	white bacterial growth near seep	medium	14.93	13,411	2.96	6.76	86	9.8

SEEP	LOCATION	PROXIMITY TO POTENTIAL SOURCE	SEDIMENT QUALITY FOR SAMPLES WITHIN 100 FT	NOTABLE FIELD OBSERVATIONS OR OTHER COMMENTS	QUALITATIVE FLOW RATE	TEMPERATURE (°C)	SPECIFIC CONDUCTIVITY (µS/cm)	DISSOLVED OXYGEN (mg/L)	pH	OXIDATION-REDUCTION POTENTIAL (mV)	SALINITY (ppt)
82	RM 1.8E; Slip 2	adjacent to Lone Star and historical waste disposal area; downgradient from Philip Services	no sediment data	construction debris	medium-high	13.27	14,477	2.90	6.76	124	11.1

[a] This seep is located at the approximate mouth of a historic natural creek that appears to have drained an upland hazardous waste site in about 1940, as well as a scrap facility in the 1960s (EPA and USACE 2004).

CSL – cleanup screening level

ML – maximum level

SL – screening level

SQS – sediment quality standard

na – pH data not available; no notable field observations or other comments

Table B-2. Summary of rationale for selecting seeps to sample for chemical analysis

SEEP	RATIONALE
10	potential historical source; sediment CSL/ML exceedances
12	adjacent to Crowley; sediment CSL/ML exceedances
20	adjacent to Jorgensen
24	adjacent to Boeing Development center; potential historical source from hazardous waste site and scrap facility; sediment CSL/ML exceedances
39	adjacent to Delta Marine; potential upland dredge spoils; high seep flow
41[a]	light sheen observed
48	located near Long Painting; public access area
53[a]	adjacent to Swan Bay Holdings; black ooze at seep; petroleum odor
54[a]	adjacent to Swan Bay Holdings on opposite bank from Seep 53; grey foamy seep water; construction and metal debris
61	adjacent to Glacier NW (near former Reichhold plant); discolored seep water; sulfide odor
62	adjacent to Glacier NW (near former Reichhold plant); dioxins/furans detected in sediment
64[a]	sheen in vicinity of seep; discolored seep water
69	near Central Painting, McFarland Property, and Birmingham Steel; restoration site; public access; sediment SQS/SL exceedances
71	near Birmingham Steel; clam collection area; public access area
75	near T-108/Chiyoda property; potential historical source; gasoline detected in upland groundwater; discolored seep water; restoration area
76	sediment CSL/ML exceedances; discolored seep water
80	adjacent to James Hardie Gypsum; downgradient from Philip Services; sediment CSL/ML exceedances
82	adjacent to Lone Star; adjacent to historical hazardous waste disposal area and junkyard; downgradient from Philip Services

[a] TPH will be an additional analyte in both filtered and unfiltered samples collected at these locations.

APPENDIX C. EXISTING SEEP DATA

This appendix summarizes existing seep data from sampling events listed in Table 2-1 at four sites along the LDW. This appendix also compares concentrations of chemicals in those seeps to Washington State marine chronic water quality standards.

Tables C-1, C-2, C-3, and C-4 are summaries of existing data for the Boeing Plant 2, Great Western, T-117, and Rhone-Poulenc sites, respectively. Table C-5 presents seep water concentrations from these sampling events that exceed Washington State marine chronic water quality standards. Table C-6 presents the number of detects and non-detects in existing seep water data that are above or below Washington State marine water quality standards.

Table C-1. Summary of existing seep water data for Boeing Plant 2

Analyte	Detection Frequency	Minimum Detected Conc.	Maximum Detected Conc.	Unit	Detection Limits [a]
Metals					
Aluminum (dissolved)	0/10	nd	nd	µg/L	0.02–0.1
Aluminum (total)	20/21	0.14	18.9	µg/L	0.1
Antimony (dissolved)	0/10	nd	nd	µg/L	0.02
Antimony (total)	1/21	0.006	0.006	µg/L	0.002–0.02
Arsenic (dissolved)	10/10	0.006	0.01	µg/L	na
Arsenic (total)	19/21	0.002	0.02	µg/L	0.005–0.005
Barium (dissolved)	1/10	0.071	0.071	µg/L	0.01–0.037
Barium (total)	21/21	0.006	0.132	µg/L	na
Beryllium (dissolved)	0/10	nd	nd	µg/L	0.001–0.005
Beryllium (total)	0/21	nd	nd	µg/L	0.001–0.005
Cadmium (dissolved)	0/10	nd	nd	µg/L	0.002–0.01
Cadmium (total)	0/21	nd	nd	µg/L	0.002–0.01
Calcium (dissolved)	10/10	129	257	µg/L	na
Calcium (total)	21/21	23.9	263	µg/L	na
Chromium (dissolved)	0/10	nd	nd	µg/L	0.005–0.02
Chromium (total)	7/21	0.006	0.049	µg/L	0.005–0.02
Cobalt (dissolved)	0/10	nd	nd	µg/L	0.003–0.02
Cobalt (total)	3/21	0.003	0.004	µg/L	0.003–0.02
Copper (dissolved)	1/10	0.008	0.008	µg/L	0.002–0.01
Copper (total)	14/21	0.002	0.116	µg/L	0.002–0.01
Hardness	21/21	140	4000	µg/L	na
Iron (dissolved)	2/10	1.63	2.36	µg/L	0.01–0.05
Iron (total)	21/21	0.45	26.4	µg/L	na
Lead (dissolved)	0/10	nd	nd	µg/L	0.001–0.02
Lead (total)	18/21	0.001	0.2	µg/L	0.02
Magnesium (dissolved)	10/10	390	783	µg/L	na
Magnesium (total)	21/21	19.5	805	µg/L	na
Manganese (dissolved)	10/10	0.012	0.262	µg/L	na
Manganese (total)	21/21	0.014	0.639	µg/L	na
Mercury (dissolved)	0/10	nd	nd	µg/L	0.0001
Mercury (total)	3/21	0.0002	0.0002	µg/L	0.0001
Nickel (dissolved)	0/10	nd	nd	µg/L	0.01–0.05
Nickel (total)	4/21	0.01	0.05	µg/L	0.01–0.05
Potassium (dissolved)	10/10	140	238	µg/L	na
Potassium (total)	21/21	8.2	246	µg/L	na
Selenium (dissolved)	4/10	0.05	0.12	µg/L	0.05–0.2
Selenium (total)	9/21	0.06	0.3	µg/L	0.05–0.2
Silver (dissolved)	0/10	nd	nd	µg/L	0.003–0.02
Silver (total)	0/21	nd	nd	µg/L	0.003–0.02
Sodium (dissolved)	10/10	3260	6280	µg/L	na
Sodium (total)	21/21	152	6440	µg/L	na

