Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

LOWER DUWAMISH WATERWAY BASELINE SEEP COLLECTION AND CHEMICAL ANALYSES - QUALITY ASSURANCE PROJECT PLAN

FINAL

Prepared for

Lower Duwamish Waterway Group

For submittal to

US Environmental Protection Agency

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Title and Approval Page
Seep Collection and Chemical Analyses
Quality Assurance Project Plan

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EPA Project Manager ELLEN HALE Digitally signed by ELLEN HALE Date: 2018.03.07 17:05:37 -08'00'

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EPA QA/QC Manager Don Matheny Digitally signed by Don Matheny Date: 2018.03.08 07:01:02 -08'00'

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Distribution List

This list identifies all individuals who will receive a copy of the approved quality assurance project plan, either in hard copy or electronic format, as well as any subsequent revisions.

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- Kathy Godtfredsen, Windward Project Manager
- Susan McGroddy, Windward Task Manager
- Thai Do, Windward Field Lead
- Suzanne Dudziak, Greylock Consulting Lead
- Donald Brown, EPA QA/QC Manager
- Amara Vandervort, Windward QA/QC Manager
- Chemistry Project Managers:
  - Sue Dunnihoo (Analytical Resources, Inc.)
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  - Brian Anderson, Joe Flaherty (The Boeing Company)
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  - Jeff Stern, Debra Williston (King County)
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Table of Contents

Tables

Figures

Maps

Acronyms

%RSD	percent relative standard deviation
AOC	Administrative Order on Consent
ARI	Analytical Resources, Inc.
Axys	Axys Analytical Services Ltd.
BBP	butyl benzyl phthalate
BDC	Boeing Developmental Center
CFR	Code of Federal Regulations
COC	chain of custody
CSL	cleanup screening level
CV-AFS	cold vapor-atomic fluorescence spectrometry
DL	detection limit
DO	dissolved oxygen
DOC	dissolved organic carbon
DQI	data quality indicator
DQO	data quality objective
ECD	electron capture data
Ecology	Washington State Department of Ecology
EDL	estimated detection limit
EIM	Environmental Information Management
EPA	US Environmental Protection Agency
FC	field coordinator
FNU	Formazin Nephelometric Unit
GC/MS	gas chromatography / mass spectrometry
GPC	gel permeation chromatography
GPS	global positioning system
HDPE	high-density polyethylene
HpCDD	heptachlorodibenzo-*p*-dioxin
HpCDF	heptachlorodibenzofuran

HRGC/HRMS	high-resolution gas chromatography / high-resolution mass spectrometry
HSP	health and safety plan
HxCDD	hexachlorodibenzo-*p*-dioxin
HxCDF	hexachlorodibenzofuran
ICP-MS	inductively coupled plasma-mass spectrometry
ID	identification
LCS	laboratory control sample
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
MDL	method detection limit
MLLW	mean lower low water
MS	matrix spike
MSD	matrix spike duplicate
NIST	National Institute of Standards and Technology
NTU	nephelometric turbidity unit
OCDD	octachlorodibenzo-*p*-dioxin
OCDF	octachlorodibenzofuran
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PeCDD	pentachlorodibenzo-*p*-dioxin
PeCDF	pentachlorodibenzofuran
PM	project manager
PPE	personal protective equipment
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RAL	remedial action level

RI	remedial investigation
RL	reporting limit
RM	river mile
ROD	Record of Decision
RPD	relative percent difference
SCO	sediment cleanup objective
SDG	sample delivery group
SDOT	Seattle Department of Transportation
SIM	selected ion monitoring
SM	Standard Methods
SMS	Washington State Sediment Management Standards
SR	state route
SVOC	semivolatile organic compound
TBAS	tetrabutylammonium sulfite
TCDD	tetrachlorodibenzo-*p*-dioxin
TCDF	tetrachlorodibenzofuran
TEQ	toxic equivalent
TM	task manager
TOC	total organic carbon
TSS	total suspended solids
UCT-KED	universal cell technology-kinetic energy discrimination
VOC	volatile organic compounds
Windward	Windward Environmental LLC
WQC	water quality criteria

1 Introduction

This quality assurance project plan (QAPP) describes the quality assurance (QA) objectives, methods, and procedures for collecting seep water from the Lower Duwamish Waterway (LDW) for chemical analyses. As described in the *Pre-Design Studies Work Plan* (Windward and Integral 2017), hereafter referred to as the Work Plan, seep water data will be collected and analyzed to address the third amendment to the Administrative Order on Consent (AOC) (EPA 2016d).

The Work Plan presented the conceptual study design for seep water collection and associated chemical analyses (Windward and Integral 2017). This QAPP presents the detailed seep water study design, including details on project organization, field data collection, laboratory analyses, and data management.

US Environmental Protection Agency (EPA) guidance for QAPPs has been followed in preparing this document (EPA 2002). The remainder of this QAPP is organized into the following sections:

- Section 2 – Project Objectives and Description
- Section 3 – Project Organization and Responsibilities
- Section 4 – Data Generation and Acquisition
- Section 5 – Assessment and Oversight
- Section 6 – Data Validation and Usability
- Section 7 – References

Appendix A to this QAPP 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. Field collection forms are included as Appendix B. Laboratory methods and the associated reporting limits (RLs) are provided in Appendix C.

2 Project Objectives and Description

EPA issued a Record of Decision (ROD) for the LDW Superfund site on November 21, 2014 (EPA 2014b). The ROD described the selected sediment remedy for the LDW, and identified monitoring and source control activities, including sampling of LDW media. This QAPP focuses on sampling of seep water.

2.1 STUDY OBJECTIVE

Per the third amendment to the AOC (EPA 2016d), seep samples will be collected and analyzed as part of the pre-design studies to aid the Washington State Department of Ecology (Ecology) in source identification. Specifically, seep sampling will be conducted in areas where existing groundwater data are insufficient to determine if groundwater may be a significant ongoing source of contamination.

2.2 PROJECT APPROACH AND SCHEDULE

Most of the significant seeps in the LDW have been sampled as part of the remedial investigation (RI) or other programs (Windward 2004a, 2010). Seep sampling locations for the pre-design study effort, as discussed in this QAPP, are based on a review of this information, available groundwater data (Windward 2017), and the criteria outlined in the flow chart depicted in Figure 2-1, which includes a reconnaissance survey. The selection process and the seeps selected for the reconnaissance survey are described in Section 4.1.

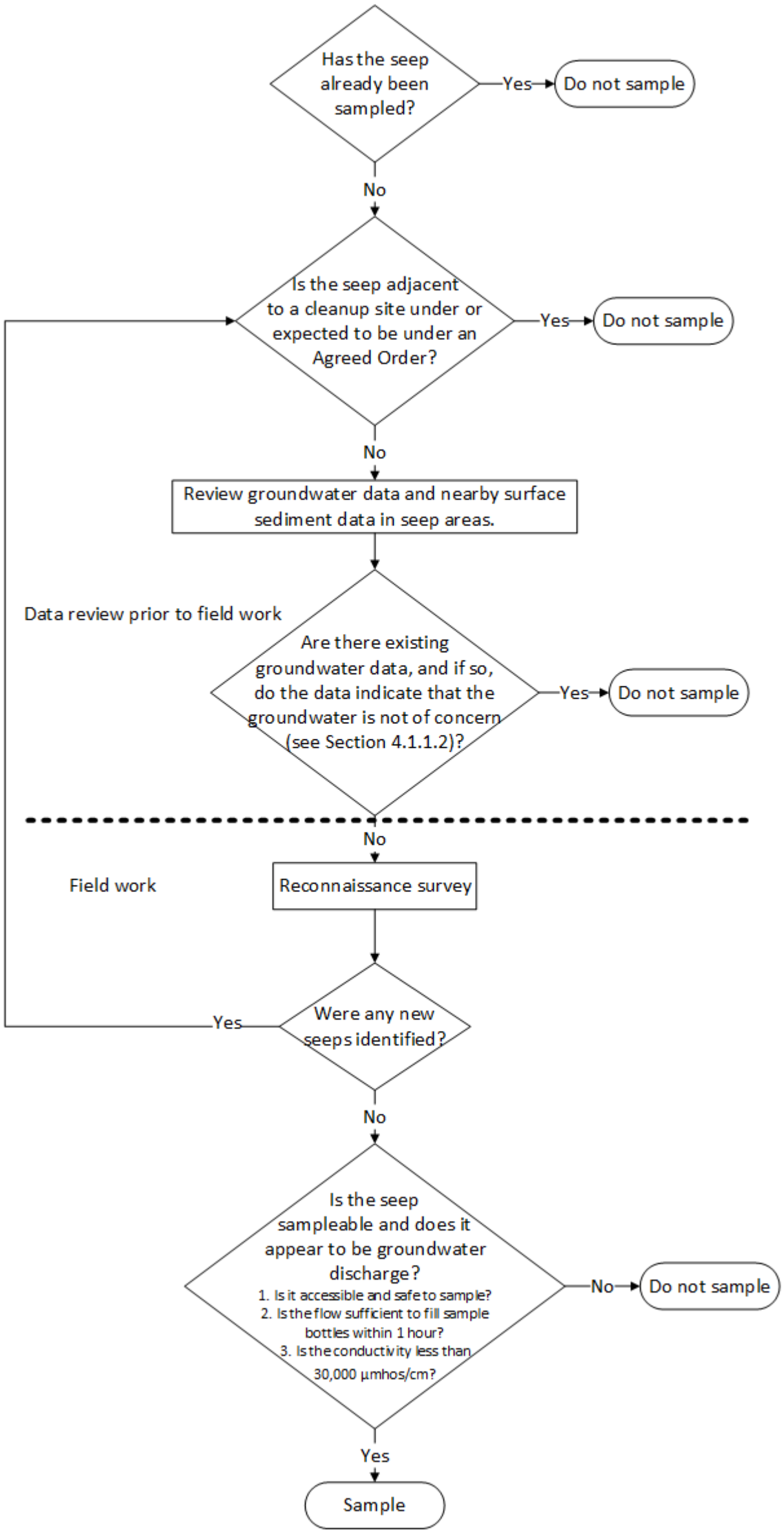

Figure 2-1. Selection criteria to determine if seeps should be sampled

In the LDW, freshwater moving downstream overlies a tidally driven saltwater wedge. These conditions result in the occurrence of saline water in the groundwater zone beneath the LDW. Less dense, fresh groundwater will not mix or migrate readily into these saline zones. As a result, fresh groundwater migrating beneath upland areas is likely to discharge upwards primarily into shallower areas of the LDW and emerge as seeps that can be sampled under low tide conditions. Based on past field experience, most of the seeps can be observed when the tide is below +1 ft mean lower low water (MLLW). Conducting the field effort during daylight low tides will maximize the observable intertidal area and will also ensure that tidal hydrostatic pressure has diminished, allowing seep flows to reach maximum rates (Windward 2004b).

Table 2-1 shows the daylight times[1] that the tide will be below + 1 ft MLLW from May through June 2018. Based on the information presented in Table 2-1, the reconnaissance survey will be conducted from May 15 to 18, 2018. Sampling during rain events could result in sampling of stormwater, not seep water. Therefore, seeps will not be sampled if there is visible storm runoff. If a rain event resulting in visible storm runoff occurs during the proposed survey dates, potential backup dates are May 19, 20, 29, 30, and 31, 2018. These survey dates were selected because of the negative tides that will occur during this period.

Table 2-1. Tidal lows available May through June 2018

Dates	Low Tide Start	Low Tide End	Duration of Work Time in Hours[a]	Low Tide Elevation (ft MLLW)
5/15/18	9:45	13:30	3.75	-1.75
5/16/18	10:00	14:30	4.5	-2.52
5/17/18	10:45	15:15	4.5	-2.92
5/18/18	11:30	16:00	4.5	-2.88
5/19/18	12:30	16:45	4.25	-2.42
5/20/17	13:30	17:30	4	-1.59
5/29/18	9:45	13:30	3.75	-1.47
5/30/18	10:15	14:15	4	-1.62
5/31/18	10:45	14:45	4	-1.59
6/12/18	8:30	12:30	4	-2.04
6/13/18	9:00	13:30	4.5	-2.98
6/14/18	9:30	14:15	4.75	-3.55
6/15/18	10:15	15:15	5	-3.67
6/16/18	11:15	16:00	4.75	-3.34
6/26/18	8:45	12:45	4	-1.31
6/27/18	9:15	13:15	4	-1.53

[1] Daylight times are targeted for crew safety and to facilitate observations during sampling.

Dates	Low Tide Start	Low Tide End	Duration of Work Time in Hours[a]	Low Tide Elevation (ft MLLW)
6/28/18	9:45	13:45	4	-1.61
6/29/18	10:30	14:30	4	-1.55

[a] Time tide elevation is below +1 ft MLLW.

MLLW – mean low low water

The seep sampling field event is scheduled for June 12 through 16, 2018 (5 days). This schedule assumes up to four samples per day as conditions allow, based on experience from previous seep sampling performed by Windward Environmental LLC (Windward) in 2004. Depending on the final number of samples, two field crews may be required. Potential backup dates for seep sampling, in the event of visible storm runoff, are June 26 through 29, 2018.

Chemical analysis of the seep samples will require approximately four weeks. Data validation will be completed approximately three weeks after receipt of the chemistry data. EPA will be notified when the final data validation report has been received. A draft seep sampling data report (Work Plan Task 5) will be submitted to EPA 21 days after receipt of the final validated analytical results (Windward and Integral 2017). A draft final seep sampling data report will be submitted to EPA 30 days after receipt of EPA's comments on the draft data report. Final validated data will be submitted to Ecology's Environmental Information Management (EIM) system and Scribe within 30 days of EPA approval of the data report. Seep data will be evaluated in the data evaluation report (Work Plan Task 6).

3 Project Organization and Responsibilities

The overall project organization and the individuals responsible for the various tasks required for seep sample collection and analysis are shown in Figure 3-1. Responsibilities of project team members, as well as laboratory project managers (PMs), are described in the following sections.

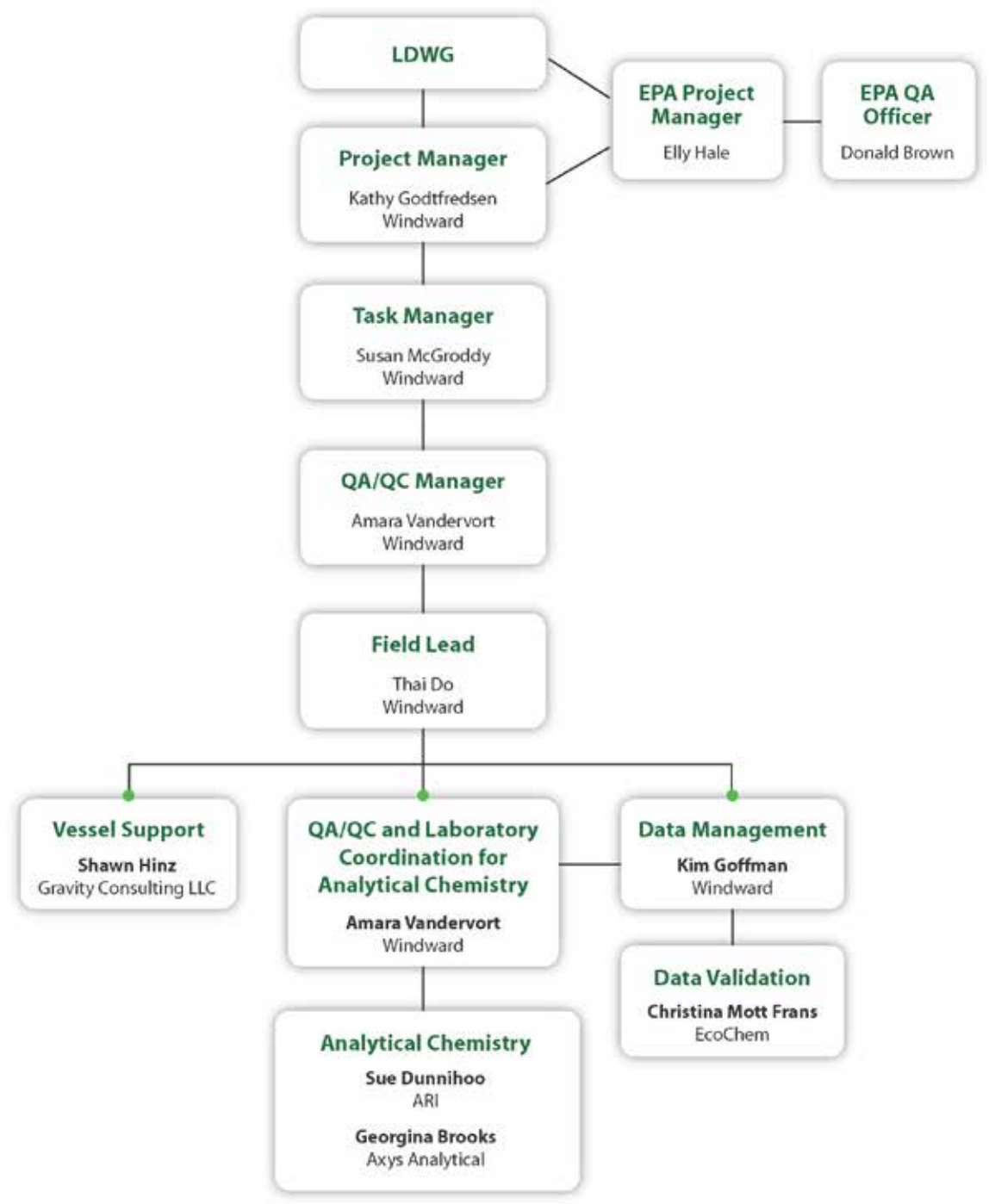

Figure 3-1.Project organization and team responsibilities

3.1 PROJECT MANAGEMENT

Both the Lower Duwamish Waterway Group (LDWG) and EPA are involved in all aspects of this project, including discussion, review, and approval of this QAPP, and interpretation of the results of the investigation. Elly Hale is the EPA PM for the pre-design studies (EPA 2016d).

Kathy Godtfredsen is the Windward PM. In this capacity, she will be responsible for overall project coordination, and for providing oversight for planning and coordination, work plans, all project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. She will also be responsible for coordinating with LDWG and EPA on schedule, deliverables, and other administrative details. Dr. Godtfredsen can be reached as follows:

Dr. Kathy Godtfredsen
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.577.1283
E-mail: kathyg@windwardenv.com

Susan McGroddy is the Windward monitoring task manager (TM). As TM, she will be responsible for communicating with the Windward PM on the progress of project tasks, conducting detailed planning and coordination, and monitoring and communicating any deviations from this QAPP. Significant deviations from this QAPP will be further reported to representatives of LDWG and EPA. Dr. McGroddy can be reached as follows:

Dr. Susan McGroddy
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5421
E-mail: susanm@windwardenv.com

3.2 FIELD COORDINATION

Thai Do is the Windward field coordinator (FC). As FC, he will be responsible for managing field sampling activities and providing general field and QA/quality control (QC) oversight. Suzanne Dudziak of Greylock Consulting LLC will assist Mr. Do in collecting seep samples. Mr. Do will ensure that appropriate protocols are observed for sample collection, preservation, and holding times, and will oversee delivery of environmental samples to the designated laboratories for chemical analyses. The FC will report deviations from this QAPP to the TM and PM for consultation. Significant deviations from this QAPP will be further reported to representatives of LDWG and EPA. Mr. Do can be reached as follows:

Mr. Thai Do
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5407[2]
Email: thaid@windwardenv.com

Shawn Hinz is the boat captain. He will be responsible for operating the boat and will coordinate closely with the FC to ensure that samples are collected in keeping with the methods and procedures presented in this QAPP. Mr. Hinz can be reached as follows:

Mr. Shawn Hinz
Gravity Consulting LLC
32617 Southeast 44th Street
Fall City, WA 98024
Mobile: 425.281.1471
Email: shawn@gravity.com

3.3 QUALITY ASSURANCE/QUALITY CONTROL

Amara Vandervort is the Windward QA / QC coordinator. In this capacity, she will oversee coordination of the field sampling and laboratory programs, and will supervise data validation and project QA coordination, including coordination with the analytical laboratories and the EPA QA officer, Donald Brown. Ms. Vandervort will also maintain the official approved QAPP and ensure that the appropriate parties receive any updated versions of the QAPP. Ms. Vandervort can be reached as follows:

Ms. Amara Vandervort
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5415
Email: amarav@windwardenv.com

Mr. Brown can be reached as follows:

Mr. Donald Brown
US Environmental Protection Agency, Region 10
1200 6th Avenue
Seattle, WA 98101
Telephone: 206.553.0717
Email: brown.donaldm@epa.gov

[2] A mobile phone number will be provided prior to field sampling.