Analyte	Detection Frequency	Minimum Detected Conc.	Maximum Detected Conc.	Unit	Detection Limits [a]
Thallium (dissolved)	2/10	0.05	0.07	µg/L	0.05–0.2
Thallium (total)	5/21	0.05	0.3	µg/L	0.05–0.2
Vanadium (dissolved)	2/10	0.002	0.004	µg/L	0.002–0.01
Vanadium (Total)	17/21	0.002	0.05	µg/L	0.002–0.01
Zinc (dissolved)	3/10	0.03	0.09	µg/L	0.004–0.02
Zinc (total)	18/21	0.006	0.223	µg/L	0.02–0.02
PCBs [b]					
Aroclor-1016	0/18	nd	nd	µg/L	1
Aroclor-1242	0/18	nd	nd	µg/L	1
Aroclor-1248	0/18	nd	nd	µg/L	1
Aroclor-1254	1/18	0.93	0.93	µg/L	1–1.5
Aroclor-1260	4/18	0.96	4.6	µg/L	1
Aroclor-1262	0/2	nd	nd	µg/L	1.2
PCBs (total calc'd)[c]	5/18	0.93	4.6	µg/L	1
V**OCs [b]**					
1,1,1-Trichloroethane	0/19	nd	nd	µg/L	1
1,1,2,2-Tetrachloroethane	0/19	nd	nd	µg/L	1
1,1,2-Trichloroethane	0/19	nd	nd	µg/L	1
1,1,2-Trichlorotrifluoroethane	0/19	nd	nd	µg/L	2
1,1-Dichloroethane	0/19	nd	nd	µg/L	1
1,1-Dichloroethene	0/19	nd	nd	µg/L	1
1,2-Dichloroethane	0/19	nd	nd	µg/L	1
1,2-Dichloropropane	0/19	nd	nd	µg/L	1
2-Chloroethyl vinyl ether	0/19	nd	nd	µg/L	5
2-Hexanone	0/19	nd	nd	µg/L	5
Acetone	0/19	nd	nd	µg/L	5
Benzene	1/19	2.2	2.2	µg/L	1
Bromodichloromethane	0/19	nd	nd	µg/L	1
Bromoform	0/19	nd	nd	µg/L	1
Bromomethane	0/19	nd	nd	µg/L	2
Carbon disulfide	0/19	nd	nd	µg/L	1
Carbon tetrachloride	0/19	nd	nd	µg/L	1
Chlorobenzene	0/19	nd	nd	µg/L	1
Chloroethane	0/19	nd	nd	µg/L	2
Chloroform	0/19	nd	nd	µg/L	1
Chloromethane	0/19	nd	nd	µg/L	2
cis-1,2-Dichloroethene	7/19	1.2	40	µg/L	1
cis-1,3-Dichloropropene	0/19	nd	nd	µg/L	1
Dibromochloromethane	0/19	nd	nd	µg/L	1
Dichloromethane	0/19	nd	nd	µg/L	2
Ethylbenzene	0/19	nd	nd	µg/L	1
Methyl ethyl ketone	0/19	nd	nd	µg/L	5
Methyl isobutyl ketone	0/19	nd	nd	µg/L	5
Styrene	0/19	nd	nd	µg/L	1

ANALYTE	DETECTION FREQUENCY	MINIMUM DETECTED CONC.	MAXIMUM DETECTED CONC.	UNIT	DETECTION LIMITS [a]
Tetrachloroethene	0/19	nd	nd	µg/L	1
Toluene	0/19	nd	nd	µg/L	1
trans-1,2-Dichloroethene	0/19	nd	nd	µg/L	1
trans-1,3-Dichloropropene	0/19	nd	nd	µg/L	1
Trichloroethene	3/19	1.9	13	µg/L	1
Trichlorofluoromethane	0/19	nd	nd	µg/L	2
Vinyl acetate	0/19	nd	nd	µg/L	5
Vinyl chloride	5/19	2.8	36	µg/L	0.01–2
Xylene (meta & para)	0/19	nd	nd	µg/L	1
Xylene (ortho)	0/19	nd	nd	µg/L	1
SVOCs [b]					
1,2,4-Trichlorobenzene	0/9	nd	nd	µg/L	1
1,2-Dichlorobenzene	0/9	nd	nd	µg/L	1
1,3-Dichlorobenzene	0/9	nd	nd	µg/L	1
1,4-Dichlorobenzene	0/9	nd	nd	µg/L	1
2,4,5-Trichlorophenol	0/9	nd	nd	µg/L	5
2,4,6-Trichlorophenol	0/9	nd	nd	µg/L	5
2,4-Dichlorophenol	0/9	nd	nd	µg/L	3
2,4-Dimethylphenol	0/9	nd	nd	µg/L	3
2,4-Dinitrophenol	0/9	nd	nd	µg/L	10
2,4-Dinitrotoluene	0/9	nd	nd	µg/L	5
2,6-Dinitrotoluene	0/9	nd	nd	µg/L	5
2-Chloronaphthalene	0/9	nd	nd	µg/L	1
2-Chlorophenol	0/9	nd	nd	µg/L	1
2-Methylnaphthalene	0/9	nd	nd	µg/L	1
2-Methylphenol	0/9	nd	nd	µg/L	2
2-Nitroaniline	0/9	nd	nd	µg/L	5
2-Nitrophenol	0/9	nd	nd	µg/L	5
3,3'-Dichlorobenzidine	0/9	nd	nd	µg/L	5
3-Nitroaniline	0/9	nd	nd	µg/L	6
4,6-Dinitro-o-cresol	0/9	nd	nd	µg/L	10
4-Bromophenyl phenyl ether	0/9	nd	nd	µg/L	1
4-Chloro-3-methylphenol	0/9	nd	nd	µg/L	2
4-Chloroaniline	0/9	nd	nd	µg/L	3
4-Chlorophenyl phenyl ether	0/9	nd	nd	µg/L	1
4-Methylphenol	0/9	nd	nd	µg/L	1
4-Nitroaniline	0/9	nd	nd	µg/L	5
4-Nitrophenol	0/9	nd	nd	µg/L	5
Acenaphthene	0/18	nd	nd	µg/L	1
Acenaphthylene	0/18	nd	nd	µg/L	1
Anthracene	0/18	nd	nd	µg/L	1
Benzo(a)anthracene	0/18	nd	nd	µg/L	1
Benzo(a)pyrene	0/18	nd	nd	µg/L	1
Benzo(b)fluoranthene	0/18	nd	nd	µg/L	1

ANALYTE	DETECTION FREQUENCY	MINIMUM DETECTED CONC.	MAXIMUM DETECTED CONC.	UNIT	DETECTION LIMITS [a]
Benzo(g,h,i)perylene	0/18	nd	nd	µg/L	1
Benzo(k)fluoranthene	0/18	nd	nd	µg/L	1
Benzofluoranthenes (total-calc'd)[d]	0/18	nd	nd	µg/L	1
Benzoic acid	0/9	nd	nd	µg/L	10
Benzyl alcohol	0/9	nd	nd	µg/L	5
bis(2-chloroethoxy)methane	0/9	nd	nd	µg/L	1
bis(2-chloroethyl)ether	0/9	nd	nd	µg/L	2
Bis(2-ethylhexyl)phthalate	0/9	nd	nd	µg/L	1
bis-chloroisopropyl ether	0/9	nd	nd	µg/L	1
Butyl benzyl phthalate	0/9	nd	nd	µg/L	1
Carbazole	0/9	nd	nd	µg/L	1
Chrysene	0/18	nd	nd	µg/L	1
Dibenzo(a,h)anthracene	0/18	nd	nd	µg/L	1
Dibenzofuran	0/18	nd	nd	µg/L	1
Diethyl phthalate	0/9	nd	nd	µg/L	1
Dimethyl phthalate	0/9	nd	nd	µg/L	1
Di-n-butyl phthalate	0/9	nd	nd	µg/L	1
Di-n-octyl phthalate	0/9	nd	nd	µg/L	1
Fluoranthene	1/18	1.3	1.3	µg/L	1
Fluorene	0/18	nd	nd	µg/L	1
Hexachlorobenzene	0/9	nd	nd	µg/L	1
Hexachlorobutadiene	0/9	nd	nd	µg/L	2
Hexachlorocyclopentadiene	0/9	nd	nd	µg/L	5
Hexachloroethane	0/9	nd	nd	µg/L	2
Indeno(1,2,3-cd)pyrene	0/18	nd	nd	µg/L	1
Isophorone	0/9	nd	nd	µg/L	1
Naphthalene	0/18	nd	nd	µg/L	1
Nitrobenzene	0/9	nd	nd	µg/L	1
N-Nitroso-di-n-propylamine	0/9	nd	nd	µg/L	2
N-Nitrosodiphenylamine	0/9	nd	nd	µg/L	1
Pentachlorophenol	0/9	nd	nd	µg/L	5
Phenanthrene	1/18	1	1	µg/L	1
Phenol	0/9	nd	nd	µg/L	2
Pyrene	0/18	nd	nd	µg/L	1
Total HPAH (calc'd)[e]	1/18	1.3	1.3	µg/L	1
Total LPAH (calc'd)[f]	1/18	1	1	µg/L	1
Total PAH (calc'd)	1/18	2	2	µg/L	1
Petroleum Hydrocarbons [b]					
TPH	0/2	nd	nd	µg/L	1
Other					
Total dissolved solids	21/21	590	20,000	mg/L	na
Total suspended solids	21/21	12	270	mg/L	na

na – not applicable

nd – not detected

[a] A range of detection limits is presented if detection limits varied among samples analyzed.

[b] PCBs, VOCs, SVOCs, and TPH were analyzed in unfiltered/uncentrifuged samples of seep water flowing over exposed intertidal sediment at low tide. Because these samples were collected in this way, it is unknown what proportion of the concentration in the seep samples is associated with sediment that may be entrained in the sample during collection.

[c] Total PCBs are calculated as the sum of the concentrations of detected Aroclors. For samples in which all individual compounds were undetected, the single highest detection limit for that sample represents the sum.

[d] Total benzofluoranthenes calculated as the sum of benzo(b)fluoranthene and benzo(k)fluoranthene.

[e] HPAHs calculated using detected concentrations of the detected concentrations of fluoranthene, pyrene, benzo(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene. For samples in which all individual compounds were undetected, the single highest detection limit for that sample represents the sum.

[f] LPAHs calculated using detected concentrations of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. For samples in which all individual compounds were undetected, the single highest detection limit for that sample represents the sum.

Table C-2. Summary of existing seep water data for Great Western

ANALYTE	DETECTION FREQUENCY	MINIMUM DETECTED CONC.	MAXIMUM DETECTED CONC.	UNIT	DETECTION LIMIT [a]
SVOCs					
1,2,4-Trichlorobenzene	0/26	nd	nd	µg/L	0.5–20
1,2-Dichlorobenzene	2/26	1	1.3	µg/L	0.5–20
1,3-Dichlorobenzene	0/26	nd	nd	µg/L	0.5–20
1,4-Dichlorobenzene	0/26	nd	nd	µg/L	0.5–20
2,4,5-Trichlorophenol	0/6	nd	nd	µg/L	5
2,4,6-Trichlorophenol	0/6	nd	nd	µg/L	5
2,4-Dichlorophenol	0/6	nd	nd	µg/L	5
2,4-Dimethylphenol	0/6	nd	nd	µg/L	0.5
2,4-Dinitrophenol	0/6	nd	nd	µg/L	5
2,4-Dinitrotoluene	0/6	nd	nd	µg/L	5
2,6-Dinitrotoluene	0/6	nd	nd	µg/L	5
2-Chloronaphthalene	0/6	nd	nd	µg/L	0.5
2-Chlorophenol	0/6	nd	nd	µg/L	0.5
2-Methylnaphthalene	0/6	nd	nd	µg/L	0.5
2-Methylphenol	0/6	nd	nd	µg/L	0.5
2-Nitroaniline	0/6	nd	nd	µg/L	0.5
2-Nitrophenol	0/6	nd	nd	µg/L	5
3,3'-Dichlorobenzidine	0/6	nd	nd	µg/L	0.5
3-Nitroaniline	0/6	nd	nd	µg/L	0.5
4,6-Dinitro-o-cresol	0/6	nd	nd	µg/L	5
4-Bromophenyl phenyl ether	0/6	nd	nd	µg/L	0.5
4-Chloro-3-methylphenol	0/6	nd	nd	µg/L	0.5–5
4-Chloroaniline	0/6	nd	nd	µg/L	0.5
4-Chlorophenyl phenyl ether	0/6	nd	nd	µg/L	0.5
4-Methylphenol	0/6	nd	nd	µg/L	0.5

ANALYTE	DETECTION FREQUENCY	MINIMUM DETECTED CONC.	MAXIMUM DETECTED CONC.	UNIT	DETECTION LIMIT [a]
4-Nitroaniline	0/6	nd	nd	µg/L	0.5–5
4-Nitrophenol	0/6	nd	nd	µg/L	5
Acenaphthene	1/6	1.3	1.3	µg/L	0.5
Acenaphthylene	0/6	nd	nd	µg/L	0.5
Aniline	0/6	nd	nd	µg/L	0.5
Anthracene	0/6	nd	nd	µg/L	0.5
Benzidine	0/6	nd	nd	µg/L	13
Benzo(a)anthracene	0/6	nd	nd	µg/L	0.5
Benzo(a)pyrene	0/6	nd	nd	µg/L	0.5
Benzo(b)fluoranthene	0/6	nd	nd	µg/L	0.5
Benzo(g,h,i)perylene	0/6	nd	nd	µg/L	0.5
Benzo(k)fluoranthene	0/6	nd	nd	µg/L	0.5
Benzofluoranthenes (total-calc'd) [b]	0/6	nd	nd	µg/L	0.5
Benzoic acid	0/6	nd	nd	µg/L	13
Benzyl alcohol	0/6	nd	nd	µg/L	0.5
bis(2-chloroethoxy)methane	0/6	nd	nd	µg/L	0.5
bis(2-chloroethyl)ether	0/6	nd	nd	µg/L	0.5
bis(2-chloroisopropyl)ether	0/6	nd	nd	µg/L	0.5
Bis(2-ethylhexyl)phthalate	0/6	nd	nd	µg/L	0.5–4.4
Butyl benzyl phthalate	0/6	nd	nd	µg/L	0.5
Carbazole	0/6	nd	nd	µg/L	0.5
Chrysene	0/6	nd	nd	µg/L	0.5
Dibenzo(a,h)anthracene	0/6	nd	nd	µg/L	0.5
Dibenzofuran	0/6	nd	nd	µg/L	0.5
Diethyl phthalate	0/6	nd	nd	µg/L	0.5
Dimethyl phthalate	0/6	nd	nd	µg/L	0.5
Di-n-butyl phthalate	0/6	nd	nd	µg/L	0.5
Di-n-octyl phthalate	0/6	nd	nd	µg/L	0.5–5
Fluoranthene	0/6	nd	nd	µg/L	0.5
Fluorene	0/6	nd	nd	µg/L	0.5
Hexachlorobenzene	0/6	nd	nd	µg/L	0.5
Hexachlorobutadiene	0/26	nd	nd	µg/L	0.5–20
Hexachlorocyclopentadiene	0/6	nd	nd	µg/L	5
Hexachloroethane	0/6	nd	nd	µg/L	0.5
Indeno(1,2,3-cd)pyrene	0/6	nd	nd	µg/L	0.5
Isophorone	0/6	nd	nd	µg/L	0.5
Naphthalene	0/26	nd	nd	µg/L	0.5–50
Nitrobenzene	0/6	nd	nd	µg/L	0.5
N-Nitroso-di-n-propylamine	0/6	nd	nd	µg/L	0.5