Independent third-party chemical data review and validation will be provided by EcoChem. The PM at EcoChem can be reached as follows:

Ms. Christina Mott Frans
EcoChem
1011 Western Avenue, Suite 1006
Seattle, WA 98104
Telephone: 206.508.2110
Email: cmfrans@ecochem.net

3.4 LABORATORY RESPONSIBILITIES

Amara Vandervort of Windward is the laboratory coordinator for the analytical chemistry laboratories. Analytical Resources, Inc. (ARI) will perform all chemical analyses on the seep samples, with the exception of analyses for dioxins/furans, which will be performed by Axys Analytical Services Ltd. (Axys).

The laboratory PM at ARI can be reached as follows:

Ms. Susan Dunnihoo
Analytical Resources, Inc.
4611 South 134th Place
Tukwila, WA 98168-3240
Telephone: 206.695.6207
Email: limsadm@arilabs.com

The laboratory PM at Axys can be reached as follows:

Ms. Georgina Brooks
Axys Analytical Services Ltd.
2045 West Mills Road
Sidney, British Columbia V8L 5X2
Canada
Telephone: 250.655.5801
Email: Georgina.Brooks@sgs.com

The laboratories will meet the following requirements:

- Adhere to the methods outlined in this QAPP, including those methods referenced for each procedure.
- Adhere to documentation, custody, and sample logbook procedures.
- Implement 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 this QAPP.

- Allow EPA and the QA/QC manager, or a representative, to perform laboratory and data audits.

3.5 DATA MANAGEMENT

Kim Goffman of Windward will oversee data management and will ensure that analytical data are incorporated into the LDW database with appropriate qualifiers following acceptance of the data validation. QA/QC of the database entries will ensure accuracy for use in the pre-design studies. Ms. Goffman can be reached as follows:

Ms. Kim Goffman
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5414
Email: kimg@windwardenv.com

3.6 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. Accordingly, 29 Code of Federal Regulations (CFR) 1910.120 requires that employees be given the training necessary to provide them with the knowledge and skills to enable 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 and 8-hour refresher courses, as necessary, to meet OSHA regulations.

Also, ARI and Axys have current environmental laboratory accreditation from Ecology for the methods to be performed.

3.7 DOCUMENTATION AND RECORDS

All field activities and laboratory analyses will be documented following the protocols described in this section. In addition, data reduction rules and data report formats are provided herein.

3.7.1 Field observations

All field activities will be recorded in a field logbook maintained by the FC or designee. The field logbook will provide a description of all sampling activities, conferences between the FC and EPA oversight personnel associated with field sampling activities, sampling personnel, and weather conditions, as well as 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, and all entries will be made in indelible ink. Photographs, taken with a digital camera, will provide additional

documentation of the seep collection activities. 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 field data collection sheets, included as Appendix B, will also be used to record pertinent information after sample collection:

- Seep Reconnaissance Survey Forms A-C
- Seep Collection Form
- Protocol Modification Form

Information regarding equipment calibration and other sampling activities will be documented in the field logbook.

3.7.2 Laboratory records

The chemistry laboratories will be responsible for internal checks on sample handling and analytical data reporting and will correct errors identified during the QA review. The laboratory data packages will be submitted electronically and will include the following:

- **Project narrative**: This summary, in the form of a cover letter, will present any problems encountered during any aspect of sample analyses. The summary will include, but not be limited to, discussion of QC, sample shipment, sample storage, and analytical difficulties. Any problems encountered by the laboratory will be documented, as will their resolutions. In addition, operating conditions for instruments 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 will also be documented.
- **Sample results**: The data package will summarize the results for each sample analyzed. The summary will include the following information, as applicable:
  - Field sample identification (ID) code and the corresponding laboratory ID code
  - Sample matrix
  - Date of sample extraction / digestion
  - Date and time of analysis
  - Volume used for analysis
  - Final dilution volumes or concentration factor for the sample
  - Identification of the instruments used for analysis

- Method detection limits (MDLs) and RLs[3]
- 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 except for isotope dilution method correction prescribed in EPA method 1613b. The required summaries are as follows:
  - The 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), relative percent difference (RPD), and retention time for each analyte will be listed, as appropriate. Results for standards analyzed to indicate instrument sensitivity will be reported.
  - The internal standard area summary will report the internal standard areas, as appropriate.
  - The 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.
  - The 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.
  - The labeled compound recovery summary will report all labeled compound recovery data for EPA method 1613b analyses. The names and concentrations of all compounds added, percent recovery, and QC limits will be listed.
  - The matrix spike (MS) recovery summary will report the MS or MS / matrix spike duplicate (MSD) recovery data for analyses, as appropriate. The names and concentrations of all compounds added, percent recoveries, and QC limits will be included. The RPDs for all MS and MSD analyses will be reported.
  - The matrix duplicate summary will report the RPDs for all matrix duplicate analyses. The QC limits for each compound or analyte will be listed.
  - The laboratory control sample (LCS) analysis summary will report the results of the analyses of LCSs. The QC limits for each compound or analyte will be included.

[3] The term MDL includes other types of detection limits (DLs), such as estimated detection limit (EDL) values calculated for dioxin / furan congeners.

- The 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.
- The ion abundance ratio summary for samples analyzed by EPA method 1613b will report computed ion abundance ratios compared to theoretical ratios listed in the applicable method.

- **Original data**: Legible copies of the original data generated by the laboratory will be provided, including the following:
  - 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 LCSs
  - Enhanced and unenhanced spectra of target compounds detected in field samples and method blanks, with associated best-match spectra and background-subtracted spectra, for all gas chromatography / mass spectrometry (GC / MS) analyses
  - Quantitation reports for each instrument used, including reports for all samples, blanks, calibrations, MSs / MSDs, laboratory replicates, and LCSs The contract laboratories for this project will submit data electronically, in EarthSoft EQuIS® standard four-file or EZ_EDD format. Guidelines for electronic data deliverables for chemical data are provided on the EarthSoft website, http: / / www.earthsoft.com / en / index.html, and additional information will be communicated to the laboratories by the project QA / QC coordinator or data manager. All electronic data submittals must be tab-delimited text files with all results, MDLs (as applicable), and RLs reported to the appropriate number of significant figures. If laboratory replicate analyses are conducted on a single submitted field sample, the laboratory sample identifier must distinguish among the replicate analyses.

3.7.3 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 will be the laboratory analyst's responsibility to reduce the data, which will be subjected to further review and reduction by the laboratory PM, the Windward TM, the QA / QC coordinator, and independent reviewers. The data will be generated in a format 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.

3.7.4 Data report

A data report will be prepared documenting all activities associated with the collection, handling, and analysis of samples, as specified in Task 5 of the Work Plan (Windward and Integral 2017). At a minimum, the following information will be included in the data report:

- Summary of all field activities, including descriptions of any deviations from the approved QAPP
- Sampling locations reported in latitude and longitude to the nearest one-tenth of a second and in northing and easting to the nearest foot
- *In situ* seep flow and water quality measurements during reconnaissance and the seep sampling event
- Summary of the chemical data QA / QC review
- Results from the analyses of field samples, included as summary tables in the main body of the report, data forms submitted by the laboratories, and cross-tab tables produced from Windward's database
- Copies of field logs and photographs (appendix)
- Copies of COC forms (appendix)
- Data validation report (appendix)

Once the data report has been approved by EPA, a database export will be created from Windward's database. The data will be exported in two formats: one that is compatible with Ecology's EIM System, and one that is compatible with EPA's Scribe database.

3.7.5 Data storage and backup

All electronic files related to the project will be stored on a secure server on Windward's network. The server contents are backed up on an hourly basis, and a copy of the backup is uploaded nightly to a secure off-site facility.

4 Data Generation and Acquisition

Seep samples will be collected, processed, and analyzed according to the procedures described in this section. In addition, QA / QC, instrument maintenance and calibration, non-direct measurement, and data management requirements are provided.

4.1 SAMPLING DESIGN

The sampling design currently includes a pre-screening of potential seep sampling locations, which were chosen using cleanup site information as well as available seep, sediment, and groundwater data prior to conducting a reconnaissance survey. A reconnaissance survey will further screen seeps to be sampled based on sampling location accessibility, flow rate, and conductivity. Any new seeps discovered during the reconnaissance survey will also be screened.

4.1.1 Sampling locations

In keeping with the approach summarized in Figure 2-1, three sources of information as well as best professional judgement were used to determine pre-screening seep sampling locations. These sources are listed below and discussed in the following subsections:

- Existing seep data and cleanup site locations
- Existing groundwater and surface sediment data
- Reconnaissance survey data

4.1.1.1 Existing seep data and cleanup site locations

Existing seep data were reviewed to identify the locations of known and previously sampled seeps. From the LDW RI and Work Plan Task 2 dataset (Map 4-1), 122 known seeps were identified, 65 of which had already been sampled and were therefore screened out (Appendix D). Of the remaining 57 seeps, 11 were located adjacent to cleanup sites under or expected to be under an Agreed Order; these were screened out, leaving 46 seeps (Appendix D).

4.1.1.2 Existing groundwater and surface sediment data

The compiled groundwater data were reviewed, and existing groundwater data from wells in the vicinity of 13 of the remaining 46 seeps were identified (Maps 4-2a,b,c). These data were evaluated for sufficiency. Groundwater data from wells near 10 of the 13 seeps were not sufficient (i.e., did not include enough analytes or had elevated polychlorinated biphenyl [PCB] detection limits [DLs]; Appendix E) to screen out the corresponding seeps, whereas groundwater data from wells near 3 of the 13 seeps were sufficient to screen out the groundwater pathway from a source control perspective.

As part of the screening assessment, existing sediment data were evaluated near seep locations to ensure the sufficiency of adjacent groundwater data. In particular, sediment data were included in the groundwater screen for two reasons:

- If the groundwater analyte list did not include the full list of chemicals with sediment remedial action levels (RALs), the sediment data were reviewed to ensure that no sediment RAL exceedances are present in that area for those chemicals.
- If a chemical had an elevated concentration in groundwater relative to a conservative benchmark,[4] the sediment data was used to assess whether RAL exceedances for that chemical are present in the vicinity of the seep. For screening purposes only, Washington State marine chronic water quality criteria (WQC) were used as the conservative benchmark.

The results of groundwater and sediment data screening step are presented in Table 4-1. Each of the 43 seeps remaining will be included in the reconnaissance survey being conducted to determine which seeps should be sampled for the full analyte list.

Where two or more seeps are located close to each other (i.e., within 0.2 river miles of each other) and also drain the same upland property or drain nearby residential properties or bridge, the results of the reconnaissance survey will be documented, and the results will be discussed with EPA and Ecology to assess which of the seeps can be grouped to represent an area (e.g., only one of two nearby seeps sampled), and which should be sampled individually. Documentation will include observations of land uses that are visible from the waterway. Potential groupings are included in Table 4-1 for reference. The final list of seeps to be sampled will be submitted to EPA for approval.

[4] There are no established groundwater criteria for sediment recontamination above the RALs.

Table 4-1. Screening assessment of subset of seeps not previously sampled and not adjacent to cleanup sites

Seep	Location (approx. RM)	Groundwater and Sediment Data Evaluation	Upland Property Information and Other Notes	Preliminary Assessment[a]	Rationale for Screening Out or Potential Grouping
SP-01	2.2 E	wells slightly cross-gradient from seep in Slip 3; groundwater analyzed for VOCs; not enough data to screen out seep	adjacent to roadway and near Glacier Marine and Seattle Distribution Center properties	recon	
SP-05	2.6 E	no groundwater data	near border between Seattle Iron and Metals and Puget Sound Truck Lines	recon	
SP-06	2.6 E	no groundwater data	Puget Sound Truck Lines; co-located with SP-07	recon SP-06 and SP-07; document seep with highest flow	co-located with SP-07
SP-07	2.6 E	no groundwater data	Puget Sound Truck Lines; co-located with SP-06		co-located with SP-06
SP-08	2.7 E	groundwater analyzed for full analyte list (except dioxins/furans); metals, naphthalene, 1 VOC, and PCBs below WQC; all other analytes ND; no nearby sediment data	Puget Sound Truck Lines	screen out	groundwater data (all groundwater analyte concentrations ND or < WQC)
SP-11	2.7 E	groundwater analyzed for full analyte list (except dioxins/furans); metals, naphthalene, 1 VOC, and PCBs below marine chronic WQC; all other analytes ND; one nearby PCB CSL exceedance in sediment; multiple PAH SCO exceedances in sediment nearby (sediment locations DENW6721-SSED-16A-2014 and LDW-SS92)	City of Seattle	screen out	groundwater data (all groundwater analyte concentrations ND or < WQC); all RLs < WQC except for pentachlorophenol; pentachlorophenol not detected in groundwater; RL was 10 µg/L vs. WQC of 7.9 µg/L and Ecology (2016) threshold of 30 or 43 µg/L for the protection of sediment
SP-24	4.2 E	no groundwater data	Boeing; tried to sample during RI (Slip 6) but seep was dry	recon	

Seep	Location (approx. RM)	Groundwater and Sediment Data Evaluation	Upland Property Information and Other Notes	Preliminary Assessment[a]	Rationale for Screening Out or Potential Grouping
SP-26	4.5 E	groundwater analyzed for 2 metals and select VOCs; no SMS exceedances in numerous nearby sediment samples, except one benzyl alcohol CSL exceedance (sediment locations LDW-SS2085-A, LDW-SS138, R71, EIT049, and R73)	Boeing; adjacent upland parcel (BDC) is a VCP site	screen out	groundwater and sediment data (limited groundwater analyte list but good sediment coverage with no SCO exceedances)
SP-27	5.0 E	no groundwater data	Boeing	recon	
SP-28	4.9 E	no groundwater data	Boeing	recon SP-28 and SP-33; document seep with highest flow	located near SP-33 and adjacent to same upland property
SP-29	4.9 W	no groundwater data	Boeing Employees Activity Center	recon SP-29, SP-30, SP-31, and SP-32; document seep with highest flow	seeps located near each other and adjacent to same upland property
SP-30	4.9 W	no groundwater data	Boeing Employees Activity Center		
SP-31	4.9 W	no groundwater data	Boeing Employees Activity Center		
SP-32	4.8 W	no groundwater data	Boeing Employees Activity Center		
SP-33	4.8 E	groundwater analyzed for 2 metals and select VOCs	Boeing	recon SP-28 and SP-33; document seep with highest flow	located near SP-28 and adjacent to same upland property
SP-34	4.6 W	no groundwater data	located adjacent to SR 99 and parcel owned by Muckleshoot Tribe	recon	
SP-35	4.6 E	groundwater analyzed for 2 metals and select VOCs; PCB SCO exceedance nearby (sediment location R75)	Boeing	recon SP-35 and SP-37; document seep with highest flow	located near SP-37 and adjacent to same upland property
SP-36	4.5 W	no groundwater data	City of Seattle	recon SP-36 and SP-38; document seep with highest flow	located near SP-38 and adjacent to same upland property owner
SP-37	4.5 E	groundwater analyzed for 2 metals and select VOCs; PCB SCO exceedance nearby but not in nearest sample (sediment location B9a)	Boeing	recon SP-35 and SP-37; document seep with highest flow	located near SP-35 and adjacent to same upland property

Seep	Location (approx. RM)	Groundwater and Sediment Data Evaluation	Upland Property Information and Other Notes	Preliminary Assessment[a]	Rationale for Screening Out or Potential Grouping
SP-38	4.4 W	no groundwater data	City of Seattle	recon SP-36 and SP-38; document seep with highest flow	located near SP-36 and adjacent to same upland property owner
SP-40	4.0 W	no groundwater data	Duwamish Yacht Club; SP-40 and SP-42 on either side of SP-41, which was previously sampled;	recon	
SP-42	3.9 W	groundwater analyzed for 3 metals, 1 PAH, 3 SVOCs; no SCO exceedances in nearby samples (sediment locations R37, R36, and WIT264)	Sea King Industrial Park; SP-40 and SP-42 on either side of SP-41, which was previously sampled	recon	
SP-43	3.8 W	groundwater analyzed for 3 metals, 1 PAH, 3 SVOCs; mercury SCO exceedance and PCB SCO exceedance nearby (sediment locations DR210, LDW-SSSP3-A, LDW-SSSP3-D, LDW-SSSP3-U, LDW-SS117, R25, and DR211)	Boeing	recon	
SP-44	3.4 W	no groundwater data	South Park Bridge	recon	
SP-45	3.3 W	no groundwater data	near residential properties	recon SP-45, SP-46, and SP-47; document seep with highest flow	seeps located near each other; drain residential properties
SP-46	3.2 W	no groundwater data	near residential properties		
SP-47	3.1 W	no groundwater data	near residential properties		
SP-49	3.0 W	no groundwater data	Silver Bay Logging	recon SP-49 and SP-50; document seep with highest flow	seeps located near each other and drain same upland property
SP-50	2.9 W	no groundwater data	Silver Bay Logging		
SP-51	2.8 W	no groundwater data	seep is adjacent to 8th Ave Park, vacant land/land owned by Cassell Point LLC; Hurlen Construction is just downstream	recon	
SP-57	2.0 W	no groundwater data	adjacent to roadway, 1st Ave bridge, and SDOT property	recon	

Seep	Location (approx. RM)	Groundwater and Sediment Data Evaluation	Upland Property Information and Other Notes	Preliminary Assessment[a]	Rationale for Screening Out or Potential Grouping
SP-58	2.1 W	no groundwater data	located adjacent to SP-59; under 1st Ave Bridge	recon SP-58 and SP-59; document seep with highest flow	seeps located near each other and drain similar environments
SP-59	2.1 W	no groundwater data	located adjacent to SP-58; under 1st Ave bridge		
SP-63	2.2 E	no groundwater data	Bunge Foods; nearby seeps (S-11 and S-12) not analyzed for PCBs	recon	
SP-65	1.0 W	no groundwater data	Lafarge; located on same property as SP-64 (previously sampled)	recon SP-65 and SP-66; document seep with highest flow	seeps located near each other and adjacent to same upland property
SP-66	0.9 W	no groundwater data	Lafarge; located on same property as SP-64 (previously sampled)		
SP-67	0.8 W	no groundwater data	Port of Seattle	recon SP-67 and SP-68; document seep with highest flow	seeps located near each other and adjacent to same upland property
SP-68	0.7 W	no groundwater data	Port of Seattle		
SP-70	0.2 W	no groundwater data	General Recycling	recon	
SP-72	0.2 E	no groundwater data	Ash Grove Cement	recon	
SP-73	0.6 E	groundwater analyzed for PAHs, PCBs, select metals; all of the analytes were below the WQC or were ND, except zinc, but no zinc SCO exceedances nearby; no SCO exceedances nearby for chemicals not analyzed in groundwater (sediment locations LDW-SS508, DUD012, DUD209, and DUD013)	Port of Seattle	recon	groundwater and sediment data (all groundwater analyte concentrations ND or < WQC, except zinc, which did not have SCO exceedance in nearby sediment); however, PCB and mercury RLs greater than chronic WQC

Seep	Location (approx. RM)	Groundwater and Sediment Data Evaluation	Upland Property Information and Other Notes	Preliminary Assessment[a]	Rationale for Screening Out or Potential Grouping
SP-74	0.7 E	groundwater analyzed for PAHs, PCBs and select metals; copper, zinc, and acenaphthene below WQC; all other analytes ND; no nearby sediment data	Port of Seattle	recon	groundwater data (all groundwater analyte concentrations ND or < WQC); however, PCB and mercury RLs greater than chronic WQC
SP-77	1.1 E	no groundwater data	King County	recon	
SP-78	1.4 E	groundwater analyzed for naphthalene, 3 SVOCs and VOCs; PCB SCO exceedances nearby (sediment locations LDW-SS50, LDW-SS52, TRI-052, LDW-SS2011-D, LDW-SS2011-A, and LDW-SS54)	King County	recon	
SP-79	1.5 E	groundwater analyzed for naphthalene, 3 SVOCs and VOCs	BPB Gypsum Inc.	recon	
SP-81	1.7 E	no groundwater data	Slip 2; Glacier Northwest	recon	

Note: Prior to the screening shown in this table, other seeps were screened out based on previous sampling or expected future sampling as part of upland cleanup. These first two tiers of screening are discussed Section 4.1.1 and Appendix D.

[a] Seeps with a preliminary assessment of "recon" will be included in the reconnaissance survey.

BBP – butyl benzyl phthalate
BDC – Boeing Developmental Center
CSL – cleanup screening level
DL – detection limit
ND – non-detect
PAH – polycyclic aromatic hydrocarbon
PCBs – polychlorinated biphenyls
RI – remedial investigation
RL – reporting limit
RM – river mile
SCO – sediment cleanup objective (benthic)
SDOT – Seattle Department of Transportation
SMS – Washington State Sediment Management Standards
SR – state route
SVOCs – semivolatile organic compounds
VCP – Voluntary Cleanup Program
VOCs – volatile organic compounds
WQC – water quality criteria

4.1.1.3 Selected locations for reconnaissance

Based on the analysis described in Section 4.1.1.2, 43 locations were selected for the reconnaissance survey, which is discussed in Section 4.1.2 (Map 4-3). Table 4-2 provides the locations of these seeps.

Table 4-2. Reconnaissance seeps locations

Seep Location ID	Potential Group[a]	X	Y	Longitude	Latitude
SP-01		1270793	201470	-122.33	47.54247
SP-05		1271788	199493	-122.326	47.5371
SP-06	SP-06 and SP-07	1272074	199134	-122.325	47.53613
SP-07		1272106	199134	-122.324	47.53613
SP-24		1277552	192967	-122.302	47.51952
SP-27		1278736	190038	-122.297	47.51155
SP-28	SP-28 and SP-33	1278342	190343	-122.299	47.51237
SP-29	SP-29, SP-30, SP-31, and SP-32	1278280	190125	-122.299	47.51177
SP-30		1278533	189981	-122.298	47.51138
SP-31		1278411	190074	-122.298	47.51163
SP-32		1277871	190291	-122.3	47.5122
SP-33	SP-28 and SP-33	1277731	190501	-122.301	47.51277
SP-34		1276855	190335	-122.305	47.51227
SP-35	SP-35 and SP-37	1277113	190719	-122.304	47.51333
SP-36	SP-36 and SP-38	1276630	190844	-122.306	47.51365
SP-37	SP-35 and SP-37	1276958	191014	-122.304	47.51413
SP-38	SP-36 and SP-38	1276541	191387	-122.306	47.51513
SP-40		1275873	193266	-122.309	47.52025
SP-42		1275903	193789	-122.309	47.52168
SP-43		1275851	194501	-122.309	47.52363
SP-44		1274678	196232	-122.314	47.52832
SP-45	SP-45, SP-46, and SP-47	1274213	196685	-122.316	47.52953
SP-46		1273887	196886	-122.317	47.53007
SP-47		1273588	197196	-122.318	47.5309
SP-49	SP-49 and SP-50	1273022	197711	-122.321	47.53228
SP-50		1272864	197873	-122.321	47.53272
SP-51		1272376	198356	-122.323	47.53402
SP-57		1269573	201184	-122.335	47.54162
SP-58	SP-58 and SP-59	1269572	200740	-122.335	47.5404
SP-59		1269565	200782	-122.335	47.54052
SP-63		1270573	200732	-122.331	47.54043

Seep Location ID	Potential Group[a]	X	Y	Longitude	Latitude
SP-65	SP-65 and SP-66	1266743	206164	-122.347	47.55512
SP-66		1266532	206284	-122.348	47.55543
SP-67	SP-67 and SP-68	1266020	206866	-122.35	47.557
SP-68		1265900	207440	-122.35	47.55857
SP-70		1266050	210057	-122.35	47.56575
SP-72		1267080	210736	-122.346	47.56767
SP-73		1267241	208423	-122.345	47.56133
SP-74		1267361	208061	-122.344	47.56035
SP-77		1268127	205985	-122.341	47.5547
SP-78		1268535	204311	-122.339	47.55013
SP-79		1268658	204102	-122.339	47.54957
SP-81		1269545	203124	-122.335	47.54693

[a] The results of the seep reconnaissance will be used, in consultation with EPA and Ecology, to determine which of the seeps in potential groups will be sampled for the analytes discussed in Section 4.4.2.

Ecology – Washington State Department of Ecology

EPA – US Environmental Protection Agency

ID - identification

4.1.2 Reconnaissance survey

In order to select seeps for sampling, a reconnaissance survey will be conducted to assess accessibility, seep flow, make observations of visual characteristics, and collect field measurements of conventional water quality parameters. Seeps identified in Section 4.1.1.3 will be evaluated in the reconnaissance survey, as well as any potential new seeps that are observed during the survey.

During the reconnaissance survey, seeps identified as inaccessible or deemed unsafe to sample, including those under piers, docks, or other overwater structures, will be documented as such through the use of photographs and field notes regarding condition observations. At safe and accessible seeps, the field team will look for evidence of flow with sufficient volume to sample, and will measure the conventional parameters (temperature, conductivity, turbidity, pH, and dissolved oxygen [DO]). The seep's conductivity will be used to confirm that it is representative of groundwater discharge. Conductivity must be less than 30 mS/cm conductivity,[5] and the flow rate must be sufficient to generate 3.5 liters of water in an hour, given the time constraints of sampling during low tides. Flow rate estimates will be made at each seep using a stopwatch. The global positioning system (GPS) location of each seep will be recorded, and a stake will be used to mark each seep in the field.

The conventional parameters will be measured in seep water collected in a glass beaker in the field using a multi-parameter water quality meter. The water collection

[5] On average, the conductivity of seawater is 53 mS/cm.

method will be based on best professional judgment in the field based on flow rate and substrate type. Potential methods of water collection, as described in more detail in Section 4.2.2, include:

- Placement of a glass funnel under the flow of an actively flowing seep from a moderately to steeply sloping embankment
- Excavation of a pit and placement of a stainless steel bowl that is allowed to fill with seep water (to be used for seeps from which water cannot be collected directly under the flow)
- Placement of Teflon™ sheeting to direct flow to a stainless steel bowl (to be used for low to moderately flowing seeps)

Seep survey observations and measurements will be recorded on the seep reconnaissance survey forms (Appendix B, forms A through C). At least two photographs will be taken of each seep.

The results of the reconnaissance survey will be briefly summarized in a spreadsheet and emailed to EPA for approval; maps, notes, and photographs will also be provided. If needed, a meeting will be held to agree upon which seep locations will be sampled for chemical analysis. In addition, EPA oversight staff may be present during the reconnaissance to aid in decision making. All results will be summarized in the data report.

4.1.3 Analytes

Seep samples collected for chemical analysis will be filtered and analyzed for the analyte list discussed in Section 4.4.2. Samples from a subset of the seeps initially will not be analyzed for dioxins/furans (Map 4-4). Samples from these seeps will be archived for potential analysis of dioxins/furans following a review of the additional surface sediment and bank data to be collected this year. The 19 seeps that will be initially analyzed for dioxins/furans are SP-01, SP-24, SP-40, SP-42, SP-51, SP-57, SP-58, SP-59, SP-63, SP-65, SP-66, SP-67, SP-68, SP-70, SP-72, SP-77, SP-78, SP-79, and SP-81.

The seeps that will not be initially analyzed for dioxins/furans were identified based on the existing surface sediment dioxin/furan toxic equivalent (TEQ) values in the vicinity of the seeps. Seeps in areas characterized by surface sediments with TEQs less than 5 ng/kg will be archived for potential dioxin/furan analysis if pentachlorophenol is detected in nearby bank samples, or if the dioxin/furan TEQ is greater than the RAL (25 ng/kg) in nearby sediment (Map 4-4 of this QAPP and Maps 4-6 and 4-10 of the sediment QAPP (Windward 2018).

Pending review of the bank and sediment data to be collected this field season, seep samples collected upstream of RM 4.4 and in RM 2.5 to RM 2.7 and RM 2.9 to RM 3.9 will be filtered and archived for potential analysis of dioxins/furans. The decision

whether to analyze any of these archived samples for dioxins/furans will be made in consultation with EPA following the data review.

4.2 SAMPLE IDENTIFICATION AND SAMPLING METHODS

Sample identification and field sampling will be performed following the protocols described in this section. Contingencies may arise during field activities that require modification of the general procedures outlined herein. Such modifications will be made at the discretion of the FC after consultation with the Windward TM and PM, and the EPA representative in the field, if applicable. LDWG and EPA will be consulted if significant deviations from the sampling design are required. All modifications will be recorded in the protocol modification form (Appendix B).

4.2.1 Sample identification

Unique alphanumeric IDs will be assigned to each seep sample and recorded on the seep collection form (Appendix B).

The sample ID will include the following:

- Project area ID (i.e., LDW) and two-digit year
- Sample type (i.e., SP for seep)
- Sample location ID (Table 4-2)[6]

For example, the seep sample collected from location SP-30 will be identified as LDW18-SP-30.

All relevant information for each sample—including ID, date, time, and location—will be recorded on the seep collection form (Appendix B) and included as an appendix in the data report.

4.2.2 Seep sampling methods

The seep water sampling method will be determined in the field based on the location of the seep, the observed flow rate and the substrate conditions. A seep collection form (Appendix B) will be completed for each seep location. At least two photographs will be taken of each seep.

Prior to collecting each seep sample for chemical analysis, as described below, water quality parameters—temperature, conductivity, turbidity, pH, and DO—will be recorded again using a multi-parameter water quality meter. Salinity values will be calculated[7] from the measured conductivity and temperature.

[6] Note that any newly identified seeps will be given a new seep location ID, and coordinates will be recorded in the field notes.

[7] Salinity is determined from conductivity and temperature measurement. Calculation is based on algorithms in Standard Methods (SM).

4.2.2.1 Seep originating from shoreline embankment

If a seep originates from a moderate or steep shoreline embankment and has turbidity ≤ 25 nephelometric turbidity unit (NTU),[8] seep water will be collected by diverting flow through a pre-cleaned glass funnel and Masterflex® platinum-cured silicone tubing into a glass beaker for measurement of conventionals using the water quality meter. If the seep meets the conductivity criterion, then sample bottle will be filled directly (Figure 4-4). If turbidity is > 25 NTU, the sample will be allowed to settle in the stainless steel bowl for approximately 5 minutes prior to its transfer to sample bottles.

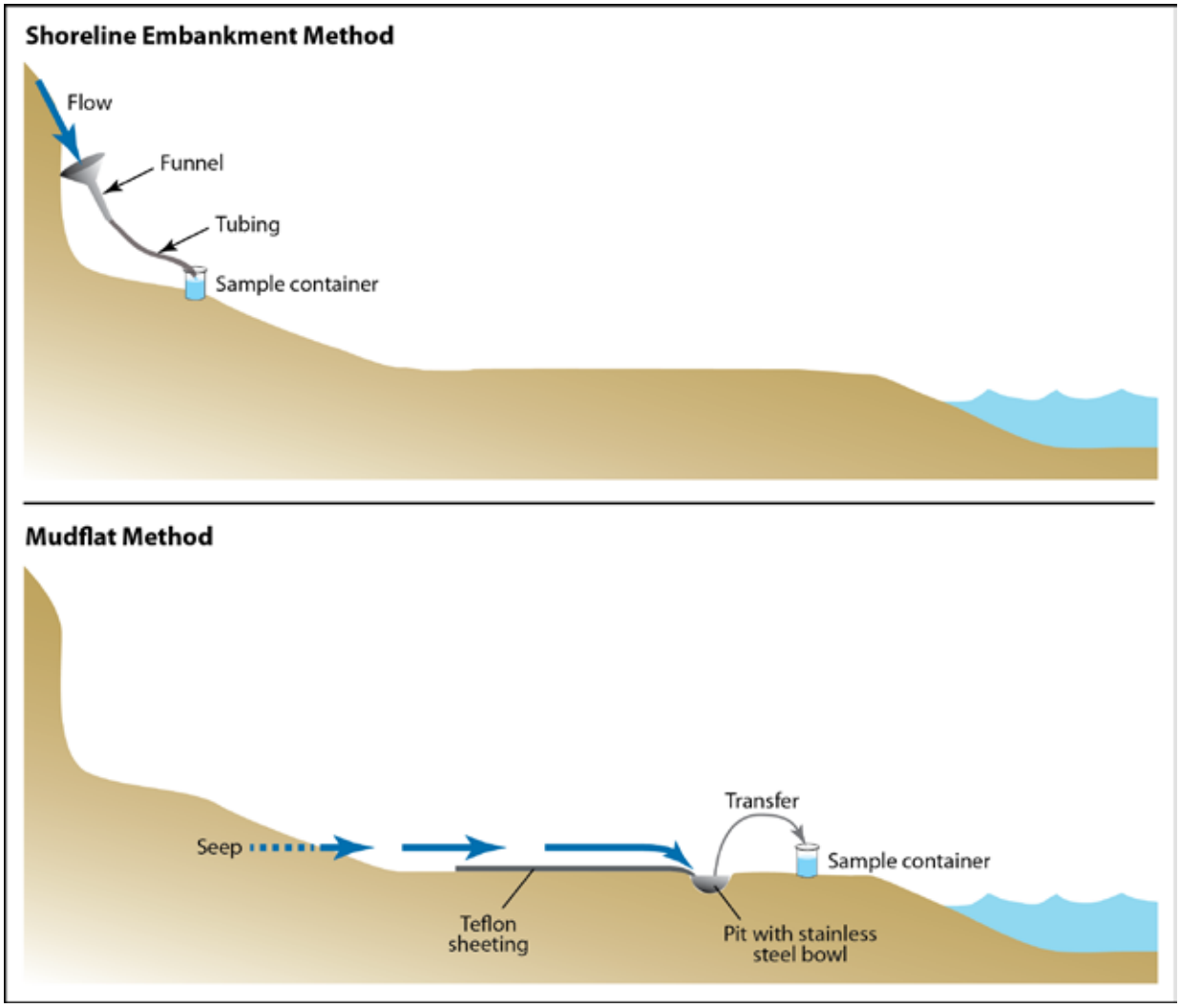

Figure 4-4.Seep sampling methods

[8] The threshold of 25 NTU is based on best professional judgement. A turbidity benchmark value of 25 NTU is used in the current *Industrial Stormwater General Permit* (Ecology 2014). Additionally, water with turbidity of 25 NTU looks clear.

4.2.2.2 Seep originating from mudflat

If a seep originates from an exposed mudflat, samples will be collected by diverting the seep water across pre-cleaned Teflon™ sheeting that is placed downgradient of the origin of the seep. The flow will be diverted into a pre-cleaned stainless steel bowl (Figure 4-4). Seep water will be transferred from the bowl to a glass beaker using a pre-cleaned stainless steel ladle for the measurement of conventional parameters using the water quality meter. If the seep water meets the conductivity criterion, sample bottles for chemistry analyses will also be filled using the ladle. If turbidity is > 25 NTU, the sample will be allowed to settle in the stainless steel bowl for approximately 5 minutes prior to transfer.

4.2.2.3 Sample collection contingencies

If seep flow is lower than anticipated on the day of sampling or if there is no flow, bottles that can be filled within one hour will be filled, and the field crew will return one additional time during the sampling event (including the backup dates) at a different tidal elevation to attempt sampling. If the full volume required for all analyses cannot be collected, analyte priorities will be discussed with EPA and Ecology on a seep-by-seep basis. If the flow rate is still insufficient, nearby seeps will be assessed to determine if they meet the criteria and can serve as representative seeps for the property. If no nearby seeps are available, EPA will be notified that seep water cannot be sampled at this location.

4.2.3 Field equipment

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

- QAPP
- Field sample collection forms
- Field notebooks (Rite in the Rain®)
- COC forms
- Pens, pencils, Sharpies®
- GPS (w / extra batteries)
- Digital camera
- Cellular phone
- Alconox® detergent and scrub brush
- Coolers
- Ice (wet and / or dry)
- Glass funnels
- Teflon™ sheeting and Masterflex® platinum-cured silicon tubing
- Peristaltic pumps
- Stainless steel ladles
- Flexible Teflon™ sheeting
- Hydrolab
- Extra membranes for Hydrolab DO probe
- Gloves
- Field notes from reconnaissance survey for seep locations

- LDW maps including property boundaries
- Seep location coordinates
- Property access notification letters
- Plywood
- Squirt bottle with distilled water
- Bucket for decontamination
- Distilled water
- Rubber boots
- Raingear
- Waders
- Stopwatch
- Reverse osmosis water
- Stainless steel bowls and glass beakers
- Pre-cleaned sample bottles

Seep samples will be collected for all analyses at each seep if sufficient flow exists[9] (see Section 4.4.2). Seven bottles will be filled at each seep for chemical analysis (see Section 4.5.6): one 250-mL amber glass bottle, one 500-mL high density polyethylene (HDPE) bottle, two 500-mL amber glass bottles, one 250-mL HDPE bottle, and two 1-L amber glass bottles.

Samples for metals analysis will be handled following clean hands-dirty hands procedures. Samples collected for metals and organic analyses will be filtered and preserved as appropriate in the laboratory,[10] as discussed in Section 4.4.1.

4.3 SAMPLE HANDLING AND CUSTODY 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 analyses, to delivery of the sample results to the recipient. Procedures to be followed for sample handling, custody, and shipping are detailed in this section. In addition, procedures for decontamination of equipment and disposal of field-generated waste are described.

4.3.1 Sample handling procedures

At each laboratory, a unique sample identifier (termed either project ID or laboratory ID) will be assigned to each sample. 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 names/initials of individuals responsible for performing the analyses, dates of sample extraction/preparation and analysis, and types of analyses being performed.

The FC will be responsible for reviewing seep sample information recorded on field collection forms (Appendix B) and will correct any improperly recorded information. Samples will be double bagged and immediately stored in coolers with wet ice.

[9] In the event that seep volume is less than the minimum requirement, EPA will be consulted to determine the analytical priority for the specific seep location.

[10] Samples will be filtered in the laboratory as soon as possible following collection. Laboratory filtration under clean, controlled conditions greatly reduces the risk of sample contamination during filtration.

Sample labels will contain the project number, sampling personnel, date, time, and sample ID. Pertinent information about the sample, including its collection location, will be traceable through the sample label. A complete sample label will be affixed to each individual sample bottle. Labels will be filled out as completely as possible prior to each sampling event.

Samples will be placed on ice after collection and for transport to the laboratories. Sample packaging and transport information is summarized in Section 4.3.3.

4.3.2 Sample custody procedures

Samples are considered to be in custody if they are: 1) in the custodian's possession or view; 2) in a secured place (under lock) with restricted access; or 3) in a container and secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s). Custody procedures, described below, will be used for all samples throughout the collection, transportation, and analytical processes, 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 all 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 collection location, project name, and unique sample ID
- Sample collection date and time
- Any special notations on sample characteristics or problems
- Name of the person who initially collected the sample
- Date sample was sent to the laboratory
- Shipping company name and waybill number

In the field, the FC will be responsible for all sample tracking and custody procedures. The FC will also be responsible for final sample inventory and will maintain sample custody documentation. The FC or a designee will complete COC forms prior to removing samples from the sampling area. At the end of each day, and prior to sample transport to the laboratories, COC entries will be made for all samples. Information on the sample labels will be checked against sample log entries, and sample tracking forms and samples will be recounted. COC forms, which will accompany all samples, will be signed at each point of transfer. Copies of all COC forms will be retained and included as appendices to QA / QC reports and data reports. Samples will be shipped in sealed coolers.