ANALYTE	DETECTION FREQUENCY	MINIMUM DETECTED CONC.	MAXIMUM DETECTED CONC.	UNIT	DETECTION LIMIT [a]
N-Nitrosodiphenylamine	0/6	nd	nd	µg/L	0.5–5
Pentachlorophenol	0/12	nd	nd	µg/L	0.5–5
Phenanthrene	0/6	nd	nd	µg/L	0.5
Phenol	0/6	nd	nd	µg/L	0.5
Pyrene	0/6	nd	nd	µg/L	0.5
Total HPAH (calc'd)[c]	0/6	nd	nd	µg/L	0.5
Total LPAH (calc'd)[d]	1/26	1.3	1.3	µg/L	1–50
Total PAH (calc'd)	1/26	1.3	1.3	µg/L	1–50
VOCs					
1,1,1,2-Tetrachloroethane	0/20	nd	nd	µg/L	1-20
1,1,1-Trichloroethane	1/80	1	1	µg/L	1-20
1,1,2,2-Tetrachloroethane	0/80	nd	nd	µg/L	1-20
1,1,2-Trichloroethane	0/80	nd	nd	µg/L	1-20
1,1-Dichloroethane	23/80	1	88	µg/L	1-20
1,1-Dichloroethene	8/80	1	27	µg/L	1-20
1,1-Dichloropropene	0/20	nd	nd	µg/L	1-20
1,2,3-Trichlorobenzene	0/20	nd	nd	µg/L	1-20
1,2,3-Trichloropropane	0/34	nd	nd	µg/L	1-20
1,2,4-Trimethylbenzene	1/20	4.1	4.1	µg/L	1-20
1,2-Dibromo-3-chloropropane	0/20	nd	nd	µg/L	5–100
1,2-Dibromoethane (EDB)	0/20	nd	nd	µg/L	1-20
1,2-Dichloroethane	8/80	1	27	µg/L	1-20
1,2-Dichloroethene (total)	25/46	1	470	µg/L	1
1,2-Dichloropropane	3/80	1	16	µg/L	1-20
1,3,5-Trimethylbenzene	0/20	nd	nd	µg/L	1-20
1,3-Dichloropropane	0/20	nd	nd	µg/L	1-20
2,2-Dichloropropane	0/20	nd	nd	µg/L	1-20
2-Chloroethyl vinyl ether	0/6	nd	nd	µg/L	5–100
2-Chlorotoluene	0/20	nd	nd	µg/L	1-20
2-Hexanone	0/60	nd	nd	µg/L	5–10
4-Chlorotoluene	0/20	nd	nd	µg/L	1-20
Acetone	3/66	1	6.4	µg/L	5–100
Benzene	7/80	3.1	40	µg/L	1–10
Bromobenzene	0/20	nd	nd	µg/L	1-20
Bromodichloromethane	0/80	nd	nd	µg/L	1-20
Bromoform	0/80	nd	nd	µg/L	1-20
Bromomethane	0/80	nd	nd	µg/L	1-20
Carbon disulfide	0/66	nd	nd	µg/L	1-20
Carbon tetrachloride	0/80	nd	nd	µg/L	1–50

ANALYTE	DETECTION FREQUENCY	MINIMUM DETECTED CONC.	MAXIMUM DETECTED CONC.	UNIT	DETECTION LIMIT [a]
Chlorobenzene	3/80	4.1	8.9	µg/L	1-20
Chloroethane	0/80	nd	nd	µg/L	1-20
Chloroform	0/80	nd	nd	µg/L	1-20
Chloromethane	0/80	nd	nd	µg/L	1-20
cis-1,2-Dichloroethene	12/20	5.2	5400	µg/L	1
cis-1,3-Dichloropropene	0/80	nd	nd	µg/L	1-20
Dibromochloromethane	0/80	nd	nd	µg/L	1-20
Dibromomethane	0/34	nd	nd	µg/L	1-20
Dichlorodifluoromethane	0/34	nd	nd	µg/L	1-20
Dichloromethane	0/80	nd	nd	µg/L	1–100
Ethylbenzene	0/80	nd	nd	µg/L	1-20
Iodomethane	0/14	nd	nd	µg/L	1
isopropylbenzene	0/20	nd	nd	µg/L	1-20
iso-Propyltoluene	0/20	nd	nd	µg/L	1-20
Methyl ethyl ketone	0/66	nd	nd	µg/L	5–400
Methyl isobutyl ketone	0/66	nd	nd	µg/L	5–100
n-Butylbenzene	0/20	nd	nd	µg/L	1-20
n-Propylbenzene	0/20	nd	nd	µg/L	1-20
sec-Butylbenzene	0/20	nd	nd	µg/L	1-20
Styrene	0/80	nd	nd	µg/L	1-20
tert-Butylbenzene	0/20	nd	nd	µg/L	1-20
Tetrachloroethene	37/80	1	760	µg/L	1-20
Toluene	4/80	1.4	3.4	µg/L	1-20
trans-1,2-Dichloroethene	12/34	3.4	110	µg/L	1
trans-1,3-Dichloropropene	0/80	nd	nd	µg/L	1-20
trans-1,4-Dichloro-2-butene	0/14	nd	nd	µg/L	5
Trichloroethene	36/80	1	480	µg/L	1–20
Trichlorofluoromethane	0/34	nd	nd	µg/L	1–20
Vinyl acetate	0/66	nd	nd	µg/L	5–100
Vinyl chloride	18/80	1	3500	µg/L	1–10
Xylene (meta & para)	0/34	nd	nd	µg/L	2
Xylene (ortho)	3/34	1.4	2.8	µg/L	1–20
Xylene (total)	1/46	1	1	µg/L	1

Note -- information regarding whether these samples were analyzed as whole samples, or whether they were filtered or centrifuged, was not available

nd – not detected

[a] A range of detections limits is presented if detection limits varied among samples analyzed.

[b] Total benzofluoranthenes calculated as the sum of benzo(b)fluoranthene and benzo(k)fluoranthene.

[c] HPAHs calculated using detected concentrations of fluoranthene, pyrene, benzo(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and

benzo(g,h,i)perylene. For samples in which all individual compounds were undetected, the single highest detection limit for that sample represents the sum.

[d] LPAHs calculated using detected concentrations of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. For samples in which all individual compounds were undetected, the single highest detection limit for that sample represents the sum.

Table C-3. Summary of existing seep water data for T-117

ANALYTE	DETECTION FREQUENCY	MINIMUM DETECTED CONC.	MAXIMUM DETECTED CONC.	UNIT	DETECTION LIMIT
Metals					
Mercury (total)	0/4	nd	nd	µg/L	0.0001
Cadmium (dissolved)	0/4	nd	nd	µg/L	0.002
Cadmium (total)	0/1	nd	nd	µg/L	0.002
Silver (dissolved)	0/1	nd	nd	µg/L	0.003
Silver (total)	0/4	nd	nd	µg/L	0.003
Chromium (dissolved)	3/4	0.008	0.01	µg/L	0.005
Chromium (total)	0/1	nd	nd	µg/L	0.005
Zinc (dissolved)	0/5	nd	nd	µg/L	0.006
Lead (dissolved)	0/4	nd	nd	µg/L	0.02
Lead (total)	0/1	nd	nd	µg/L	0.02
Arsenic (dissolved)	0/4	nd	nd	µg/L	0.05
Arsenic (total)	0/1	nd	nd	µg/L	0.05
Copper (dissolved)	5/5	0.004	0.005	µg/L	nd
PCBs (uncentrifuged)[a]					
Aroclor-1016	0/4	nd	nd	µg/L	1
Aroclor-1221	0/4	nd	nd	µg/L	1
Aroclor-1232	0/4	nd	nd	µg/L	1
Aroclor-1242	0/4	nd	nd	µg/L	1
Aroclor-1248	0/4	nd	nd	µg/L	1
Aroclor-1254	0/4	nd	nd	µg/L	1
Aroclor-1260	1/4	0.94	0.94	µg/L	1
PCBs (total calc'd)[b]	1/4	0.94	0.94	µg/L	1
PCBs (centrifuged)					
PCBs (total calc'd)[b]	0/1	nd	nd	µg/L	0.034
VOCs					
1,2,4-Trichlorobenzene	0/4	nd	nd	µg/L	1
1,2-Dichlorobenzene	0/1	nd	nd	µg/L	1
1,4-Dichlorobenzene	0/1	nd	nd	µg/L	1
SVOCs [a]					
Hexachlorobenzene	0/4	nd	nd	µg/L	0.05
Hexachlorobutadiene	0/4	nd	nd	µg/L	0.05
1,3-Dichlorobenzene	0/4	nd	nd	µg/L	1
2,4-Dimethylphenol	0/4	nd	nd	µg/L	1
2-Methylnaphthalene	0/4	nd	nd	µg/L	1
2-Methylphenol	0/4	nd	nd	µg/L	1
4-Methylphenol	0/4	nd	nd	µg/L	1
Acenaphthene	0/4	nd	nd	µg/L	1
Acenaphthylene	0/4	nd	nd	µg/L	1
Anthracene	0/4	nd	nd	µg/L	1