The laboratories will ensure that COC forms are properly signed upon receipt of the samples and will note any questions or observations concerning sample integrity on the COC forms. The laboratories will contact the FC and project QA / QC coordinator

immediately if discrepancies are discovered between the COC forms and the sample shipment upon receipt.

4.3.3 Shipping requirements

Samples for analysis at ARI will be transported directly by field staff, and samples for analysis at Axys will be transported via courier. Prior to shipping, containers with samples will be wrapped in bubble wrap and securely packed inside a cooler with ice packs. The original signed COC forms will be placed in a sealed plastic bag and taped to the inside lid of the cooler. Fiber tape will be wrapped completely around the cooler. On each side of the cooler, a *This Side Up* arrow label will be attached; a *Handle with Care* label will be attached to the top of the cooler, and the cooler will be sealed with a custody seal in two locations.

The temperature inside the cooler(s) containing the seep samples will be checked by the laboratory upon receipt of the samples. The laboratory will specifically note any coolers that do not contain ice packs, or that are not sufficiently cold ($\leq 4 \pm 2°C$) upon receipt. All samples will be handled so as to prevent contamination or sample loss. Any remaining sample following analysis will be disposed of upon receipt of written notification by the Windward PM. Water sample holding times will vary by analysis, as summarized in Section 4.4.2.

4.3.4 Decontamination procedures

Water sampling requires strict measures to prevent sample contamination. Sources of extraneous contamination can include sampling gear, dust, ice chests, and ice used for cooling. All potential sources of contamination in the field will be identified by the FC, and appropriate steps will be taken to minimize or eliminate contamination. Ice chests will be scrubbed clean with Alconox® detergent and rinsed with distilled water after use to prevent potential cross contamination. To avoid contamination from melting ice, wet ice will be placed in separate plastic bags. Dedicated Teflon™ sheeting, Masterflex® platinum-cured tubing, and funnels will be cleaned by the laboratory prior to sampling. Between each sampling location, the field team will clean all non-dedicated sampling equipment with Alconox® phosphate-free detergent, rinse it with deionized water, and rinse it with site water.

4.3.5 Field-generated waste disposal

Excess sample water, generated equipment rinsates, and decontamination water[11] will be returned to each sampling location after sampling has been completed for that location. All disposable sampling materials and personal protective equipment (PPE) used in sample processing, such as disposable coveralls, gloves, and paper towels, will be placed in heavyweight garbage bags or other appropriate containers. Disposable

[11] Because decontamination water is an Alconox® water solution that is phosphate free, it can be returned to the sampling location for disposal.

supplies will be removed from the site by sampling personnel and placed in a standard refuse container for disposal as solid waste.

4.4 LABORATORY METHODS

Laboratories will meet the sample handling requirements and follow the procedures described in this section. In addition, analytical methods and data quality indicator (DQI) criteria are provided herein.

4.4.1 Laboratory sample handling

Samples will be packed in coolers and held at ≤ 4 ± 2°C. Samples for ARI will be directly delivered to the laboratory by field staff. Samples for Axys will be delivered via courier service.

Each sample will be filtered at its respective laboratory. Laboratory filtration will be performed for three reasons:

1) Filtration will remove any sediment that is entrained in the seep sample during sampling.
2) The dissolved phase is the mobile phase for groundwater chemical transport and is thus more relevant for source control.
3) Collecting both total and dissolved samples would require significantly more volume than the field crew will have time to collect at lower-volume seeps.

Filtration will be performed in the laboratory to reduce risk of contamination. Samples for dioxin/furan analyses will be filtered by Axys upon receipt. All other samples will be filtered at ARI after samples have been received and before preservatives are added. Samples for semivolatile organic compounds (SVOCs), PCB Aroclors, polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticide analyses will be filtered through a 1-µm glass fiber filter to remove any non-colloidal particles greater than 1 µm that may have been introduced into the seep water by the sampling method. Samples for metals (including mercury) analyses will be filtered using a 0.45-µm polyvinylidene difluoride filter to represent the dissolved fraction.

4.4.2 Analytical methods

Chemical analysis of the seep samples will be conducted at ARI and Axys (Table 4-3). All analyses will be performed on the dissolved fraction of the seep water. Analytical methods and laboratory sample handling requirements for all measurement parameters are presented in Table 4-4.

Table 4-3. Procedures to be conducted at each analytical laboratory

Laboratory	Analyses to be Conducted	Individual Analytes
ARI	conventionals	DOC, TOC, and TSS
	metals	arsenic, cadmium, chromium, copper, lead, silver, zinc, mercury
	PAHs	acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(j)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, naphthalene, phenanthrene, and pyrene
	PCB Aroclors[a]	Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260
	SVOCs	1,2-dichlorobenzene, 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, 2,4-dimethylphenol, 4-methylphenol, benzoic acid, benzyl alcohol, bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, dibenzofuran, dimethyl phthalate, hexachlorobenzene, n-nitrosodiphenylamine, PCP, and phenol
Axys	dioxin/furan congeners	2,3,7,8-TCDD, 1,2,3,7,8-PeCDD, 1,2,3,4,7,8-HxCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,7,8,9-HxCDD, 1,2,3,4,6,7,8-HpCDD, OCDD, 2,3,7,8-TCDF, 1,2,3,7,8-PeCDF, 2,3,4,7,8-PeCDF, 1,2,3,4,7,8-HxCDF, 1,2,3,6,7,8-HxCDF, 1,2,3,7,8,9-HxCDF, 2,3,4,6,7,8-HxCDF, 1,2,3,4,6,7,8-HpCDF, 1,2,3,4,7,8,9-HpCDF, and OCDF

[a] If PCB Aroclors are not detected with an RL greater than 39 ng/L (Ecology 2016), then the archived sample for this seep will be analyzed for PCB congeners at Axys. This analysis will include all 209 congeners.

ARI – Analytical Resources, Inc.
Axys – Axys Analytical Services Ltd.
DOC – dissolved organic carbon
HpCDD – heptachlorodibenzo-*p*-dioxin
HpCDF – heptachlorodibenzofuran
HxCDD – hexachlorodibenzo-*p*-dioxin
HxCDF – hexachlorodibenzofuran
OCDD – octachlorodibenzo-*p*-dioxin
OCDF – octachlorodibenzofuran
PAH –polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
PCP - pentachlorophenol
PeCDD – pentachlorodibenzo-*p*-dioxin
PeCDF – pentachlorodibenzofuran
RL – reporting limit
SVOC – semivolatile organic compound
TCDD – tetrachlorodibenzo-p-dioxin
TCDF – tetrachlorodibenzofuran
TOC – total organic carbon
TSS – total suspended solids

Table 4-4. Analytical methods and sample handling requirements for seep samples

Parameter[a]	Method	Reference	Extraction Solvent	Cleanup	Laboratory	Container	Preservative	Sample Holding Time
TSS	gravimetric	SM 2540 D-97	na	na	ARI	500-mL HDPE	cool to ≤ 4 ± 2°C	7 days
TOC	high-temperature combustion	SM 5310 B-00	na	na	ARI	250-mL amber glass	cool to ≤ 4 ± 2°C; sulfuric acid to pH < 2	28 days
DOC	high-temperature combustion	SM 5310 B-00	na	na	ARI	250-mL amber glass	cool to ≤ 4 ± 2°C; 0.45 µm filter within 48 hours; sulfuric acid to pH < 2	28 days
Metals	ICP-MS	EPA 6020A UCT-KED	na	na	ARI	250-mL HDPE	nitric acid to pH < 2; samples filtered with 0.45-µm filter	6 months
Mercury	CV-AFS	EPA 7470A	na	na	ARI	250-mL HDPE or glass bottle	nitric acid to pH < 2; samples filtered with 0.45-µm filter	28 days
PAHs	GC/MS	EPA 3510C/ EPA 8270D-SIM	DCM	silica gel (EPA 3630C)	ARI	500-mL amber glass	cool to ≤ 4 ± 2°C; samples filtered with 1-µm filter	7 days until extraction, 40 days after extraction; store extracts at ≤ 6°C and in the dark
PCB Aroclors	GC/ECD	EPA 3310-C Mod EPA 8082A	hexane	acid (EPA 3665A); sulfur with TBAS (EPA 3660B), silica gel (EPA 3630C)	ARI	1-L amber glass	cool to ≤ 4 ± 2°C; samples filtered with 1-µm filter	7 days until extraction, 40 days after extraction; store extracts at ≤ 6°C and in the dark
PCB congeners[b]	HRGC/HRMS	EPA 1668a	DCM	biobead multi-layered acid/base silica, silica, florisil	Axys	1-L amber glass	cool to ≤ 4 ± 2°C; samples filtered with 1-µm filter	1 year until extraction and 1 year after extraction if stored at ≤ 10°C

Parameter[a]	Method	Reference	Extraction Solvent	Cleanup	Laboratory	Container	Preservative	Sample Holding Time
SVOCs	GC/MS	EPA 3510C/ EPA 8270D	DCM	none	ARI	500-mL amber glass	cool to ≤ 4 ± 2°C; samples filtered with 1-µm filter	7 days until extraction, 40 days after extraction; store extracts at ≤ 6°C and in the dark
Dioxins/ furans	HRGC/ HRMS	EPA 1613B	DCM/hexane	biobead multi-layered acid/base silica, florisil, alumina, carbon/celite	Axys	1-L amber glass	cool to ≤ 4 ± 2°C; samples filtered with 1-µm filter	store in the dark at 0–4°C; store extracts for up to 1 year at ≤ 10°C

[a] Individual analytes are listed in Table 4-3.

[b] If PCB Aroclors are not detected with an RL greater than 39 ng/L (Ecology 2016), then the archived sample for this seep will be analyzed for PCB congeners at Axys.

ARI – Analytical Resources, Inc.
Axys – Axys Analytical Services Ltd.
CV-AFS – cold vapor-atomic fluorescence spectrometry
DCM – dichloromethane
DOC – dissolved organic carbon
ECD – electron capture data
EPA – US Environmental Protection Agency
GC – gas chromatography/mass spectrometry
HDPE – high-density polyethylene
HRGC/HRMS – high-resolution gas chromatography/high-resolution mass spectrometry
ICP-MS – inductively coupled plasma-mass spectrometry
na – not applicable or not available
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
RL – reporting limit
SIM – selected ion monitoring
SM – Standard Methods
SVOC – semivolatile organic compound
TBAS – tetrabutylammonium sulfite
TOC – total organic carbon
TSS – total suspended solids
UCT-KED – universal cell technology-kinetic energy discrimination

All seep samples will be analyzed for the analytes included in ROD Tables 19 and 20,[12] with the exception of dioxin/furans, which will be initially analyzed in a subset of the seeps. An archive sample will be collected for each seep. This 1-L sample will be filtered upon receipt by the laboratory, and will be used in the following ways:

- Samples to be analyzed initially for dioxins/furans will be co-extracted for dioxins/furans and PCB congeners. Some of the extract will be analyzed for dioxins/furans, and the rest will be archived. Following PCB Aroclor analysis, if PCB Aroclors are not detected and the RL is greater than 39 ng/L[13] for a given seep, the archived extract will be analyzed for PCB congeners.
- Samples that are not being analyzed initially for dioxins/furans will be archived without extraction.
  - Following PCB Aroclor analysis, if PCB Aroclors are not detected and the RL is greater than 39 ng/L for a given seep, the archived samples will be extracted for both PCB congeners and dioxins/furans and analyzed for PCB congeners. The dioxins/furans extract will be archived.
  - Following review of the 2018 sediment and bank data, archived samples or extracts will be analyzed for dioxins/furans, if necessary based on the criteria in Section 4.1.3.

RL goals for all individual analytes are listed in Appendix C. The RL goals will be sufficient to obtain results below Washington State marine chronic water quality standards, except for pentachorophenol. The water quality standards are provided (Appendix C) only to demonstrate method sensitivity. Study goals do not include comparison of seep results to water quality standards. The RL values represent the lowest concentrations at which the laboratory can quantitatively measure and report results obtained using the methods listed in Table 4-4.

4.5 ANALYTICAL DATA QUALITY OBJECTIVE AND CRITERIA

The analytical data quality objective (DQO) for seep samples 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 the following sections, and specific DQIs are presented in Section 4.5.6.

[12] Analytes in ROD Tables 19 (titled *Cleanup levels for PCBs, arsenic, cPAHs, and dioxins/furans in sediment for human health and ecological COCs [RAOs 1, 2, and 4]*) and 20 (titled *Sediment cleanup levels for ecological [benthic invertebrate] COCs for RAO 3*) include metals, PAHs, SVOCs, PCBs, and dioxins/furans. Individual analytes are listed in Table 4-3.

[13] Ecology (2016) estimates 39 ng/L PCBs for the protection of sediment.

4.5.1 Precision

Precision is the measure of 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; it is expressed as a RPD when duplicate analyses are performed, and as a %RSD when more than two analyses are performed on the same sample (e.g., triplicates). Precision is assessed by laboratory duplicate analyses (e.g., duplicate samples, MSDs, and LCS duplicates) for all parameters. Precision measurements can be affected by the nearness of a chemical concentration to the DL, whereby the percent error (expressed as either %RSD or RPD) increases. The DQI for precision varies depending on the analyte (Section 4.5.6). The equations used to express precision are as follows:

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

Equation 1a

$$\%RSD = (SD/D_{ave}) \times 100$$

Where:

$$SD = \sqrt{\frac{\sum (D_n - D_{ave})^2}{(n-1)}}$$

Equation 1b

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

4.5.2 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 MS and LCS analyses. The DQI for accuracy varies depending on the analyte (Section 4.5.6). The equation used to express accuracy for spiked samples is as follows:

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

Equation 2

4.5.3 Representativeness

Representativeness is an expression of 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 2.1. Assuming those objectives are met, the samples collected should be considered adequately representative of the environmental conditions they are intended to characterize.

4.5.4 Comparability

Comparability is an expression of the confidence with which one dataset can be evaluated in relation to another dataset. Therefore, the sample collection and chemical and physical testing will adhere to EPA and SM analysis protocols.

4.5.5 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. The equation used to express completeness is as follows:

$$\text{Completeness} = \frac{\text{number of valid measurements}}{\text{total number of data points planned}} \times 100 \qquad \text{Equation 3}$$

The DQI for completeness for all components of this project is 90%. 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.

4.5.6 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[14] will be used as the measure of sensitivity for each measurement process. Tables 4-5 and 4-6 list specific DQIs for water quality measurements and laboratory analyses of seep samples. Standard seep volume requirements are specified to meet RLs for each particular analytical method. Table 4-7 summarizes the required analytical volumes for each analysis. Samples that require additional volume for QC are noted in the table.

Table 4-5. DQIs for water quality measurements

Parameter	Precision[a]	Accuracy[b]	Completeness
DO	± 20%	± 0.1 mg/L or 1% of reading	90%
pH	± 20%	± 0.2 pH unit	90%
Specific conductance	± 20%	± 0.5% of reading or 0.001 mS/cm	90%
Temperature	± 20%	± 0.05 °C	90%
Turbidity	± 20%	0–999 FNU: 0.3 FNU or ±2 % of reading, (whichever is greater); 1,000–4,000 FNU: ± 5% of reading	90%

Note: Water quality measurements will be made using a YSI© EXO1 or similar water quality meter.

[a] Precision will be assessed by duplicate field measurements.

[b] Accuracy will be as reported for YSI© EXO1 instrument specifications.

DO – dissolved oxygen DQI – data quality indicator FNU – Formazin Nephelometric Unit

[14] The term MDL includes other types of DLs such as EDL values calculated for dioxin/furan congeners.

Table 4-6. DQIs for laboratory analyses

Parameter[a]	Unit	Precision[b]	Accuracy[b]		Completeness
			LCS	Spiked Samples	
TOC	mg/L	± 20%	80–120%	80–120%	90%
DOC	mg/L	± 20%	80–120%	80–120%	90%
TSS	mg/L	± 20%	90–110%	na	90%
Metals	µg/L	± 20%	75–125%	75–125%	90%
Mercury	µg/L	± 25%	80–120%	71–125%	90%
PAHs	µg/L	± 30%	30–160%	30–160%	90%
PCB Aroclors	µg/L	± 30%	51–128%	54–120%	90%
SVOCs	µg/L	± 30%	10–160%	10–160%	90%
Dioxins/ furans	pg/L	± 20%	70–130%	17–130%	90%

[a] Individual analytes are listed in Table 4-3.

[b] Values listed are performance-based limits provided by the laboratories.

DOC – dissolved organic carbon
DQI – data quality indicator
LCS – laboratory control sample
na – not applicable
PAH - polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
ppt – parts per thousand
SVOC – semivolatile organic compound
TOC – total organic carbon
TSS – total suspended solids

Table 4-7. Analytical and target sample volumes

Analyte[a]	Required Analytical Sample Volume[b] (mL)	Additional Volume for Analytical QC (mL)	Target Sample Volume (mL)	Sample Bottle
ARI				
TOC	20	40	120[c]	250-mL amber glass
DOC	20	40		
TSS	500	500	500	500-mL HDPE[d]
PAHs	500	1,000	500	500-mL amber glass[e]
PCB Aroclors	1,000	2,000	1,000	1-L amber glass[f]
SVOCs	500	1,000	500	500-mL amber glass[e]
Metals	25	50	135[c]	250-mL HDPE
Mercury	20	40		
Axys				
Dioxin/furan and PCB congeners[g]	1,000	na	1,000	1-L amber glass
Total volume	**3,585 mL**	**4,670 mL**	3,755	**7 bottles**

[a] Individual analytes are listed in Table 4-3.

[b] The required analytical volume does not include volume for QA/QC, re-analysis, or spills.

[c] The target volume for these analyses is less than the total volume of the sample volume. The field crew will collect the target volume and will fill the sample bottle whenever possible to minimize the head space in the sample bottle.

[d] A second bottle will be collected for a field duplicate sample at a frequency of one per twenty samples.

[e] Two additional 500-mL amber glass bottles will be collected at a frequency of one per twenty samples for a MS/MSD sample.

[f] Two additional 1-L amber glass bottles will be collected at a frequency of 1 per 20 samples for a MS/MSD sample.

[g] Samples will be co-extracted or archived for dioxins/furans and PCB congeners analyses (Section 4.4.2).

ARI – Analytical Resources, Inc.
Axys – Axys Analytical Services, Ltd.
DOC – dissolved organic carbon
EPA – US Environmental Protection Agency
HDPE – high-density polyethylene
MS – matrix spike
MSD – matrix spike duplicate
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
QA/QC – quality assurance/quality control
SVOC – semivolatile organic compound
TOC – total organic carbon
TSS – total suspended solids

4.6 QUALITY ASSURANCE/QUALITY CONTROL

The types of samples analyzed and the procedures conducted for QA / QC in the field and laboratory are described in this section.

4.6.1 Field quality control samples

Field QA / QC samples, such as field duplicates and equipment blanks, are generally used to evaluate the efficiency of field decontamination procedures and the variability attributable to sample handling. One equipment blank will be generated for each seep sampling procedure (shoreline embankment and mudflat) during the sampling event. A field duplicate will be collected if sufficient volume can be obtained at one of the seeps.

4.6.2 Laboratory quality control

Before analyzing the samples, the laboratory must provide written protocols for the analytical methods to be used, calculate RLs for each analyte in each matrix of interest as applicable, and establish an initial calibration curve for all analytes. The laboratory must also demonstrate its continued proficiency by participation in inter-laboratory comparison studies, and by repeated analysis of calibration checks, laboratory reagent and rinsate blanks, and spiked samples.

4.6.2.1 Sample delivery group

Project- and / or method-specific QC measures, such as MSs and MSDs or laboratory duplicates, will be analyzed per sample delivery group (SDG) preparatory batch, or per analytical batch as specified in Table 4-8. A SDG is defined as no more than 20 samples, or those samples received at the laboratory within a 2-week period. Although a SDG may span two weeks, all holding times specific to each analytical method will be met for each sample in the SDG.