Analyte	Detection Frequency	Minimum Detected Conc.	Maximum Detected Conc.	Unit	Detection Limit
Benzo(a)anthracene	0/4	nd	nd	µg/L	1
Benzo(a)pyrene	0/4	nd	nd	µg/L	1
Benzo(b)fluoranthene	0/4	nd	nd	µg/L	1
Benzo(g,h,i)perylene	0/4	nd	nd	µg/L	1
Benzo(k)fluoranthene	0/4	nd	nd	µg/L	1
Benzofluoranthenes (total-calc'd)[c]	0/4	nd	nd	µg/L	1
Benzyl alcohol	0/4	nd	nd	µg/L	1
Bis(2-ethylhexyl)phthalate	2/4	2.7	15	µg/L	1
Butyl benzyl phthalate	0/4	nd	nd	µg/L	1
Chrysene	0/4	nd	nd	µg/L	1
Dibenzo(a,h)anthracene	0/4	nd	nd	µg/L	1
Dibenzofuran	0/4	nd	nd	µg/L	1
Diethyl phthalate	0/4	nd	nd	µg/L	1
Dimethyl phthalate	0/4	nd	nd	µg/L	1
Di-n-butyl phthalate	0/4	nd	nd	µg/L	1
Di-n-octyl phthalate	0/4	nd	nd	µg/L	1
Fluoranthene	0/4	nd	nd	µg/L	1
Fluorene	0/4	nd	nd	µg/L	1
Indeno(1,2,3-cd)pyrene	0/4	nd	nd	µg/L	1
Naphthalene	0/4	nd	nd	µg/L	1
N-Nitrosodiphenylamine	0/4	nd	nd	µg/L	1
Phenanthrene	0/4	nd	nd	µg/L	1
Phenol	0/4	nd	nd	µg/L	1
Pyrene	0/4	nd	nd	µg/L	1
Total HPAH (calc'd)[d]	0/4	nd	nd	µg/L	1
Total LPAH (calc'd)[e]	0/4	nd	nd	µg/L	1
Total PAH (calc'd)	0/4	nd	nd	µg/L	1
Pentachlorophenol	0/4	nd	nd	µg/L	5
Benzoic acid	0/4	nd	nd	µg/L	10
Conventional/Physical					
Total organic carbon (TOC)	2/5	2.1	2.5	mg/L	1.5
Total suspended solids	5/5	2	28	mg/L	na

na – not applicable

nd – not detected

[a] PCBs, VOCs, and SVOCs were analyzed in unfiltered/uncentrifuged samples of seep water flowing over exposed intertidal sediment at low tide. Because these samples were collected in this way, the proportion of the concentration in the seep samples that is associated with sediment that may have been entrained in the sample during collection is unknown. The results of PCB analyses on both uncentrifuged (i.e., whole) and centrifuged samples collected at Seep T117-SW-3 indicate that PCBs detected in the whole seep water sample could have been associated with entrained sediments. The uncentrifuged sample had a PCB concentration of 0.94 µg/L (qualified as an estimate). PCBs were undetected at a detection limit of 0.034 µg/L in a second sample from the same location that was centrifuged.

[b] Total PCBs are calculated as the sum of the concentrations of detected Aroclors. For samples in which all individual compounds were undetected, the single highest detection limit for that sample represents the sum.

[c] Total benzofluoranthenes calculated as the sum of benzo(b)fluoranthene and benzo(k)fluoranthene.

[d] HPAHs calculated using detected concentrations of fluoranthene, pyrene, benzo(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene. For samples in which all individual compounds were undetected, the single highest detection limit for that sample represents the sum.

[e] LPAHs calculated using detected concentrations of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. For samples in which all individual compounds were undetected, the single highest detection limit for that sample represents the sum.

Table C-4. Summary of existing seep water data for Rhône-Poulenc

CHEMICAL	DETECTION FREQUENCY	MINIMUM DETECTED CONC.	MAXIMUM DETECTED CONC.	UNIT	DETECTION LIMIT
Metals					
Aluminum (total)	8/8	0.361	64.7	µg/L	na
Arsenic (total)	2/2	0.0295	0.0325	µg/L	na
Barium (total)	8/8	0.00454	0.187	µg/L	na
Beryllium (total)	2/2	0.00084	0.00094	µg/L	na
Cadmium (total)	3/3	0.0021	0.0126	µg/L	na
Calcium (total)	6/6	15.0	168	µg/L	na
Chromium (total)	2/2	0.192	0.211	µg/L	na
Cobalt (total)	3/3	0.0029	0.0591	µg/L	na
Copper (total)	2/2	0.196	0.209	µg/L	na
Lead (total)	2/2	0.0403	0.0478	µg/L	na
Magnesium (total)	6/6	46.6	541	µg/L	na
Mercury (total)	1/1	0.00065	0.00065	µg/L	na
Nickel (total)	2/2	0.0641	0.0759	µg/L	na
Potassium (total)	6/6	30.6	211	µg/L	na
Sodium (total)	6/6	693	5190	µg/L	na
Vanadium (total)	8/8	0.0028	0.419	µg/L	na
Zinc (total)	2/2	0.203	0.242	µg/L	na
SVOC/VOCs					
Bis(2-ethylhexyl)phthalate	3/3	13.8	38.6	µg/L	na
Formaldehyde	1/1	24	24	µg/L	na
Other					
Dissolved oxygen	7/7	2.6	9.9	mg/L	na
pH	7/7	6.37	7.79	pH units	na
Salinity	5/5	2.5	12.3	ppt	na
Specific Conductance	7/7	2,450	14,200	µS/cm	na
Total Dissolved Solids	8/8	1,900	17,000	mg/L	na

na – not available

Information regarding whether these samples were analyzed as whole samples, or whether they were filtered or centrifuged, was not available. It is assumed that samples for total metals were not filtered or centrifuged.

Table C-5. Existing seep water chemical concentrations exceeding Washington State marine chronic water quality standards

SITE	SAMPLE ID	ANALYTE	DETECTED CONCENTRATION	QUALIFIER	UNITS	WASHINGTON STATE MARINE CHRONIC WATER QUALITY STANDARD [a]
Rhone Poulenc	02-SP	chromium (total)[b]	0.211		mg/L	0.05
Rhone Poulenc	02-SP-FD	chromium (total) [b]	0.192		mg/L	0.05
Boeing Plant 2	SE-04105-0001	copper (dissolved)	0.008		mg/L	0.0031
T-117	T117-SW-1	copper (dissolved)	0.005		mg/L	0.0031
T-117	T117-SW-1	copper (dissolved)	0.005		mg/L	0.0031
T-117	T117-SW-2	copper (dissolved)	0.005		mg/L	0.0031
T-117	T117-SW-4	copper (dissolved)	0.005		mg/L	0.0031
T-117	T117-SW-3	copper (dissolved)	0.004		mg/L	0.0031
Rhone Poulenc	05-SP	mercury (total) [b]	0.00065		mg/L	0.000025
Boeing Plant 2	SE-01003-0001	mercury (total) [b]	0.0002		mg/L	0.000025
Boeing Plant 2	SE-SWY01-1001	mercury (total) [b]	0.0002		mg/L	0.000025
Boeing Plant 2	SE-SWY03-0001	mercury (total) [b]	0.0002		mg/L	0.000025
Boeing Plant 2	SE-SWY03-0001	PCBs (total) [b,c]	4.6		µg/L	0.03
Boeing Plant 2	SE-SWY01-1001	PCBs (total) [b,c]	2.5		µg/L	0.03
Boeing Plant 2	SE-04102-0001	PCBs (total) [b,c]	1.8		µg/L	0.03
Boeing Plant 2	SE-SWY01-0001	PCBs (total) [b,c]	0.96	J	µg/L	0.03
T-117	T117-SW-3	PCBs (total) [b,c]	0.94	J	µg/L	0.03
Boeing Plant 2	SW-SWY01-0001	PCBs (total) [b,c]	0.93	J	µg/L	0.03
Boeing Plant 2	SE-SWY04-0002	zinc (dissolved)	0.09		mg/L	0.081

[a] Marine water quality standards for metals are for dissolved concentrations except for mercury and chromium. Mercury and chromium concentrations are given as the total recoverable fraction (if dissolved trivalent chromium data are not available).