Table 4-8. Laboratory quality control sample analysis summary

Analysis Type	Initial Calibration	Initial Calibration Verification (second source)	Continuing Calibration Verification	LCS	Laboratory Replicates	MSs	MSDs	Method Blanks	Surrogate Spikes
TOC/DOC	prior to analysis	after initial calibration	every 10 samples	1 per prep batch	1 per batch or SDG	1 per batch or SDG	na	1 per prep batch	na
TSS	na	na	na	1 per prep batch	1 per batch or SDG	na	na	1 per prep batch	na
Metals	prior to analysis	after initial calibration	every 10 samples	1 per prep batch	1 per batch or SDG	1 per batch or SDG	1 per batch or SDG	1 per prep batch	na
Mercury	prior to analysis	after initial calibration	beginning and end of each batch	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	3 per batch	na
PAHs	prior to analysis	after initial calibration	every 12 hours	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each sample
PCB Aroclors	prior to analysis	after initial calibration	every 10–20 analyses or 12 hours	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each sample
SVOCs	prior to analysis	after initial calibration	every 10–20 analyses or 12 hours	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each sample
Dioxins/furans	prior to analysis	after initial calibration	every 12 hours	1 per prep batch	na[a]	na	na	1 per prep batch	each sample

Note: A batch is a group of samples of the same matrix analyzed or prepared at the same time, not exceeding 20 samples.

[a] Precision will be assessed by analysis of an LCS duplicate.

DOC – dissolved organic carbon
LCS – laboratory control sample
MS – matrix spike
MSD – matrix spike duplicate
na – not applicable or not available
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
SDG – sample delivery group
SVOC – semivolatile organic compound
TOC – total organic carbon
TSS – total suspended solids

4.6.2.2 Laboratory quality control samples

The analyst will review the results of the QC analyses 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 have been exceeded, then appropriate corrective action—such as recalibration followed by reprocessing of the affected samples—must be initiated before a subsequent group of samples is processed. The project QA / QC coordinator must be contacted immediately by the laboratory PM if satisfactory corrective action to achieve the DQIs outlined in this QAPP is not possible. All laboratory corrective action reports relevant to the analysis of project samples must be included in the data deliverable packages.

All primary chemical standards and standard solutions used in this project will be traceable to the National Institute of Standards and Technology (NIST), Environmental Resource Associates, National Research Council of Canada, or other documented, reliable, commercial sources. To determine their accuracy, standards will be validated by comparing them to independent standards. Laboratory QC standards are verified in various ways: second-source calibration verifications (i.e., same standard, two different vendors) are analyzed to verify initial calibrations; new working standard mixes (e.g., calibrations, spikes, etc.) are verified against the results of the original solution and must be within 10% of the true value; and 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 4-8 summarizes the QC procedures to be performed by the laboratories, as well as the associated control limits for precision and accuracy.

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 SDG or for every 20 samples, whichever is more frequent.

Laboratory Control Samples

LCSs are prepared from a clean matrix using the same process used for the project samples that are spiked with known amounts of the target compounds. The recoveries of the compounds are used as a measure of the accuracy of the test methods.

Laboratory Replicate Samples

Laboratory replicate samples provide information on the precision of the analysis, and are useful in assessing potential sample heterogeneity and matrix effects. Laboratory replicates are subsamples of the original sample that are prepared and analyzed as separate samples, assuming sufficient sample matrix is available. A minimum of

1 laboratory replicate sample will be analyzed for each SDG or for every 20 samples, whichever is more frequent, for inorganic and conventional parameters.

Matrix Spikes and Matrix Spike Duplicates

The analysis of MS samples provides information on the extraction efficiency of the method on the sample matrix. By performing MSD analyses, information on the precision of the method is also provided for organic analyses. For organic analyses, a minimum of 1 MS/MSD pair will be analyzed for each SDG or for every 20 samples, whichever is more frequent, when sufficient sample volume is available, with the exception of dioxins/furans. For inorganic analyses (i.e., metals), a minimum of one MS sample will be analyzed for each SDG, when sufficient sample volume is available.

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.

Isotope Dilution Quantitation

All project samples analyzed for dioxin/furan congeners will be spiked with a known amount of surrogate compounds, as defined in the analytical methods. The labeled surrogate compounds will respond similarly to the effects of extraction, concentration, and GC. Data will be corrected for the recovery of the surrogates used for quantification.

Internal Standard Spikes

Internal standards may be used for calibrating and quantifying organic compounds and metals using MSs. If internal standards are required by the method, all calibration, QC, and project samples will be spiked with the same concentration of the selected internal standard(s). Internal standard recoveries and retention times must be within method and laboratory criteria.

4.7 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 multi-parameter water quality meter, differential GPS unit, and digital camera, will be tested for accuracy 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 laboratory equipment testing, inspection, and maintenance requirements are met. The methods to be used in calibrating the analytical instrumentation are described in the following section.

4.8 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Multipoint initial calibration will be performed on each analytical instrument at the start of the project, after each major interruption to the instrument, and when any continuing calibration does not meet the specified criteria. The number of points used in the initial calibration is defined in the relevant 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.

Calibration of analytical equipment used for chemical analyses includes the use of 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 1 blank for every 10 samples analyzed for inorganic analyses and 1 blank 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.

The multi-parameter water quality meter will be used to collect *in situ* water quality data at each sampling location and associated with each seep sample, as outlined in this QAPP. All sensors, except those for temperature, require calibration to ensure high performance. The meter will be calibrated daily to ensure that the sensors meet the manufacturer's accuracy specifications for conductivity, DO, pH, and turbidity.

A Trimble© SPS461 or similar GPS receiver unit will be employed for the various sampling methods outlined in this QAPP. The GPS receiver will be calibrated daily to ensure that it is accurately recording positions from known benchmarks and functioning within the individual unit's factory specifications.

4.9 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The FC will gather and check field supplies daily for satisfactory conditions before each field event. Batteries used in the digital camera will be checked daily and recharged as necessary. Supplies and consumables for the field sampling effort will be inspected upon delivery and accepted if the condition of the supplies is satisfactory.

4.10 DATA MANAGEMENT

All field data will be recorded on field forms, which the FC will check for missing information at the end of each field day and amend as necessary. A QC check will be done to ensure that all data have been transferred accurately from the field forms to the database. Field forms will be archived in the Windward library.

The analytical laboratories are required to submit data in an electronic format, as described in Section 3.7.2. The laboratory PM will 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 will ensure that all data are consistently converted to 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 analytical 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. All data management files will be secured on the Windward network. Data management procedures outlined in Appendix C of the Work Plan will be followed (Windward and Integral 2017).

5 Assessment and Oversight

5.1 Compliance Assessments and Response Actions

EPA or its designees may observe field activities during each sampling event, as needed. If situations arise wherein there is a significant inability to follow the QAPP methods precisely, the Windward PM will determine the appropriate actions and consult EPA (or its designee).

5.1.1 Compliance assessments

Laboratory and field performance assessments will 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. Analytical laboratories will be required to have written procedures addressing internal QA/QC. All laboratories and QA/QC coordinators will be required to ensure that all personnel engaged in sampling and analysis tasks have appropriate training.

5.1.2 Response actions for field sampling

The FC, or a designee, will be responsible for correcting equipment malfunctions throughout field sampling, and for resolving situations in the field that may result in nonconformance or noncompliance with this QAPP. All corrective measures will be immediately documented in the field logbook, and protocol modification forms will be completed.

5.1.3 Corrective action for laboratory analyses

Analytical laboratories will be required to comply with their current written standard operating procedures, laboratory QA plan, and analytical methods. All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data. The analysts will identify and correct any anomalies before continuing with sample analysis. The laboratory PMs will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this QAPP.

The project QA/QC coordinator will be notified immediately if any QC sample exceeds the DQIs outlined in this QAPP (Table 4-6) and the exceedance cannot be resolved through standard corrective action procedures. A description of the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, and re-extraction) will be submitted with the data package using the case narrative or corrective action form.

5.2 REPORTS TO MANAGEMENT

The FC will prepare a summary email for submittal to LDWG and EPA following each sampling day. The project QA / QC coordinator will prepare progress reports for submittal by email to LDWG and EPA on the following occasions: 1) after sampling has been completed and samples have been submitted for analysis, 2) when information is received from the laboratory, and 3) when analyses are complete. The status of the samples and analyses will be indicated, with emphasis on any deviations from this QAPP. A data report will be written after validated data are available, as described in Section 2.2.

6 Data Validation and Usability

6.1 DATA VALIDATION

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

Data will not be considered final until validated. Data validation will be conducted following EPA guidance (EPA 2014a, 2016a, b, c).

Independent third-party data review and summary validation of the analytical chemistry data will be conducted by EcoChem or a suitable alternative. All data will undergo validation, and a minimum of 10% or one SDG will undergo full data validation. Full data validation parameters will include:

- QC analysis frequencies
- Analysis holding times
- Laboratory blank contamination
- Instrument calibration
- Surrogate recoveries
- LCS recoveries
- MS recoveries
- MS / MSD RPDs
- Compound identifications—verification of raw data with the reported results (10% of analytes)
- Compound quantitations—verification of calculations and RLs (10% of analytes)
- Instrument performance check (tune) ion abundances
- Internal standard areas and retention time shifts
- Ion abundance ratio compared to theoretical ratios for samples analyzed by EPA method 1613b

If no discrepancies are found between reported results and raw data in the dataset that undergoes full data validation, then a summary validation of the rest of the data can proceed using all of the QC forms submitted in the laboratory data package. QA review of the seep chemistry data will be performed in accordance with the QA

requirements of the project, the technical specifications of the analytical methods indicated in Table 4-6, and EPA guidance for organic and inorganic data review (EPA 2016b, c). 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 issuance of the formal data validation report. The project QA / QC coordinator will be informed of all contacts with the laboratories during data validation. Review procedures used and findings made during data validation will be documented on worksheets. The data validator will prepare a data validation report that will summarize QC results, qualifiers, and possible data limitations. This data validation report will be appended to the data report. Only validated data with appropriate qualifiers will be released for general use.

6.2 RECONCILIATION WITH DATA QUALITY OBJECTIVES

Data QA will be conducted by the project QA / QC coordinator in accordance with EPA guidelines (EPA 2016b, c). The results of the third-party independent review and validation will be reviewed, and cases wherein 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.

7 References

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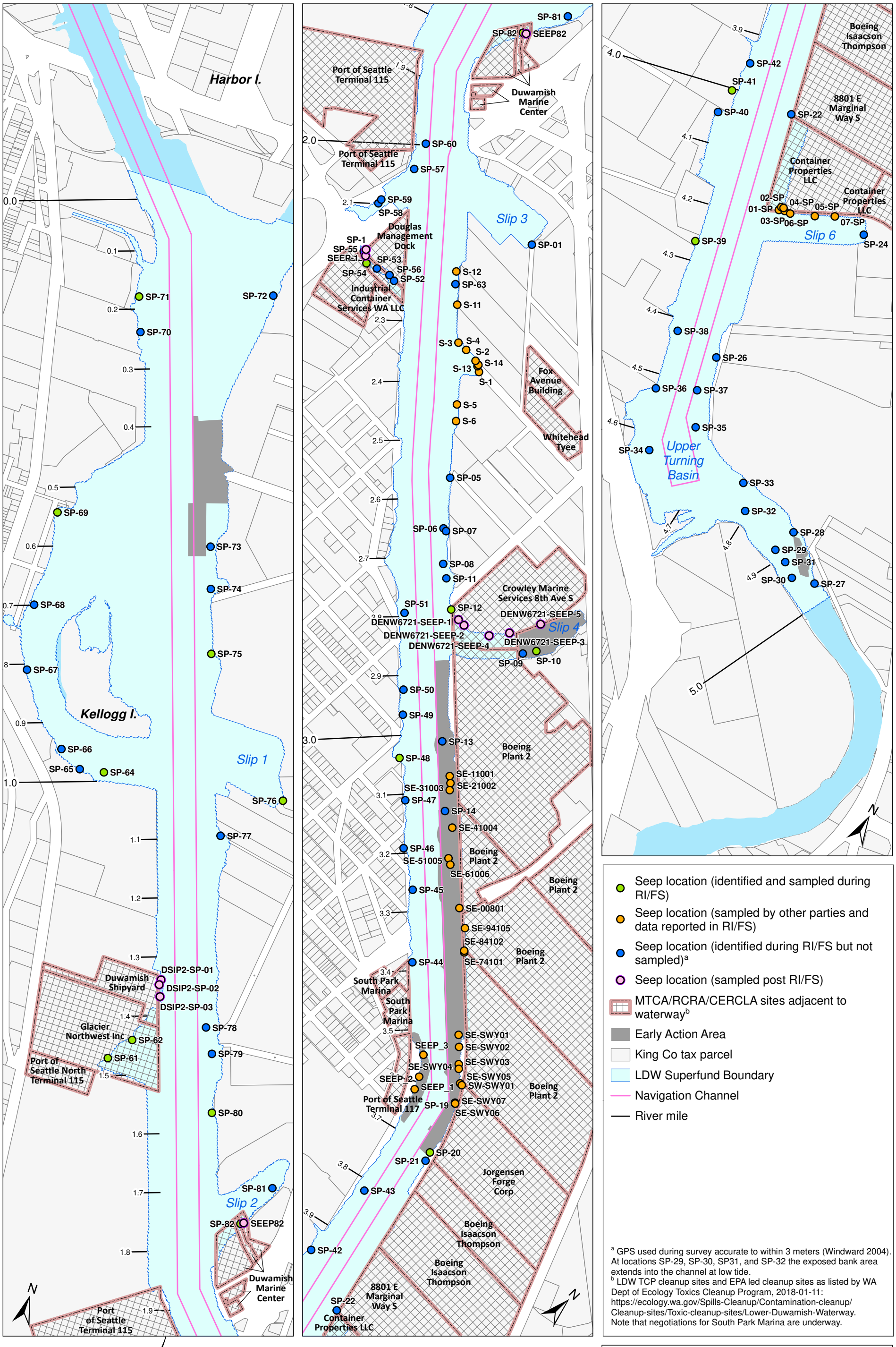
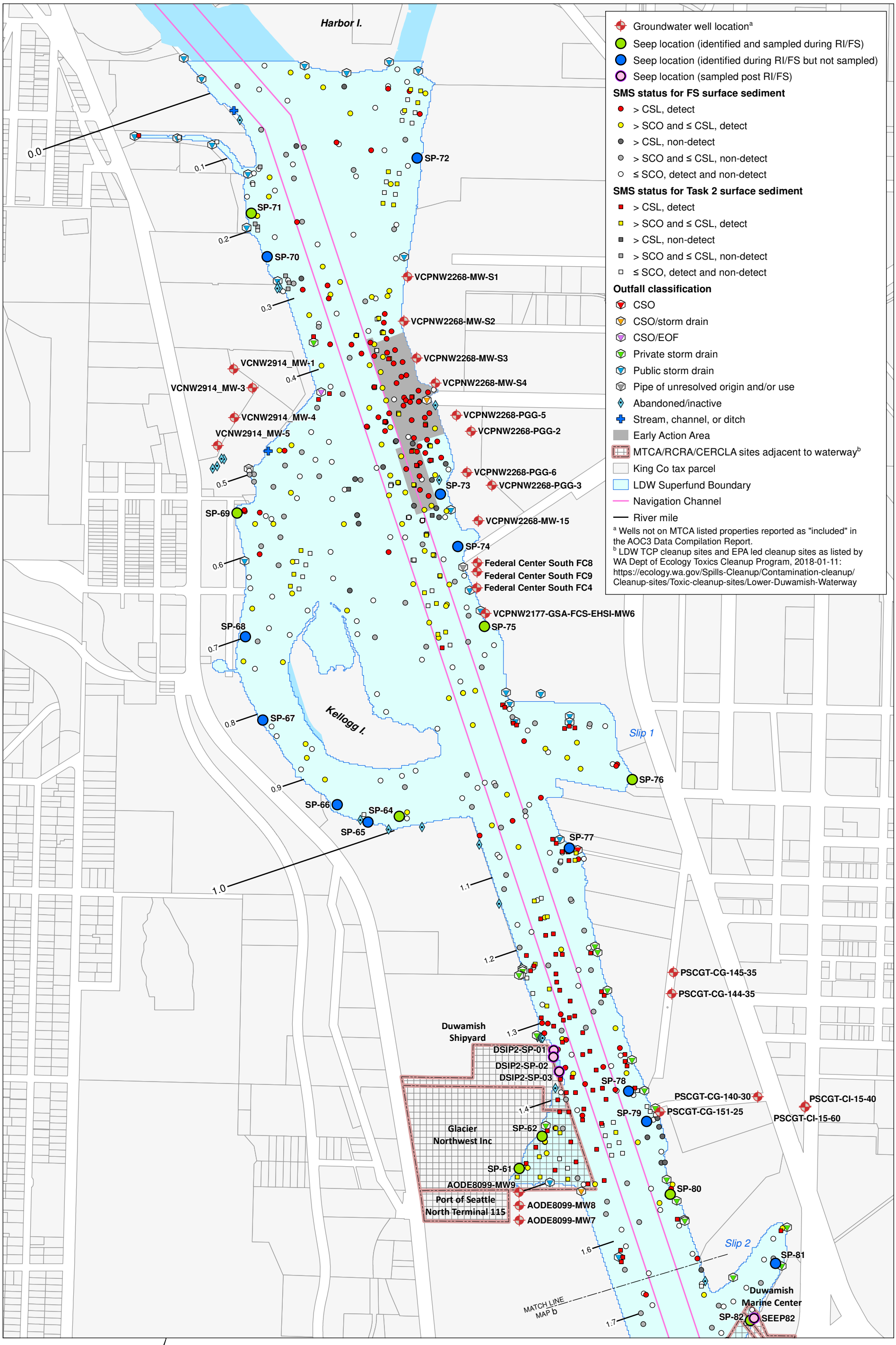


Map 4-1. MTCA/RCRA/CERCLA sites adjacent to the waterway and seeps

Windward environmental LLC

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

Prepared by craigh, 3/8/2018; W:\Projects\Duwamish AOC3\GIS\Maps and Analyses\Task 03 QAPPs\Seep\Map 4-1 6661 Listed sites and seeps.mxd



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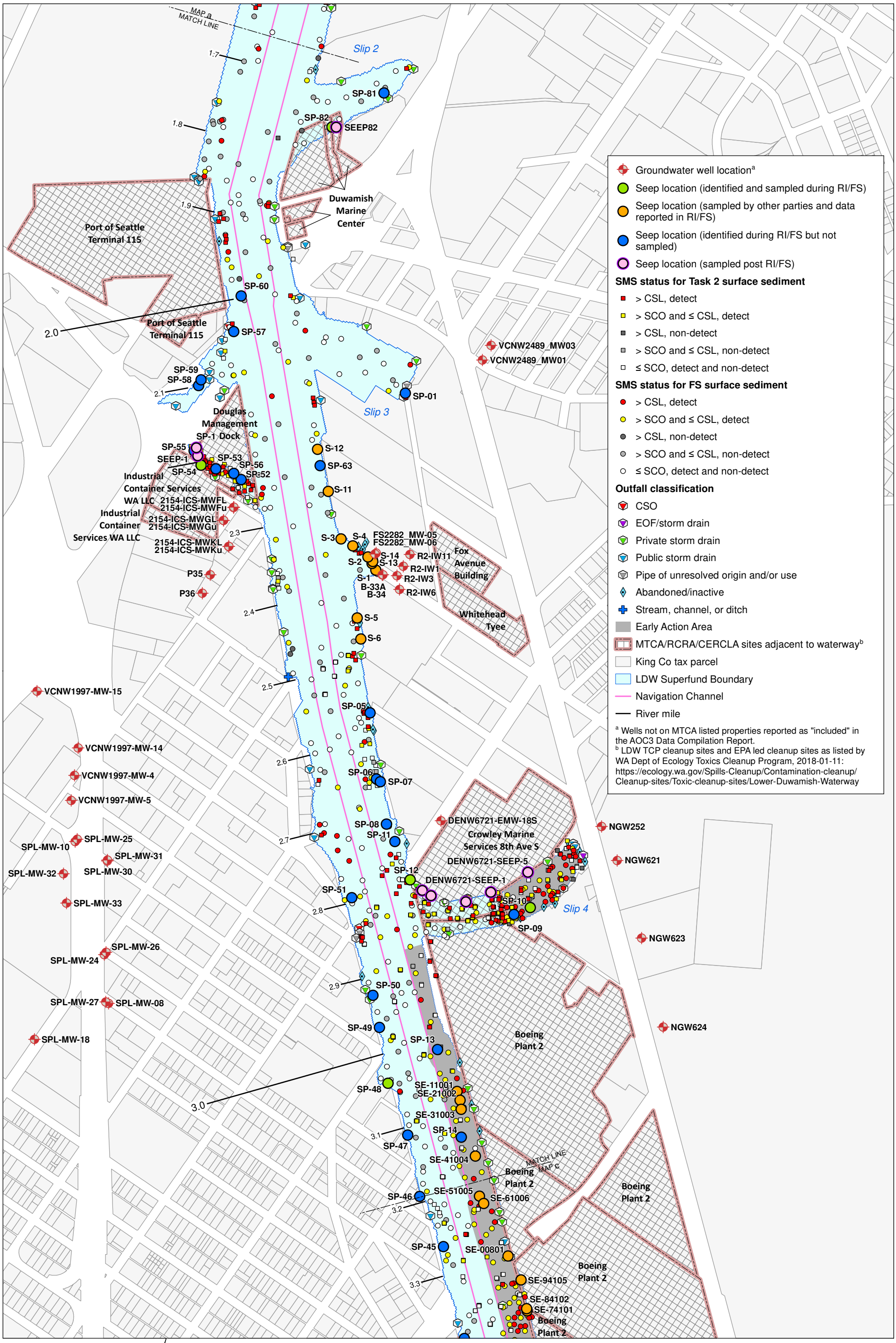
Map 4-2a. MTCA/RCRA/CERCLA sites adjacent to the waterway, seeps, groundwater wells, and sediment data, RM 0.0 to RM 1.7