[b] Concentrations were measured in unfiltered/uncentrifuged samples of seep water flowing over exposed intertidal sediment at low tide. Because the water samples were collected over exposed sediment, it is unknown what proportion of the concentration in the seep samples is associated with sediment that may be entrained in the sample during collection. At T-117, seep T117-SW-3 was sampled twice. The first sample was not centrifuged and had a PCB concentration of 0.94 µg/L (qualified as an estimate). The second sample was centrifuged; PCBs were undetected at a detection limit of 0.033 µg/L. Also, by using total suspended solids data collected with the Boeing Plant 2 data, it can be shown that the concentrations of PCBs in the seep samples may have been associated with entrained sediment (i.e., the concentrations in sediment where the seep samples were collected are generally within the same order of magnitude as those calculated assuming all PCBs measured in the seep samples were associated with suspended particulates).

[c] PCB concentrations are presented as the sum of detected Aroclor concentrations for each sample.

Table C-6. Summary of seep water exceedances (for both detected concentrations and detection limits) of Washington State marine chronic water quality standards [a]

			Detected Concentrations		Non-detected Concentrations	
Site	**Analyte**	**# Samples**	**≤Standard**	**>Standard**	**≤Standard**	**>Standard**
Boeing Plant 2[b]	Arsenic (dissolved)	10	10			
Boeing Plant 2[b]	Cadmium (dissolved)	10			5	5
Boeing Plant 2[b]	Chromium (total)	21	7		14	
Boeing Plant 2[b]	Copper (dissolved)	10		1	3	6
Boeing Plant 2[b]	Lead (dissolved)	10			6	4
Boeing Plant 2[b]	Mercury (total)	21		3		18
Boeing Plant 2[b]	Nickel (dissolved)	10				10
Boeing Plant 2[b]	Silver (dissolved)	10				10
Boeing Plant 2[b]	Zinc (dissolved)	10	2	1	7	
Boeing Plant 2[b,c]	PCBs[d] (total)	18		5		13
Boeing Plant 2[b,c]	Pentachlorophenol (total)	9			9	
Great Western[e]	Pentachlorophenol (total)	12			12	
Rhone Poulenc[f]	Chromium (total)	7		2	na	na
Rhone Poulenc[f]	Mercury (total)	7		1	na	na
T-117[g]	Arsenic (dissolved)	4				4
T-117[g]	Cadmium (dissolved)	4			4	
T-117[g]	Chromium (dissolved)	4	3		1	
T-117[g]	Chromium (total)	1			1	
T-117[g]	Copper (dissolved)	5		5		
T-117[g]	Lead (dissolved)	4				4
T-117[g]	Silver (dissolved)	1				1
T-117[g]	Zinc (dissolved)	5			5	
T-117[c,g]	PCBs[d] (total)	4		1		3
T-117[c,g]	Pentachlorophenol (total)	4				4

na – detection limits for these samples not available

[a] Note that Washington State standards are available only for metals, PCBs, pentachlorophenol, and nine organochlorine pesticides.

[b] Boeing Plant 2 seep samples were not analyzed for organochlorine pesticides.

[c] PCBs, VOCs, SVOCs, and TPH were analyzed in unfiltered/uncentrifuged samples of seep water flowing over exposed intertidal sediment at low tide. Because these samples were collected in this way, it is unknown what proportion of the concentration in the seep samples is associated with sediment that may be entrained in the sample during collection.

[d] Total PCBs are calculated as the sum of the concentrations of detected Aroclors. For samples in which all individual compounds were undetected, the single highest detection limit for that sample represents the sum.

[e] Great Western seep samples were not analyzed for metals, PCBs, or organochlorine pesticides.

[f] Detection limits were not reported for chemicals not detected in Rhone–Poulenc seep samples. Organochlorine pesticides, PCBs, and pentachlorophenol were not detected in Rhone–Poulenc seep samples.

[g] T-117 seep samples were not analyzed for organochlorine pesticides.

APPENDIX D. LABORATORY METHOD DETECTION LIMITS AND REPORTING LIMITS FOR ORGANIC COMPOUNDS

This appendix presents the method detection limits (MDLs) and reporting limits (RLs) for the organic compounds that will be analyzed by ARI using EPA Methods 8081 (Table D-1), 8082 (Table D-2), 8270 (Table D-3), and 8260 (Table D-4).

Table D-1. Table provided by ARI with list of analytes, MDLs, and RLs for EPA Method 8081: MDL/RL Summary for Pesticide Analysis of Water EPA Method SW-846-8081 – Manchester Extraction

Method Reference	**8081**	**8081**	**8081**	**8081**	
Sample Matrix	**Water**	**Water**	**Water**	**Water**	
Spike Level	**1.67 ng/L**	**1.67 ng/L**	**1.67 ng/L**	**1.67 ng/L**	
Sample Weight/Volume	**3000 mL**	**3000 mL**	**3000 mL**	**3000 mL**	
Extract Final Volume	**0.5 mL**	**0.5 mL**	**0.5 mL**	**0.5 mL**	
Extraction Method	**Stir Bar**	**Stir Bar**	**Stir Bar**	**Stir Bar**	
ARI Extraction SOP	**336S**	**336S**	**336S**	**336S**	
ARI Analytical SOP	**423S**	**423S**	**423S**	**423S**	**Water**
Instrument ID	**ECD 3**	**ECD 3**	**ECD 4**	**ECD 4**	**Reporting**
Column ID	**DB-5**	**DB-608**	**DB-5**	**DB-608**	**Limit**
Date Analyzed	**8/17/02**	**8/17/02**			
Reporting Units	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**
Analyte	**MDL**	**MDL**	**MDL**	**MDL**	**RL**
Alpha-BHC	0.136	0.151			**1.0**
Beta-BHC	0.867	1.048			**1.0**
Gamma-BHC (Lindane)	0.141	0.167			**1.0**
Delta-BHC	0.707	0.282			**1.0**
Heptachlor	0.115	0.380			**1.0**
Aldrin	0.122	0.837			**1.0**
Heptachlor Epoxide	0.191	0.471			**1.0**
Gamma chlordane	0.160	0.192			**1.0**
Alpha chlordane	1.107	0.161			**1.0**
Endosulfan I	0.183	0.247			**1.0**
DDE	0.291	0.297			**2.0**
Dieldrin	0.310	0.350			**2.0**
Endrin	0.388	0.447			**2.0**
Endosulfan II	0.331	0.397			**2.0**
DDD	0.286	0.356			**2.0**
Endrin Aldehyde	0.349	0.314			**2.0**
DDT	0.461	0.446			**2.0**
Endosulfan Sulfate	0.526	0.284			**2.0**
Endrin Ketone	0.349	0.319			**2.0**
Methoxychlor	2.000	14.188			**15.0**
Toxaphene (8/12/02)	30.00	30.00	54.984	79.159	**100.0**

Method Detection Limit studies are performed in accordance with 40 CFR Part 136, Appendix B, using six or seven degrees of freedom.

Method Detection Limits (MDLs) are statistically derived values, and are a measure of short-term precision. True detection at the statistical MDL may not be achievable for all analytes and methods. Reporting Limit (RL) is defined as the lowest value at which qualitative detection of a given analyte is reported. The RL is based on the MDL, method efficiency, and analyte response. The RL will, at a minimum, equal the MDL (rounded). The RL may exceed the MDL for certain analytes.

Table D-2. Table provided by ARI with list of analytes, MDLs, and RLs for EPA Method 8082: MDL/RL Summary for PCB Analysis of Water (Low Level) Separatory Funnel Extraction - SOP = 336S EPA Method SW-846-8082 – Large Volume Injection* - SOP = 429S Effective 4/10/03

Sample Volume	**1000 mL**	**1000 mL**	
Extract Final Volume	**1.0 mL**	**1.0 mL**	
GC Injection Volume	**10 µ/L**	**10 µ/L**	
Spike Level	**0.02 µg/L**	**0.02 µg/L**	**Water**
Instrument ID	**ECD 5**	**ECD 5**	**Reporting**
Column ID	**CLP-1**	**CLP-2**	**Limit**
Reporting Units	**µg/L**	**µg/L**	**µg/L**
Analyte	**MDL**	**MDL**	**RL**
Aroclor 1016	0.0096	0.0022	**0.01**
Aroclor 1221			**0.01**
Aroclor 1232	0.0088	0.0108	**0.01**
Aroclor 1242	0.0062	0.0023	**0.01**
Aroclor 1248			**0.01**
Aroclor 1254	0.0049	0.0062	**0.01**
Aroclor 1260	0.0036	0.0016	**0.01**
Aroclor 1262	--	--	**0.01**
Aroclor 1268	--	--	**0.01**

*MDL Studies performed between 2/27/03 and 3/10/03.

Method Detection Limit studies are performed in accordance with 40 CFR Part 136, Appendix B, using six or seven degrees of freedom.

Method Detection Limits (MDLs) are statistically derived values, and are a measure of short-term precision. True detection at the statistical MDL may not be achievable for all analytes and methods.

Reporting Limit (RL) is defined as the lowest value at which qualitative detection of a given analyte is reported. The RL is based on the MDL, method efficiency, and analyte response. The RL will, at a minimum, equal the MDL (rounded). The RL may exceed the MDL for certain analytes.

Table D-3. Table provided by ARI with list of analytes, MDLs, and RLs for EPA Method 8270: MDL and RL Summary GC-MS – SVOA Analysis of Water EPA Method SW-846-8270 - Liquid/Liquid Extraction

Sample Weight/Volume	**500 mL**	**500 mL**	
Final Extract Volume	**0.5 mL**	**0.5 mL**	
Spike Level*	**4 µg/L**	**2 µg/L**	
ARI Extraction SOP	**344S**	**344S**	**Water**
ARI Analytical SOP	**801S**	**801S**	**Reporting**
Instrument	**NT6**	**NT4**	**Limit**
Date Analyzed	**2/9/04**	**2/20/04**	
Reporting Units	**µg/L**	**µg/L**	**μg/L**
Analyte	**MDL**	**MDL**	**RL**
Phenol	0.371	0.605	**2.0**
Bis-(2-chloroethyl) ether	0.640	0.743	**2.0**
2-Chlorophenol	0.658	0.746	**1.0**
1,3-Dichlorobenzene	0.596	0.637	**1.0**
1,4-Dichlorobenzene	0.665	0.596	**1.0**
Benzyl Alcohol	0.547	0.749	**5.0**
1,2-Dichlorobenzene	0.498	0.697	**1.0**
2-Methylphenol	0.450	0.647	**1.0**
2,2'-oxybis(1-chloropropane)	0.529	0.796	**1.0**
4-Methylphenol	0.454	0.420	**1.0**
N-Nitroso-di-n-propylamine	0.691	0.862	**2.0**
Hexachloroethane	0.498	0.719	**2.0**
Nitrobenzene	0.484	0.623	**1.0**
Isophorone	0.532	0.594	**1.0**
2-Nitrophenol	0.711	0.770	**5.0**
2,4-Dimethylphenol	0.675	0.813	**3.0**
Bis-(2-chloroethoxy) methane	0.656	0.743	**1.0**
Benzoic Acid (40 µg/L)	4.337	4.436	**10.0**
2,4-Dichlorophenol	0.710	0.566	**3.0**
1,2,4-Trichlorobenzene	0.667	0.666	**1.0**
Naphthalene	0.592	0.501	**1.0**
4-Chloroaniline (10 µg/L)	1.998	2.163	**3.0**
Hexachlorobutadiene	0.536	0.555	**2.0**
4-Chloro-3-methylphenol	0.646	0.755	**2.0**
2-Methylnaphthalene	0.536	0.528	**1.0**
Hexachlorocyclopentadiene (12 µg/L)	1.973	2.464	**5.0**
2,4,6-Trichlorophenol	0.663	0.600	**5.0**
2,4,5-Trichlorophenol	0.291	0.416	**5.0**
2-Chloronaphthalene	0.501	0.581	**1.0**

Sample Weight/Volume	**500 mL**	**500 mL**	
Final Extract Volume	**0.5 mL**	**0.5 mL**	
Spike Level*	**4 µg/L**	**2 µg/L**	
ARI Extraction SOP	**344S**	**344S**	**Water Reporting Limit**
ARI Analytical SOP	**801S**	**801S**	
Instrument	**NT6**	**NT4**	
Date Analyzed	**2/9/04**	**2/20/04**	
Reporting Units	**µg/L**	**µg/L**	**µg/L**
Analyte	**MDL**	**MDL**	**RL**
2-Nitroaniline (10 µg/L)	1.212	1.463	**5.0**
Dimethylphthalate	0.570	0.720	**1.0**
Acenaphthylene	0.454	0.523	**1.0**
2,6-Dinitrotoluene	0.581	0.555	**5.0**
3-Nitroaniline (10 µg/L)	1.438	1.249	**5.0**
Acenaphthene	0.487	0.587	**1.0**
2,4-Dinitrophenol (40 µg/L)	8.179	9.137	**10.0**
Dibenzofuran	0.496	0.524	**1.0**
4-Nitrophenol (20 µg/L)	2.237	3.037	**5.0**
2,4-Dinitrotoluene	0.493	0.723	**5.0**
Fluorene	0.525	0.572	**1.0**
Diethylphthlalate	0.638	0.676	**1.0**
4-Chlorophenyl-phenyl ether	0.697	0.561	**1.0**
4-Nitroaniline (10 µg/L)	1.252	1.436	**5.0**
4,6-Dinitro-2-Methylphenol (40 µg/L)	7.060	7.199	**10.0**
N-Nitrosodiphenylamine	0.531	0.531	**1.0**
4-bromophenyl-phenyl ether	0.542	0.744	**1.0**
Hexachlorobenzene	0.751	0.879	**1.0**
Pentachlorophenol (20 µg/L)	2.352	3.105	**5.0**
Phenanthrene	0.462	0.468	**1.0**
Anthracene	0.385	0.471	**1.0**
Carbazole	0.439	0.542	**1.0**
Di-n-butylphthalate	0.462	0.612	**1.0**
Fluoranthene	0.570	0.637	**1.0**
Pyrene	0.700	0.525	**1.0**
Butylbenzylphthalate	0.687	0.722	**1.0**
Benzo(a)Anthracene	0.872	0.976	**1.0**
3,3’-Dichlorobenzidine (20 µg/L)	1.687	1.718	**5.0**
Chrysene	1.102	1.036	**1.0**
bis(2-Ethylhexyl) phthalate	0.722	1.183	**3.0**
Di-n-octylphthalate	0.754	0.821	**1.0**
Benzo(b)Fluoranthene	1.030	1.088	**1.0**
Benzo(k)Fluoranthene	1.029	0.934	**1.0**

Sample Weight/Volume	**500 mL**	**500 mL**	
Final Extract Volume	**0.5 mL**	**0.5 mL**	
Spike Level*	**4 µg/L**	**2 µg/L**	
ARI Extraction SOP	**344S**	**344S**	**Water**
ARI Analytical SOP	**801S**	**801S**	**Reporting**
Instrument	**NT6**	**NT4**	**Limit**
Date Analyzed	**2/9/04**	**2/20/04**	
Reporting Units	**µg/L**	**µg/L**	**µg/L**
Analyte	**MDL**	**MDL**	**RL**
Benzo(a)Pyrene	1.045	1.086	**1.0**
Indeno(1,2,3-cd)Pyrene	0.987	0.936	**1.0**
Dibenzo(a,h)anthracene	1.142	1.305	**1.0**
Benzo(g,h,i)perylene	1.319	1.270	**1.0**
1,4-Dioxane	0.387	0.503	**1.0**

Method Detection Limit studies are performed in accordance with 40 CFR Part 136, Appendix B, using six or seven degrees of freedom.