Prepared by craigh, 1/12/2018; W:\Projects\Duwamish AOC3\GIS\Maps and Analyses\Task 03 QAPPs\Seep\Map 4-2a 6662a Listed sites and groundwater.mxd



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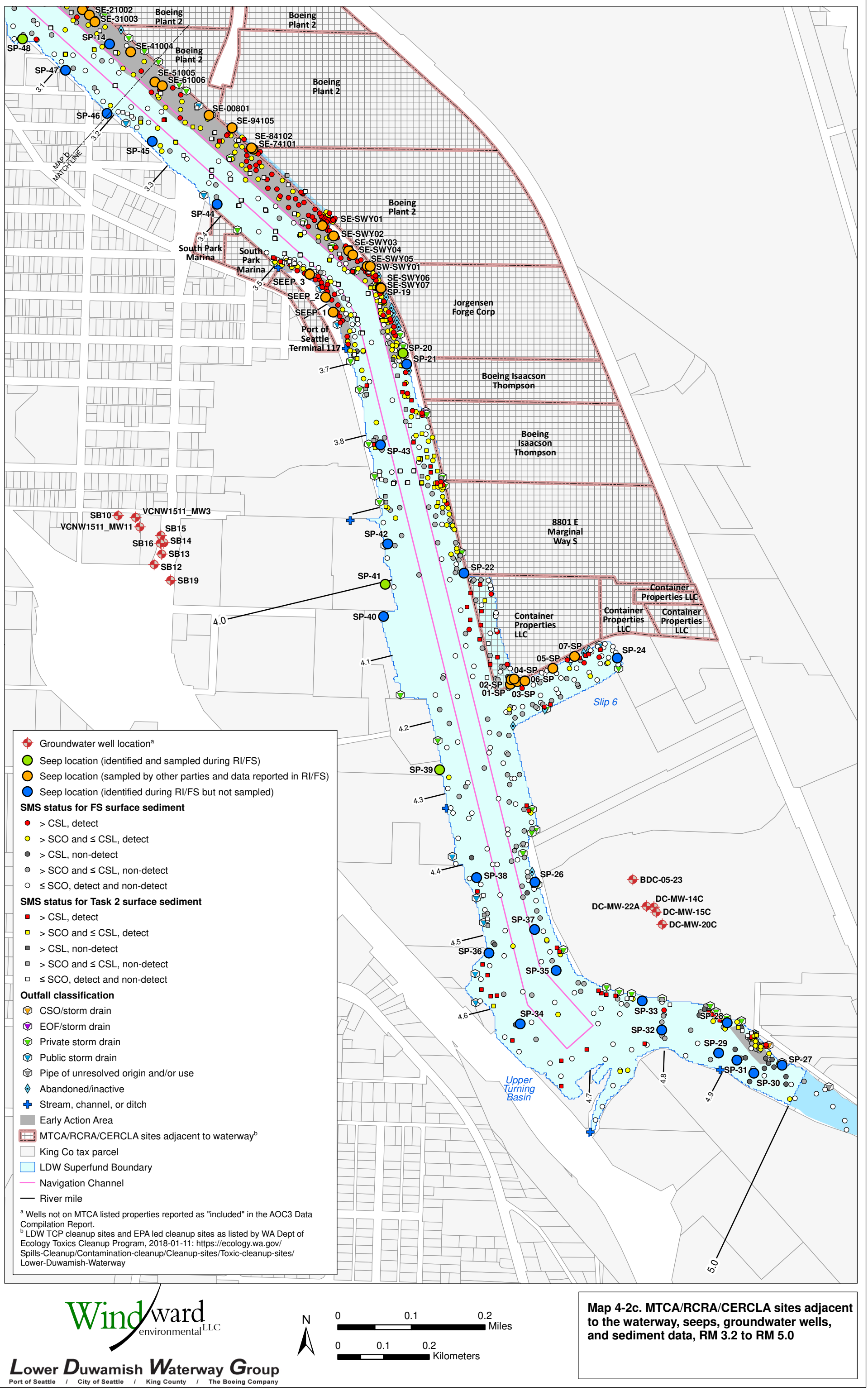
0 0.1 0.2 Miles

0 0.1 0.2 Kilometers

Map 4-2b. MTCA/RCRA/CERCLA sites adjacent to the waterway, seeps, groundwater wells, and sediment data, RM 1.7 to RM 3.2

Prepared by craigh, 1/12/2018; W:\Projects\Duwamish AOC3\GIS\Maps and Analyses\Task 03 QAPPs\Seep\Map 4-2b 6662b Listed sites and groundwater.mxd



Groundwater well location[a]
Seep location (identified and sampled during RI/FS)
Seep location (sampled by other parties and data reported in RI/FS)
Seep location (identified during RI/FS but not sampled)

SMS status for FS surface sediment

- > CSL, detect
- > SCO and ≤ CSL, detect
- > CSL, non-detect
- > SCO and ≤ CSL, non-detect
- ≤ SCO, detect and non-detect

SMS status for Task 2 surface sediment

- > CSL, detect
- > SCO and ≤ CSL, detect
- > CSL, non-detect
- > SCO and ≤ CSL, non-detect
- ≤ SCO, detect and non-detect

Outfall classification

- CSO/storm drain
- EOF/storm drain
- Private storm drain
- Public storm drain
- Pipe of unresolved origin and/or use
- Abandoned/inactive
- Stream, channel, or ditch
- Early Action Area
- MTCA/RCRA/CERCLA sites adjacent to waterway[b]
- King Co tax parcel
- LDW Superfund Boundary
- Navigation Channel
- River mile

[a] Wells not on MTCA listed properties reported as "included" in the AOC3 Data Compilation Report.
[b] LDW TCP cleanup sites and EPA led cleanup sites as listed by WA Dept of Ecology Toxics Cleanup Program, 2018-01-11: https://ecology.wa.gov/Spills-Cleanup/Contamination-cleanup/Cleanup-sites/Toxic-cleanup-sites/Lower-Duwamish-Waterway

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N

0 0.1 0.2 Miles

0 0.1 0.2 Kilometers

Map 4-2c. MTCA/RCRA/CERCLA sites adjacent to the waterway, seeps, groundwater wells, and sediment data, RM 3.2 to RM 5.0

Harbor I.
Kellogg I.
Slip 1
Slip 2
Slip 3
Slip 4
Slip 6
Upper Turning Basin
LEFT PANEL MATCH LINE
MIDDLE PANEL MATCH LINE
MATCH LINE MIDDLE PANEL
MATCH LINE RIGHT PANEL
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4
3.5
3.6
3.7
3.8
3.9
4.0
4.1
4.2
4.3
4.4
4.5
4.6
4.7
4.8
4.9
5.0
SP-01
SP-05
SP-06
SP-07
SP-24
SP-27
SP-28
SP-29
SP-30
SP-31
SP-32
SP-33
SP-34
SP-35
SP-36
SP-37
SP-38
SP-40
SP-42
SP-43
SP-44
SP-45
SP-46
SP-47
SP-49
SP-50
SP-51
SP-57
SP-58
SP-59
SP-63
SP-66
SP-65
SP-67
SP-68
SP-70
SP-72
SP-73
SP-74
SP-77
SP-78
SP-79
SP-81
N

Seep to be sampled, unless eliminated based on reconnaissance

King Co tax parcel

LDW Superfund Boundary

Navigation Channel

River mile

Note: Additional seeps identified during reconnaissance will be added, provided they meet the sampling criteria.

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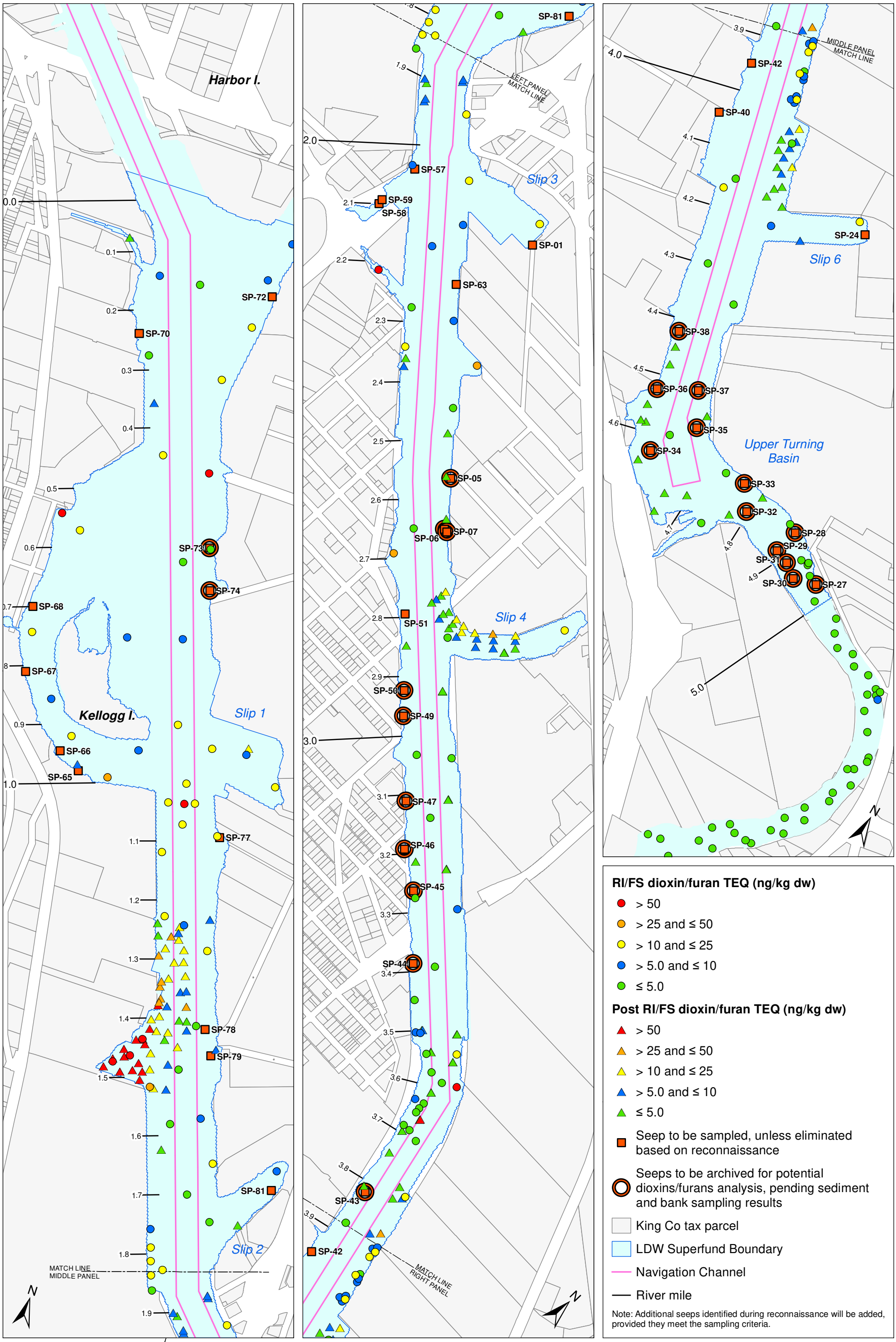
0 0.1 0.2 Miles

0 0.2 0.4 Kilometers

Scale is the same for each inset map

Map 4-3. Seeps selected for reconnaissance

Prepared by craigh, 3/8/2018; W:\Projects\Duwamish AOC3\GIS\Maps and Analyses\Task 03 QAPPs\Seep\Map 4-3 6683 Recon seeps.mxd



RI/FS dioxin/furan TEQ (ng/kg dw)

- > 50
- > 25 and ≤ 50
- > 10 and ≤ 25
- > 5.0 and ≤ 10
- ≤ 5.0

Post RI/FS dioxin/furan TEQ (ng/kg dw)

- > 50
- > 25 and ≤ 50
- > 10 and ≤ 25
- > 5.0 and ≤ 10
- ≤ 5.0

- Seep to be sampled, unless eliminated based on reconnaissance
- Seeps to be archived for potential dioxins/furans analysis, pending sediment and bank sampling results
- King Co tax parcel
- LDW Superfund Boundary
- Navigation Channel
- River mile

Note: Additional seeps identified during reconnaissance will be added, provided they meet the sampling criteria.

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0 0.1 0.2 Miles

0 0.2 0.4 Kilometers

Scale is the same for each inset map

Map 4-4. Surface sediment dioxin/furan TEQs and seeps to be archived for potential dioxins/furans analysis, pending sediment and bank sampling results

Prepared by craigh, 3/8/2018; W:\Projects\Duwamish AOC3\GIS\Maps and Analyses\Task 03 QAPPs\Seep\Map 4-4 6683 Recon seeps and DF.mxd

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LOWER DUWAMISH WATERWAY BASELINE SEEP COLLECTION AND CHEMICAL ANALYSES - QUALITY ASSURANCE PROJECT PLAN: APPENDIX A: HEALTH AND SAFETY PLAN

FINAL

Prepared for

Lower Duwamish Waterway Group

For submittal to

US Environmental Protection Agency

Prepared by:

Windward environmental LLC

200 West Mercer Street, Suite 401 s Seattle, Washington s 98119

HEALTH AND SAFETY PLAN

Title and Approval Page: LDW Seep Collection Health and Safety Plan

By their signature, the undersigned certify that this health and safety plan 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
Project Manager

March 9, 2018
Date

Name
Corporate Health and Safety Manager

March 9, 2018
Date

Name
Field Coordinator/Health and Safety Officer

March 9, 2018
Date

Table of Contents

Tables

Maps

Acronyms

CFR	Code of Federal Regulations
CPR	cardiopulmonary resuscitation
FC	field coordinator
HSM	health and safety manager
HSO	health and safety officer
HSP	health and safety plan
LDW	Lower Duwamish Waterway
MSDS	material safety data sheets
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PFD	personal flotation device
PM	project manager
PPE	personal protective equipment
QAPP	quality assurance project plan
TBT	tributyltin
TCDD	tetrachlorodibenzo-*p*-dioxin
USCG	US Coast Guard
Windward	Windward Environmental LLC

1 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 specified in 29 Code of Federal Regulations (CFR) 1910§120. The procedures and guidelines contained herein are based on generally recognized health and safety practices. Any changes or revisions to this HSP will be made by a written amendment that will become a permanent part of this document. The goal of this HSP is to establish procedures for safe working practices for all field personnel and visitors.

This HSP addresses all activities associated with the collection and handling of seep water samples from the Lower Duwamish Waterway (LDW) for chemical analyses. During site work, this HSP is to be implemented by the field coordinator (FC), who is also the designated site health and safety officer (HSO), in cooperation with the Windward Environmental LLC (Windward) health and safety manager (HSM) and the Windward 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. This HSP may be revised based on new information and / or changed conditions during site activities. Revisions will be documented in the project records.

2 Site Description and Project Scope

2.1 SITE DESCRIPTION

The sampling area is in the LDW (see Map 4-1 in the quality assurance project plan [QAPP]). The QAPP to which this HSP is appended provides complete details of the sampling program. This section summarizes the types of work that will be performed during field activities.

2.2 SCOPE OF WORK

Specific tasks to be performed are as follows:

- Collection of seep water samples
- Sample handling, processing, and shipping

Additional details on sampling design and methods are provided in Section 4 of the QAPP.

3 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; they will be responsible for informing all individuals who are assigned to work on the site, or who visit the site, of the contents of this plan, and for ensuring that each person signs the Health and Safety Plan Acknowledgment Form (Attachment 1). By signing the Health and Safety Plan Acknowledgment Form, individuals recognize the site health and safety hazards, known or suspected, and agree to adhere to the protocols required to minimize exposure to such hazards.

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

Field Coordinator/Health and Safety Officer: Because of the limited scope and duration of fieldwork for this project, the FC and 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 will also have stop-work authority, to be used if there is an imminent safety hazard or potentially dangerous situation. The FC / HSO or his designee will be present during sampling and operations.

Corporate Health and Safety Manager: The HSM will have 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 and comply with the information in this HSP. They will also have the responsibility to report any potentially unsafe or hazardous conditions to the FC / HSO immediately.

4 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 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.

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.

4.1.1 Slips, trips, and falls

As with all field work, caution should be exercised to prevent slips on slick surfaces. In particular, sampling under wet or rainy conditions or on the shoreline where slick rocks are found requires careful attention to minimize the risk of falling. Slips can be minimized by wearing boots with good tread, made of material that does not become overly slippery when wet. The same care should be used when on a boat or vessel that may be used to access the sampling site.

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.

4.1.2 Sampling equipment

Samples will primarily collected by decanting seep water that has been collected into a stainless steel bowl or extracting the seep water through a piezometer and peristaltic pump into samples containers, as described in Section 4.2.2 of the QAPP. To minimize any potential hazards (e.g., punctures, pinch points) that may arise from the use of sampling equipment, there will be a training session prior to sampling activities for all field personnel for the equipment that will be used to collect seep samples.

4.1.3 Falling overboard

Sampling locations along the shoreline may be accessed from a boat. As with any work from a floating platform, there is a chance of falling overboard. US Coast Guard-approved Type II or III personal flotation devices (PFDs) will be worn while travelling from site to site by boat.

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.

4.1.5 Heat stress

Heat stress could be an issue during summer. Heat-related problems include heat rash, heat cramps, heat exhaustion, and heat stroke if the person does not ingest sufficient fluids. Heat rash can occur when sweat is not allowed to evaporate, leaving the skin wet most of the time and making it subject to irritation. Heat cramps are painful spasms of the muscles from excessive salt loss associated with sweating. Excessive sweating can also lead to heat exhaustion, resulting in moist, clammy skin. Physical signs and symptoms of heat exhaustion include headache, nausea, vertigo, weakness, thirst, and giddiness. Heat exhaustion may progress to heat stroke if a worker is unable to cool and re-hydrate his or her body. The primary signs and symptoms of heat stroke are confusion, irrational behavior, loss of consciousness, convulsions, a lack of sweating, hot dry skin, and an abnormally high body temperature. Workers should be aware of the key differences between the signs and symptoms of heat stroke and those of heat exhaustion, such as the lack of sweating, the color of the skin (red), and the rise in body temperature associated with the former. Heat stroke is a medical emergency that requires immediate medical attention.

A person exhibiting any of the signs of heat stress should be removed from the work area to a shaded area. Immediate steps that can be taken to reduce the symptoms include using a fan or soaking with water to increase cooling and promote evaporation, rehydrating with electrolyte replacement fluids, and removing outer layers of clothing.

Sampling operations and conditions that might result in the occurrence of heat stress are not anticipated. The sampling will take place when extreme warm weather conditions are not expected to occur.

4.1.6 Hypothermia or frostbite

Hypothermia occurs when the body's core temperature falls below 95°F. The sampling may occur during the time of year when cold and wet weather conditions prevail, making hypothermia a concern. Hypothermia is also a risk when someone becomes wet from falling overboard. The FC / HSO will monitor all crew members for early symptoms of hypothermia (e.g., shivering, muscle incoordination, mild confusion). If such symptoms are observed, the FC / HSO will take immediate steps to reduce heat loss by providing extra layers of clothing, or by temporarily moving the affected crew member to a warmer environment.

All personnel will wear protective clothing appropriate for the weather conditions and physical activity. A person exhibiting any of the signs of hypothermia should be

removed from the work area to a warmer environment. Immediate steps that can be taken to reduce the symptoms of hypothermia include minimizing exposure to cold and wet conditions, limiting sitting or standing still for long periods, rehydration with warm fluids, and the removal of any wet outer layers of clothing to permit sweat evaporation during rest periods in a warm environment.

4.1.7 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.

4.1.8 Vessel traffic

Because of the high volume of vessel traffic on the LDW, precautions and safe boating practices will be implemented to ensure that the field boat does not interrupt such traffic. As practical, the field boat will stay out of the navigation channel.

4.2 CHEMICAL HAZARDS

Previous investigations have shown that some chemicals are present at higher-than-background concentrations in the sampling area. For the purposes of discussing the potential exposure of individuals to chemicals in sediments, the chemicals of concern are metals, tributyltin, petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). Care will also be exercised with adding chemical preservatives used for some analytes.

4.2.1 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 7.

4.2.1.1 Inhalation

Inhalation is a route of exposure primarily for chemicals used to decontaminate sampling equipment; such chemicals are only to be used in open, well-ventilated areas.

4.2.1.2 Dermal exposure

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

4.2.1.3 Ingestion

Incidental ingestion of sediment or water is not considered a major route of exposure for this project. Accidental ingestion of seep water is possible. However, careful handling of equipment and containers should prevent water from splashing or spilling during sample collection and handling activities.

4.2.2 Description of chemical hazards

4.2.2.1 Metals and tributyltin

Exposure to metals may occur via ingestion or skin contact. As mentioned above, neither is a likely exposure route. Metal fumes or metal-contaminated dust will not be encountered during field and sample handling activities. Momentary skin contact allows little, if any, opportunity for metals to pass into the body. Field procedures require immediate washing of water or sediments from exposed skin.

4.2.2.2 Petroleum hydrocarbons and polycyclic aromatic hydrocarbons

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

4.2.2.3 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 contribute substantially to the uptake of PCBs. Large amounts of water would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for compounds to pass into the body. Field procedures require immediate washing of water or sediments from exposed skin.

4.2.2.4 Dioxins/furans

Prolonged skin contact with dioxins/furans may cause acne-like symptoms known as chloracne. Other effects on the skin, such as red skin rashes, have been reported to occur in people following exposure to high concentrations of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD). Acute and chronic exposure can damage the liver, increase the risk of diabetes and abnormal glucose tolerance, and possibly

increase the risk for reproductive and developmental effects. 2,3,7,8-TCDD is a possible human carcinogen, and a mixture of dioxins/furans with six chlorine atoms (four of the six chlorine atoms at the 2-, 3-, 7-, and 8-positions) is a probable human carcinogen. Skin absorption may substantially contribute to the uptake of dioxins/furans. Large amounts of water would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for the passage of any of the compounds into the body. Field procedures require the immediate washing of water or sediments from exposed skin.

4.3 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-1 presents the activity hazard analysis for seep sampling.

Table A-1. Activity hazard analysis

Activity	Hazard	Control
Seep sampling[a]	Slips and trips	Use extra care when walking along uneven and unstable surfaces along the shoreline, and under wet/slippery conditions. Wear boots with good tread.
	falling overboard	Use care in boarding/departing from the vessel. Deploy and recover the net or traps from the back deck of the boat. Wear a PFD.
	skin contact with contaminated sediments or liquids	Wear modified Level D PPE.
	back strain	Use appropriate lifting technique when deploying and retrieving pots, or seek help.
	open hatches	Keep hatches closed when not being accessed. Be aware around hatch area and use caution when entering/exiting hatch.
	heat stress	Monitor crew members for signs/symptoms of heat stress. Remove person to cool area and remove extra layers of clothing. Promote evaporative cooling and rehydrate with electrolytic fluids.
	hypothermia	Monitor crew members for signs/symptoms of hypothermia. Minimize prolonged exposure to wet and cold conditions. Remove person to warm area and remove wet clothing. Rehydrate with warm fluids.

[a] Hazards related to sampling from a boat are also applicable.

PFD – personal flotation device

PPE – personal protective equipment

5 Work Zones and Shipboard Access Control

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 zones is to limit the migration of sample material out of its zone, and to restrict unauthorized access to active work areas by defining work zone boundaries.

5.1 WORK ZONE

A work zone will encompass the area where sample collection and handling activities are being performed. The FC / HSO will delineate the work zone as a particular area around the seep. 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.

5.2 DECONTAMINATION STATION

A decontamination station where personnel will clean soiled boots and / or PPE prior to leaving the work zone will be set up for LDW locations. The station will have the buckets, brushes, soapy water, rinse water, or wipes necessary to clean boots, PPE, or other equipment leaving the work zone. Plastic bags will be provided for expendable and disposable materials. If the sampling location does not allow for the establishment of a decontamination station, the FC / HSO will provide alternatives to prevent the spread of contamination.

5.3 ACCESS CONTROL

Security and control of access to the boat will be the responsibility of the FC / HSO and boat captain. Boat access will be granted to necessary project personnel and authorized visitors only. Any security or access control problems will be reported to the client or appropriate authorities.

6 Safe Work Practices

Following common sense will minimize the risk of exposure or accidents at a work site. The following general safety rules will be adhered to 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 conditions.
- Report all accidents, no matter how minor, to the FC / HSO.
- Do not do anything dangerous or unwise even if ordered by a supervisor.

7 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 onboard 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 in Sections 7.1 and 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.

New personnel or visitors will be informed of PPE requirements during their initial site briefing (see Section 3).

7.1 Level D Personal Protective Equipment

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

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

7.2 Modified Level D Personal Protective Equipment

Workers performing activities during which skin contact with contaminated materials is possible, and during 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
- Waterproof and chemical-resistant steel-toed boots
- Chemical-resistant outer gloves

7.3 Safety Equipment

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

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

- Sunscreen

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

8 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 volatile organic compounds 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 will emit 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 personnel develop any of these conditions, work will 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.

9 Decontamination

Decontamination is necessary to prevent the migration of contaminants from the work zone(s) into the surrounding environment, and to minimize the risk of exposure of personnel to contaminated materials that might adhere to PPE. The following sections discuss personnel and equipment decontamination. The following supplies will be available to perform decontamination activities:

- Wash buckets
- Rinse buckets
- Scrub brushes
- Clean water sprayers
- Paper towels
- Plastic garbage bags
- Alconox® or similar decontamination solution

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 or aluminum foil to avoid direct contact with contaminated media.
- Keep contaminated equipment and tools separate from clean equipment and tools.
- Clean boots before entering the boat.

9.2 PERSONNEL DECONTAMINATION

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

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.

Before returning to work, personnel will re-don all necessary PPE. If leaving for the day, personnel will dispose of soiled, expendable PPE.

9.3 SAMPLING EQUIPMENT DECONTAMINATION

Sampling equipment will be decontaminated, as described in Section 4.3.4 of the QAPP, to minimize sample contamination and worker exposure to contamination from samples. The following practices will be followed:

- All sampling equipment used directly in collecting seep samples (e.g., piezometers, stainless steel bowls) will be scrubbed with Alconox® detergent and rinsed with deionized water before use.
- Ice chests will be scrubbed with Alconox® detergent and rinsed with deionized water prior to any sampling activities.
- Wet ice used for sample storage during field activities will be contained in separate plastic bags, and samples will be placed in resealable, waterproof plastic bags to avoid contamination from melting ice.
- Sampling equipment will be free from contaminants such as oils, grease, and fuels.

10 Disposal of Contaminated Materials

Contaminated materials that may be generated during field activities include PPE and excess sample material. These contaminated materials will be disposed of as an integral part of the project.

10.1 Personal Protective Equipment

Gross surface contamination will be removed from PPE. 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.

10.2 Excess Sample Materials

At each sampling location, excess seep water collected for the samples will be returned to sampling site.

11 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.

11.1 PROJECT-SPECIFIC TRAINING

In addition to HAZWOPER training, as described in Section 3.6 of the QAPP, field personnel will undergo training specifically for this project. All personnel and visitors must read this HSP and be familiar with its contents before beginning work or providing oversight. They must acknowledge reading the HSP by signing the HSP review form in Attachment 1. The signed form will be kept in the project files.

The boat captain and FC / HSO will also be required to have the US Coast Guard (USCG) Auxiliary Boating Safety certification. The boat captain or a designee will provide project-specific training prior to the first day of fieldwork and whenever new workers arrive. Field personnel will not be allowed to begin work until project-specific training has been 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 exposure to chemicals
- Activities that pose physical hazards, and actions to control the hazards
- Ship access control and procedures
- Use and limitations of PPE
- Decontamination procedures
- Emergency procedures
- Use and hazards of sampling equipment
- Location of emergency equipment on the vessel
- Vessel safety practices
- Vessel evacuation and emergency procedures

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 all safety briefings in the logbook.

11.3 FIRST AID AND CPR

At least two members 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.

12 Medical Surveillance

A medical surveillance program conforming to the provisions of 29 CFR 1910§120(f) is not necessary for field team members on this project, because they do not meet any of the following 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 8, employees will monitor themselves and each other for any deleterious changes in their physical or mental conditions during the performance of all field activities.

13 Reporting and Record Keeping

Each member of the field crew will sign the HSP review form (Attachment 1). If necessary, accident/incident report forms and Occupational Safety and Health Administration (OSHA) Form 200s will be completed by the FC/HSO.

The FC/HSO or a designee will maintain a health and safety field logbook with records of health- and safety-related details for 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.

14 Emergency Response Plan

As a result of the hazards onboard the vessels 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 respond to emergency situations. Given the location of the site, 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; otherwise, all personnel will 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 and a map for getting from any sampling location to a hospital.

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 between the FC / HSO and equipment handlers concerning 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 its uses, and proper evacuation procedures
- A training session given by senior staff on 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

14.2 Project Emergency Coordinator

The FC / HSO will serve as the project emergency coordinator in the event of an emergency. He will designate his replacement during those times when he is not present 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.

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-2 lists the names and phone numbers for emergency response services and individuals.

Table A-2. Emergency response contacts

Contact	Telephone Number
Emergency Numbers	
Ambulance	911
Police	911
Fire	911
Harborview Medical Center	206.323.3074
Emergency Responders	
US Coast Guard Emergency General information	206.286.5400 206.442.5295 UHF Channel 16
National Response Center	800.424.8802
US Environmental Protection Agency	800.424.8802
Washington State Department of Ecology – Northwest Region Spill Response (24-hour emergency line)	206.649.7000
Emergency Contacts	
Windward Project Manager	
Kathy Godtfredsen	206.812.5413
Windward Corporate Health and Safety Manager	
Susan McGroddy	206.812.5421
Field Coordinator/ Field Health and Safety Officer	
Thai Do	206.812.5407

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.

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 informed of the type of contamination. To the extent possible, contaminated PPE will be removed from the injured individual, 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.

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 the onboard fire extinguisher 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.

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:

- Designate an individual to call 911 and 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 injured individual(s), the location of the individual, 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(s).
- Follow the emergency procedures for retrieving or disposing of equipment reviewed in the training session, and leave the site en route to the predetermined land-based emergency pickup.
- 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 ambulance unit at the nearest accessible dock.

- If a non-life-threatening emergency occurs (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 his choice if that would be more expedient.
- Notify the HSM and the PM.

If the project emergency coordinator determines that an emergency response is not necessary, he may direct someone to decontaminate and transport the individual by vehicle to the nearest hospital. Directions showing the route to the hospital are in Section 14.11.

If a worker leaves the boat to seek medical attention, another worker should accompany him 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 be responsible for completing all accident/incident field reports, OSHA Form 200s, and other required follow-up forms.

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.

14.8.1 Skin contact

- Wash/rinse the affected area thoroughly with copious amounts of soap and water.
- If eye contact has occurred, rinse the eyes for at least 15 minutes using the eyewash that is part of the onboard emergency equipment.
- After initial response actions have been taken, seek appropriate medical attention.

14.8.2 Inhalation

- Move victim to fresh air.
- Seek appropriate medical attention.

14.8.3 Ingestion

- Seek appropriate medical attention.

14.8.4 Puncture wound or laceration

- Seek appropriate medical attention.

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.

14.10 BOATING HAZARDS

Emergency responses to boating hazards are described in Table A-3.

Table A-3. Potential boat 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 USCG or 911, evacuate the area (by life rafts, rescue boat, or swimming), and meet at a designated location. The HSO will take roll call to make sure everyone has evacuated safely. Emergency meeting locations will be determined in the field during the daily safety briefings.
Medical emergency/ personal injury	At least two people with current first aid and CPR training will be onboard the vessel at all times. This person will attempt to assess the nature and critical path of the injury, call 911 immediately, and apply first aid/CPR if necessary. Stop work and wait for medical personnel to arrive. Fill out a site accident report.
Falling into an open hatch	Stop work and rescue the person, if safe and necessary. Assess the nature of the injury, and follow the response for medical emergency/personal injury.
Person overboard	Immediately throw a life ring to the person in the water. Have one onboard person keep an eye on the victim and shout the distance (boat lengths) and direction (o'clock) of the victim from the vessel. Stop work and use the vessel to retrieve the person in the water.
Sinking vessel	Call the USCG immediately. If possible, wait for a rescue boat to arrive to evacuate vessel personnel. See fire/explosion section (above) for emergency evacuation procedures. The HSO will take roll call to make sure everyone has evacuated safely.
Hydraulic oil spill or leak	If the leak/spill is small, immediately apply absorbent pads to control the leak and continue work. If the leak/spill is uncontainable, stop work, call 911 immediately, and wait for assistance. The vessel operator will assess the personal safety hazard associated with the leak/spill and begin evacuation procedures if necessary.
Lack of visibility	If navigation visibility or personal safety is compromised because of smoke, fog, or other unanticipated hazards, stop work immediately. The vessel operator and HSO will assess the hazard and, if necessary, send out periodic horn blasts to notify other vessels potentially in the area of the sampling vessel's location. Move to a secure location (i.e., berth) and wait for visibility to clear.
Loss of power	Stop work and call the USCG for assistance. 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 the USCG for assistance. HSO and vessel operator will assess damage and potential hazards. If necessary, vessel will be evacuated and secured until repairs can be made.

CPR – cardiopulmonary resuscitation
HSO – health and safety officer
USCG – US Coast Guard

14.11 EMERGENCY ROUTES 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 - 9th Avenue
Seattle, WA
206.323.3074

Directions from the vicinity of the LDW to Harborview Medical Center are as follows (Map 1):

From the 1st Avenue South boat launch:

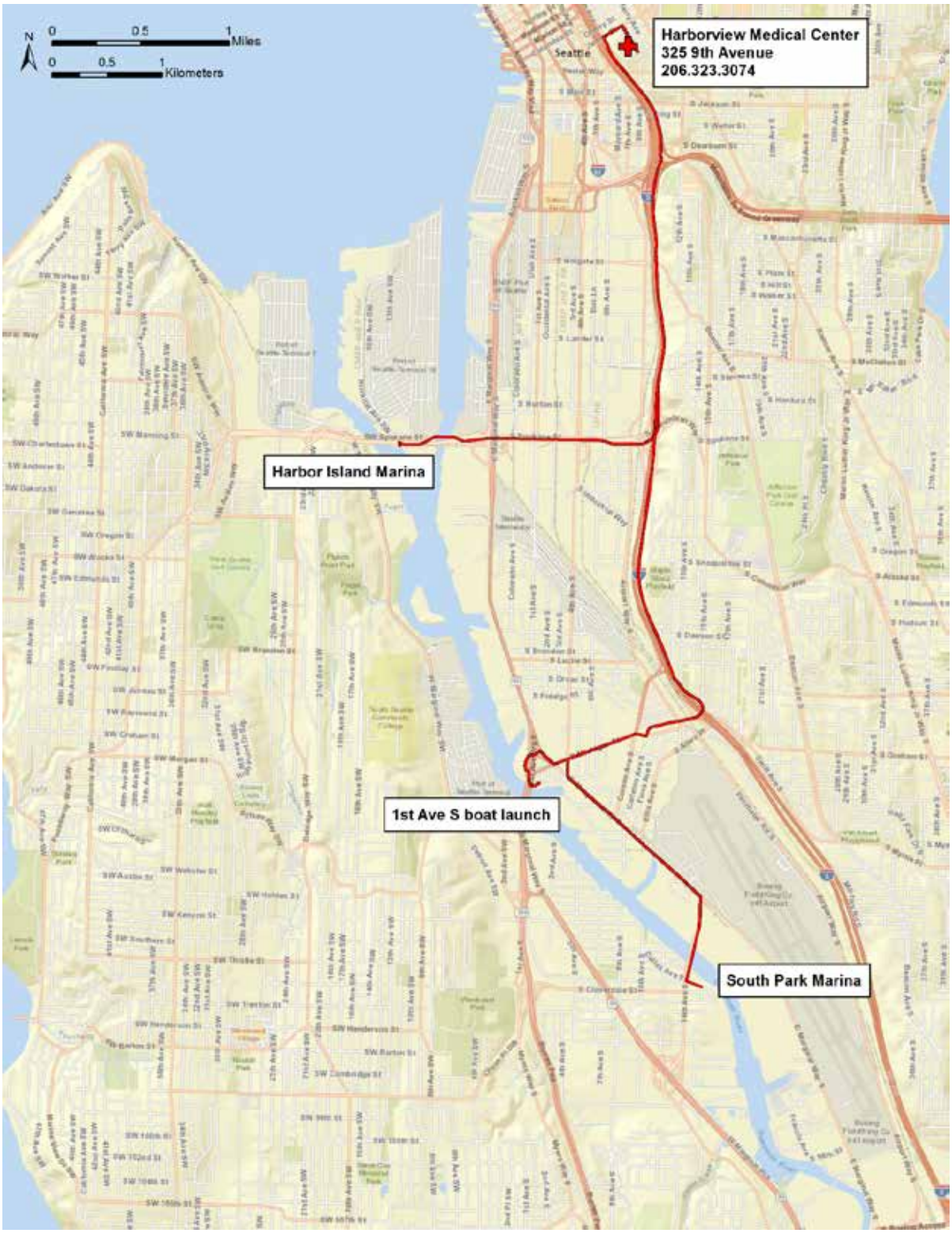
- Drive east on South River Street.
- Turn left on Occidental Avenue South.
- Turn left on East Marginal Way South.
- Turn right on South Michigan Street.
- Look for entrance ramps to I-5 Northbound.
- Drive north on I-5.
- Take the James Street exit.
- Drive east on James Street to 9th Avenue.
- Turn right on 9th Avenue.
- Emergency entrance will be two blocks south on the right.

From Harbor Island Marina:

- From marina parking lot, turn sharp right onto Klickitat Way Southwest.
- Turn slight right onto Southwest Spokane Street
- Turn slight left to take the ramp toward WA-99 N/I-5/Columbian Way.
- Keep left at the fork in the ramp.
- Stay straight to go onto West Seattle Bridge.
- Merge onto I-5 North via the ramp on the left.
- 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.

From South Park Marina:

- From marina parking lot, turn right onto Dallas Avenue South.
- Turn right onto 16th Avenue South.
- Turn left on East Marginal Way South.
- Look for entrance ramps to I-5 Northbound.
- Drive north on I-5.
- Take the James Street exit.
- Drive east on James Street to 9th Avenue.
- Turn right on 9th Avenue.
- Emergency entrance will be two blocks south on the right.