Method Detection Limits (MDLs) are statistically derived values, and are a measure of short-term precision. True detection at the statistical MDL may not be achievable for all analytes and methods.

Reporting Limit (RL) is defined as the lowest value at which qualitative detection of a given analyte is reported. The RL is based on the MDL, method efficiency, and analyte response. The RL will, at a minimum, equal the MDL (rounded). The RL may exceed the MDL for certain analytes.

Table D-4. Table provided by ARI with list of analytes, MDLs, and RLs for EPA Method 8260: MDL and RL Summary GC-MS – VOA Analysis of Water 5 mL Purge Volume (EPA Methods 8260B & ARI SOP 704S-R4)

Method Reference	**8260B**	**SOP 700**	
Sample Weight/Volume	**5.0 mL**	**5.0 mL**	
Spike Level*	**1.5 µg/L**	**5.0 µg/L**	**Water**
Preparation Method	**5030B**	**5030B**	**Reporting**
ARI Analytical SOP	**S708**	**700S**	**Limit**
Instrument	**NT-3**	**NT-3**	
Date Analyzed	**3/24/04**	**4/26/02**	
Reporting Units	**µg/L**	**µg/L**	**µg/L**
Analyte	**MDL**	**MDL**	**RL**
Chloromethane	0.12	0.630	**1.0**
Vinyl Chloride	0.35	0.930	**1.0**
Bromomethane	0.16	0.860	**1.0**
Chloroethane	0.17	0.620	**1.0**
Trichlorofluoromethane	0.11	0.640	**1.0**
Acrolein*	1.01	2.000	**50.0**
Acetone*	1.16	2.290	**5.0**
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.06	0.390	**2.0**
1,1-Dichloroethene	0.08	0.750	**1.0**
Bromoethane	0.17	0.420	**2.0**
Iodomethane	0.08	0.570	**1.0**
Methylene Chloride	0.12	0.690	**2.0**
Carbon Disulfide	0.09	0.400	**1.0**
Acrylonitrile	0.32	0.500	**1.0**
trans-1,2-Dichloroethene	0.11	0.720	**1.0**
Vinyl Acetate	0.63	0.340	**5.0**
1,1-Dichloroethane	0.08	0.700	**1.0**
2-Butanone*	1.26	2.360	**5.0**
2,2-Dichloropropane	0.08	0.640	**1.0**
cis-1,2-Dichloroethene	0.15	0.780	**1.0**
Chloroform	0.12	0.690	**1.0**
Bromochloromethane	0.18	0.750	**1.0**
1,1,1-Trichloroethane	0.05	0.740	**1.0**
1,1-Dichloropropene	0.16	0.650	**1.0**
Carbon Tetrachloride	0.07	0.190	**1.0**
1,2-Dichloroethane	0.07	0.770	**1.0**
Benzene	0.07	0.710	**1.0**
Trichloroethene	0.12	0.770	**1.0**
1,2-Dichloropropane	0.13	0.750	**1.0**

Method Reference	**8260B**	**SOP 700**	
Sample Weight/Volume	**5.0 mL**	**5.0 mL**	
Spike Level*	**1.5 µg/L**	**5.0 µg/L**	**Water**
Preparation Method	**5030B**	**5030B**	**Reporting**
ARI Analytical SOP	**S708**	**700S**	**Limit**
Instrument	**NT-3**	**NT-3**	
Date Analyzed	**3/24/04**	**4/26/02**	
Reporting Units	**µg/L**	**µg/L**	**µg/L**
Analyte	**MDL**	**MDL**	**RL**
Bromodichloromethane	0.07	0.620	**1.0**
Dibromomethane	0.18	0.670	**1.0**
2-Chloroethyl Vinyl Ether	0.33	0.520	**5.0**
4-Methyl-2-Pentanone*	0.87	1.780	**5.0**
cis-1,3-Dichloropropene	0.15	0.660	**1.0**
Toluene	0.06	0.620	**1.0**
trans-1,3-Dichloropropene	0.14	0.620	**1.0**
1,1,2-Trichloroethane	0.17	0.640	**1.0**
2-Hexanone*	1.20	1.700	**5.0**
1,3-Dichloropropane	0.09	0.640	**1.0**
Tetrachloroethene	0.21	0.780	**1.0**
Chlorodibromomethane	0.16	0.590	**1.0**
Chlorobenzene	0.07	0.620	**1.0**
1,1,1,2-Tetrachloroethane	0.13	0.830	**1.0**
Ethyl Benzene	0.15	0.680	**1.0**
m,p-Xylene	0.37	1.220	**1.0**
o-Xylene	0.16	0.220	**1.0**
Styrene	0.18	0.180	**1.0**
Bromoform	0.21	0.700	**1.0**
Isopropyl Benzene	0.23	0.930	**1.0**
1,1,2,2-Tetrachloroethane	0.16	0.760	**1.0**
1,2,3-Trichloropropane	0.21	1.050	**3.0**
trans-1,4-Dichloro-2-Butene	0.38	0.500	**5.0**
n-Propyl Benzene	0.25	0.950	**1.0**
Bromobenzene	0.16	0.290	**1.0**
1,3,5-Trimethylbenzene	0.25	0.920	**1.0**
2-Chlorotoluene	0.32	0.980	**1.0**
4-Chlorotoluene	0.24	1.030	**1.0**
t-Butylbenzene	0.22	0.990	**1.0**
1,2,4-Trimethylbenzene	0.28	0.910	**1.0**
s-Butylbenzene	0.29	0.280	**1.0**
4-Isopropyl Toluene	.28	0.270	**1.0**
1,3-Dichlorobenzene	0.32	0.940	**1.0**

Method Reference	8260B	SOP 700	
Sample Weight/Volume	5.0 mL	5.0 mL	
Spike Level*	1.5 µg/L	5.0 µg/L	Water
Preparation Method	5030B	5030B	Reporting
ARI Analytical SOP	S708	700S	Limit
Instrument	NT-3	NT-3	
Date Analyzed	3/24/04	4/26/02	
Reporting Units	µg/L	µg/L	µg/L
Analyte	**MDL**	**MDL**	**RL**
1,4-Dichlorobenzene	0.33	0.950	**1.0**
n-Butylbenzene	0.39	0.770	**1.0**
1,2-Dichlorobenzene	0.30	1.100	**1.0**
1,2-Dibromo-3-Chloropropane	0.94	0.720	**5.0**
1,2,4-Trichlorobenzene	0.79	0.710	**5.0**
Hexachloro-1,3-Butadiene	0.99	0.820	**5.0**
Naphthalene	0.88	0.200	**5.0**
1,2,3-Trichlorobenzene	1.11	0.220	**5.0**
1,4-Dioxane	---	53.21	**200**

* Compounds noted with an * are spiked at a higher level. The ketones are spiked at 7.5 µg/L and m/p-xylene at 3 µg/L.

Method Detection Limit studies are performed in accordance with 40 CFR Part 136, Appendix B, using six degrees of freedom.

Method Detection Limits (MDLs) are statistically derived values, and are a measure of short-term precision. True detection at the statistical MDL may not be achievable for all analytes and methods.

Reporting Limit (RL) is defined as the lowest value at which qualitative detection of a given analyte is reported. The RL is based on the MDL, method efficiency, and analyte response. The RL will, at a minimum, equal the MDL (rounded). The RL may exceed the MDL for certain analytes.