Map A-1. Emergency routes to Harborview Medical Center

Attachment 1. Health and Safety Plan Acknowledgment Form

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

Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date

APPENDIX B. FIELD FORMS

- Seep Reconnaissance Survey Form A
- Seep Reconnaissance Survey Form B
- Seep Reconnaissance Survey Form C
- Seep Collection Form
- Protocol Modification Form

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:			

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:**		
Calculated flow rate					
Temp	**SpC**	**DO**	**pH**	**Turbidity**	**Salinity**
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
Comments:					

Location ID:	**Easting (x):**	**Northing (y)**	**Time:**		
Calculated flow rate					
Temp	**SpC**	**DO**	**pH**	**Turbidity**	**Salinity**
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
Comments:					

Location ID:	**Easting (x):**	**Northing (y)**	**Time:**		
Calculated flow rate					
Temp	**SpC**	**DO**	**pH**	**Turbidity**	**Salinity**
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
Comments:					

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:	

SEEP COLLECTION FORM

Project Name: _____ **Project Task:** _____

Date/Time: _____ **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**	**Turbidity**	**Salinity**
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3

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:	

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:** _____

APPENDIX C. ANALYTICAL METHODS AND REPORTING LIMITS

Tables

Table C-1. Methods and RL goals for conventional analyses

Analyte	Method	Unit	RL
TSS	SM 2540 D-97	mg/L	1.0
TOC	SM 5310 B-00	mg/L	0.500
DOC	SM 5310 B-00	mg/L	0.500

DOC – dissolved organic carbon
RL – reporting limit
SM- Standard Methods
TOC – total organic carbon
TSS – total suspended solids

Table C-2. Method and RL goals for dioxins/furans

Analyte	EPA Method 1613B Water (pg/L) Based on a 1-L sample	
	EDL[a]	LMCL[b]
2,3,7,8-TCDD	0.50	2.0
1,2,3,7,8-PeCDD	0.50	10.0
1,2,3,4,7,8-HxCDD	0.50	10.0
1,2,3,6,7,8-HxCDD	0.50	10.0
1,2,3,7,8,9-HxCDD	0.50	10.0
1,2,3,4,6,7,8-HpCDD	0.50	10.0
OCDD	0.50	20.0
2,3,7,8-TCDF	0.50	2.0
1,2,3,7,8-PeCDF	0.50	10.0
2,3,4,7,8-PeCDF	0.50	10.0
1,2,3,4,7,8-HxCDF	0.50	10.0
1,2,3,6,7,8-HxCDF	0.50	10.0
1,2,3,7,8,9-HxCDF	0.50	10.0
2,3,4,6,7,8-HxCDF	0.50	10.0
1,2,3,4,6,7,8-HpCDF	0.50	10.0
1,2,3,4,7,8,9-HpCDF	0.50	10.0
OCDF	0.50	20.0

[a] EDL is a sample-specific DL. The value provided here is an estimate, and the sample-specific values will vary based on sample mass and the analytical conditions at the time of analysis

[b] LMCL is Axys's lowest calibration limit. Detected values below the LMCL are J-qualified. The reported LMCL will be adjusted based on the sample mass of each sample.

Axys – Axys Analytical Services, Ltd.
DL – detection limit
EPA – US Environmental Protection Agency
EDL – estimated detection limit
HpCDD – heptachlorodibenzo-p-dioxin
HpCDF – heptachlorodibenzofuran
HxCDD – hexachlorodibenzo-p-dioxin
HxCDF – hexachlorodibenzofuran
LMCL – lower method calibration limit
OCDD – octachlorodibenzo-p-dioxin
OCDF – octachlorodibenzofuran
PeCDD – pentachlorodibenzo-p-dioxin
PeCDF – pentachlorodibenzofuran
RL – reporting limit
TCDD – tetrachlorodibenzo-p-dioxin
TCDF – tetrachlorodibenzofuran

Table C-3 Seep analytical methods, MDLs, RL goals, and WQC

Analyte	Method	Unit	MDL	RL	National Recommended AWQC	Washington State Criteria[a]
					Marine Aquatic Life	
					CCC (Chronic)	Chronic
Metals						
Arsenic	EPA 6020A UCT-KED	µg/L	0.022	0.200	36[b]	36[b]
Cadmium	EPA 6020A UCT-KED	µg/L	0.030	0.100	7.9[b]	9.3[b]
Chromium	EPA 6020A	µg/L	0.130	0.500	–	–
Copper	EPA 6020A UCT-KED	µg/L	0.340	0.500	3.1[b]	3.1[b]
Lead	EPA 6020A	µg/L	0.068	0.100	8.1[b]	8.1[b]
Mercury	EPA 7470A	µg/L	0.0026	0.020	0.94[b]	0.025
Silver	EPA 6020A	µg/L	0.017	0.200	–	–
Zinc	EPA 6020A UCT-KED	µg/L	0.820	4	81[b]	81[b]
PAHs						
Acenaphthene	EPA 8270D-SIM	µg/L	0.00289	0.0100	–	–
Anthracene	EPA 8270D-SIM	µg/L	0.00116	0.0100	–	–
Benzo(a)anthracene	EPA 8270D-SIM	µg/L	0.000750	0.0100	–	–
Benzo(a)pyrene	EPA 8270D-SIM	µg/L	0.00248	0.0100	–	–
Benzo(b)fluoranthene	EPA 8270D-SIM	µg/L	0.000460	0.0100	–	–
Benzo(j)fluoranthene	EPA 8270D-SIM	µg/L	0.00187	0.0100	–	–
Benzo(k)fluoranthene	EPA 8270D-SIM	µg/L	0.00321	0.0100	–	–
Benzo(g,h,i)perylene	EPA 8270D-SIM	µg/L	0.00142	0.0100	–	–
Chrysene	EPA 8270D-SIM	µg/L	0.000900	0.0100	–	–
Dibenzo(a,h)anthracene	EPA 8270D-SIM	µg/L	0.00134	0.0100	–	–
Fluoranthene	EPA 8270D-SIM	µg/L	0.00171	0.0100	–	–
Fluorene	EPA 8270D-SIM	µg/L	0.00152	0.0100	–	–
Indeno(1,2,3-cd)pyrene	EPA 8270D-SIM	µg/L	0.00101	0.0100	–	–
2-Methylnaphthalene	EPA 8270D-SIM	µg/L	0.00102	0.0100	–	–
Naphthalene	EPA 8270D-SIM	µg/L	0.00131	0.0100	–	–

Table C-3 Seep analytical methods, MDLs, RL goals, and WQC

Analyte	Method	Unit	MDL	RL	National Recommended AWQC	Washington State Criteria[a]
					Marine Aquatic Life	
					CCC (Chronic)	Chronic
Phenanthrene	EPA 8270D-SIM	µg/L	0.00130	0.0100	–	–
Pyrene	EPA 8270D-SIM	µg/L	0.00118	0.0100	–	–
PCB Aroclors[c]						
Aroclor 1016	Mod EPA 8082A	µg/L	0.0025	0.010[d]	–	–
Aroclor 1221	Mod EPA 8082A	µg/L	0.0025	0.010[d]	–	–
Aroclor 1232	Mod EPA 8082A	µg/L	0.0025	0.010[d]	–	–
Aroclor 1242	Mod EPA 8082A	µg/L	0.0025	0.010[d]	–	–
Aroclor 1248	Mod EPA 8082A	µg/L	0.0025	0.010[d]	–	–
Aroclor 1254	Mod EPA 8082A	µg/L	0.0025	0.010[d]	–	–
Aroclor 1260	Mod EPA 8082A	µg/L	0.0028	0.010[d]	–	–
Total PCB Aroclors	Mod EPA 8082A	µg/L	–	–	0.03	0.030
SVOCs						
1,2-Dichlorobenzene	EPA 8270D	µg/L	0.231	1.00	–	–
1,2,4-Tetrachlorobenzene	EPA 8270D	µg/L	0.227	1.00	–	–
1,4-Dichlorobenzene	EPA 8270D	µg/L	0.212	1.00	–	–
2,4-Dimethylphenol	EPA 8270D	µg/L	0.350	3.00	–	–
4-Methylphenol	EPA 8270D	µg/L	0.445	2.00	–	–
Benzoic acid	EPA 8270D	µg/L	3.03	20.0	–	–
Benzyl alcohol	EPA 8270D	µg/L	0.607	2.00	–	–
Bis(2-ethylhexyl)phthalate	EPA 8270D	µg/L	0.345	3.00	–	–
Butyl benzyl phthalate	EPA 8270D	µg/L	0.320	1.00	–	–
Dibenzofuran	EPA 8270D	µg/L	0.329	1.00	–	–
Dimethyl phthalate	EPA 8270D	µg/L	0.362	1.00	–	–
Hexachlorobenzene	EPA 8270D	µg/L	0.333	1.00	–	–
n-Nitrosodiphenylamine	EPA 8270D	µg/L	0.252	1.00	–	–

Table C-3 Seep analytical methods, MDLs, RL goals, and WQC

Analyte	Method	Unit	MDL	RL	National Recommended AWQC Marine Aquatic Life CCC (Chronic)	Washington State Criteria[a] Marine Aquatic Life Chronic
Pentachlorophenol	EPA 8270D	µg/L	1.58	**10.0**	7.9	7.9
Phenol	EPA 8270D	µg/L	0.154	1.00	–	–
Dioxins/furans						
2,3,7,8-TCDD	EPA 1613B	pg/L	0.62[e]	2.0	–	–

[a] Washington State criteria include standards promulgated in WAC 173-201A. Comparison is being made to these criteria as a highly conservative screen only.

[b] Criteria applied to dissolved fraction.

[c] If an RL of 39 ng/L or less cannot be achieved for non-detected PCB Aroclor results in any seep sample, the archived sample for that seep will be analyzed for PCB congeners using EPA method 1668c. For individual congeners, the EDL goal will be 1.0 pg/L, and the LMCL goal will be 4.0 pg/L. EDL is a sample-specific DL. The goal value is an estimate, and the sample-specific values will vary based on sample mass and the analytical conditions at the time of analysis. LMCL is Axys's lowest calibration limit. Detected values below the LMCL are J-qualified. The reported LMCL will be adjusted based on the volume or mass of each sample.

[d] RL value can only be achieved in the absence of matrix interferences. RL values will be elevated if interferences are present in samples.

[e] EDL is a sample-specific DL. The value provided here is an estimate, and the sample-specific values will vary based on sample mass and the analytical conditions at the time of analysis.

ARI – Analytical Resources, Inc.
AWQC – ambient water quality criteria
Axys – Axys Analytical Services Ltd.
CCC – criterion continuous concentration
CFR – Code of Federal Regulations
DL – detection limit
EPA – US Environmental Protection Agency
EDL – estimated detection limit
LLOQ – lower limit of quantification
LMCL – lower method calibration limit
MDL – method detection limit
na – not applicable
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
RL – reporting limit
ROD – Record of Decision
SIM – selective ion monitoring
SVOC – semivolatile organic compound
TCDD – tetrachlorodibenzo-*p*-dioxin
UCT-KED – universal cell technology-kinetic energy discrimination
WAC – Washington Administrative Code
WQC – water quality criteria

APPENDIX D. INITIAL SEEP SCREENING INFORMATION

Tables

Table D-1. Initial seep screening

Seep	Location (approx. RM) and Location Notes	Already Sampled?	Adjacent Cleanup Site
SP-01	2.2 E	no	none
SP-02	same location as S-11 (see below)	yes (S-11)	none
SP-03	same location as S-1 (see below)	yes (S-1)	none
SP-04	same location as S-13 (see below)	yes (S-13)	none
SP-05	2.6 E	no	none
SP-06	2.6 E	no	none
SP-07	2.6 E	no	none
SP-08	2.7 E	no	none
SP-09	2.9 E	no	Slip 4 EAA
SP-10	2.9 E	yes	Slip 4 EAA
SP-11	2.7 E	no	none
SP-12	2.8 E	yes	Crowley Marine Services 8th Avenue South
SP-13	3.0 E	no	Boeing Plant 2
SP-14	3.1 E	no	Boeing Plant 2
SP-15	same location as SE-SWY01 (see below)	yes (SE-SWY01)	Boeing Plant 2
SP-16	same location as SE-SWY02 (see below)	yes (SE-SWY02)	Boeing Plant 2
SP-17	same location as SE-SWY03 (see below)	yes (SE-SWY03)	Boeing Plant 2
SP-18	same location as SE-SWY05 (see below)	yes (SE-SWEY05)	Boeing Plant 2
SP-19	3.6 E	no	Jorgensen Forge Corp.
SP-20	3.7 E	yes	Jorgensen Forge Corp.
SP-21	3.7 E	no	Boeing Isaacson Thompson
SP-22	4.0 E	no	8801 East Marginal Way South
SP-23	same location as 02-SP (see below)	yes (02-SP)	Container Properties LLC
SP-24	4.2 E	no	none
SP-25	same location as 07-SP (see below)	yes (07-SP)	Container Properties LLC
SP-26	4.5 E	no	none
SP-27	5.0 E	no	none
SP-28	4.9 E	no	none
SP-29	4.9 W	no	none
SP-30	4.9 W	no	none
SP-31	4.9 W	no	none
SP-32	4.8 W	no	none

Seep	Location (approx. RM) and Location Notes	Already Sampled?	Adjacent Cleanup Site
SP-33	4.8 E	no	none
SP-34	4.6 W	no	none
SP-35	4.6 E	no	none
SP-36	4.5 W	no	none
SP-37	4.5 E	no	none
SP-38	4.4 W	no	none
SP-39	4.3 W	yes	none
SP-40	4.0 W	no	none
SP-41	4.0 W	yes	none
SP-42	3.9 W	no	none
SP-43	3.8 W	no	none
SP-44	3.4 W	no	~~South Park Marina~~none
SP-45	3.3 W	no	none
SP-46	3.2 W	no	none
SP-47	3.1 W	no	none
SP-48	3.0 W	yes	none
SP-49	3.0 W	no	none
SP-50	2.9 W	no	none
SP-51	2.8 W	no	none
SP-52	2.2 W	no	Industrial Container Services WA LLC
SP-53	2.2 W	no	Industrial Container Services WA LLC
SP-54	2.2 W	yes	Industrial Container Services WA LLC
SP-55	2.2 W	no	Douglas Management Dock
SP-56	2.2 W	no	Douglas Management Dock
SP-57	2.0 W	no	none
SP-58	2.1 W	no	none
SP-59	2.1 W	no	none
SP-60	2.0 W	no	Port of Seattle Terminal 115
SP-61	1.5 W	yes	Glacier Northwest Inc.
SP-62	1.4 W	yes	Glacier Northwest Inc.
SP-63	2.2 E	no	none
SP-64	1.0 W	yes	none
SP-65	1.0 W	no	none
SP-66	0.9 W	no	none
SP-67	0.8 W	no	none

Seep	Location (approx. RM) and Location Notes	Already Sampled?	Adjacent Cleanup Site
SP-68	0.7 W	no	none
SP-69	0.5 W	yes	none
SP-70	0.2 W	no	none
SP-71	0.2 W	yes	none
SP-72	0.2 E	no	none
SP-73	0.6 E	no	none
SP-74	0.7 E	no	none
SP-75	0.8 E	yes	none
SP-76	1.0 E	yes	none
SP-77	1.1 E	no	none
SP-78	1.4 E	no	none
SP-79	1.5 E	no	none
SP-80	1.6 E	yes	none
SP-81	1.7 E	no	none
SP-82	1.8 E	yes	Duwamish Marine Center
SE-00801	3.3 E	yes	Boeing Plant 2
SE-11001	3.1 E	yes	Boeing Plant 2
SE-21002	3.1 E	yes	Boeing Plant 2
SE-31003	3.1 E	yes	Boeing Plant 2
SE-41004	3.2 E	yes	Boeing Plant 2
SE-51005	3.2 E	yes	Boeing Plant 2
SE-61006	3.2 E	yes	Boeing Plant 2
SE-74101	3.4 E	yes	Boeing Plant 2
SE-84102	3.4 E	yes	Boeing Plant 2
SE-94105	3.3 E	yes	Boeing Plant 2
SE-SWY01	3.5 E	yes	Boeing Plant 2
SE-SWY02	3.5 E	yes	Boeing Plant 2
SE-SWY03	3.6 E	yes	Boeing Plant 2
SE-SWY04	3.6 E	yes	Boeing Plant 2
SE-SWY05	3.6 E	yes	Boeing Plant 2
SE-SWY06	3.6 E	yes	Jorgensen Forge Corp
SE-SWY07	3.6 E	yes	Jorgensen Forge Corp
SW-SWY01	3.6 E	yes	Jorgensen Forge Corp
S-1	2.4 E	yes	none
S-11	2.3 E	yes	none
S-12	2.2 E	yes	none
S-13	2.4 E	yes	none

Seep	Location (approx. RM) and Location Notes	Already Sampled?	Adjacent Cleanup Site
S-14	2.4 E	yes	none
S-2	2.4 E	yes	none
S-3	2.3 E	yes	none
S-4	2.3 E	yes	none
S-5	2.4 E	yes	none
S-6	2.5 E	yes	none
01-SP	4.2 E	yes	Container Properties LLC
02-SP	4.2 E	yes	Container Properties LLC
03-SP	4.2 E	yes	Container Properties LLC
04-SP	4.2 E	yes	Container Properties LLC
05-SP	4.2 E	yes	Container Properties LLC
06-SP	4.2 E	yes	Container Properties LLC
07-SP	4.2 E	yes	Container Properties LLC
SEEP_1	3.6 W	yes	Port of Seattle Terminal 117
SEEP_2	3.6 W	yes	Port of Seattle Terminal 117
SEEP_3	3.5 W	yes	Port of Seattle Terminal 117
SEEP82	1.8 E	yes	Duwamish Marine Center
SEEP-1	2.8 E	yes	Crowley Marine Services 8th Avenue South
SP-1	2.2 W	yes	Douglas Management Dock
DENW6721-SEEP-1	2.8 E	yes	Crowley Marine Services 8th Avenue South
DENW6721-SEEP-2	2.8 E	yes	Crowley Marine Services 8th Avenue South
DENW6721-SEEP-3	2.8 E	yes	Crowley Marine Services 8th Avenue South
DENW6721-SEEP-4	2.8 E	yes	Crowley Marine Services 8th Avenue South
DENW6721-SEEP-5	2.8 E	yes	Crowley Marine Services 8th Avenue South
DSIP2-SP-01	1.3 W	yes	Duwamish Shipyard
DSIP2-SP-02	1.3 W	yes	Duwamish Shipyard
DSIP2-SP-03	1.4 W	yes	Duwamish Shipyard

EAA – early action area
RM – river mile

APPENDIX E. GROUNDWATER WELL INFORMATION

Tables

Table E-1. Groundwater well location names

Seep ID	Nearby Groundwater Well Locations
SP-08	DENW6721-EMW-18S
SP-09	NGW623
SP-11	DENW6721-EMW-18S
SP-26	BDC-05-23
SP-33	DC-MW-14C, DC-MW-15C, DC-MW-20C, DC-MW-22A
SP-35	DC-MW-14C, DC-MW-15C, DC-MW-20C, DC-MW-22A
SP-37	BDC-05-23, DC-MW-14C, DC-MW-15C, DC-MW-20C, DC-MW-22A
SP-42	VCNW1511_MW11, VCNW1511_MW3, SB10, SB12, SB13, SB14, SB15, SB16, SB19
SP-43	VCNW1511_MW11, VCNW1511_MW3, SB10, SB12, SB13, SB14, SB15, SB16, SB19
SP-73	VCPNW2268-PGG-3, VCPNW2268-PGG-6
SP-74	VCPNW2268-MW-15, Federal Center South FC8
SP-78	PSCGT-CG-140-30, PSCGT-CG-151-25
SP-79	PSCGT-CG-140-30, PSCGT-CG-151-25

ID - identification

Table E-2. Number of chemicals analyzed for at each groundwater monitoring well used in the groundwater screen

Location Name	Sample Name	Sample Date	Conventionals	Metals	PAHs	PCBs	Phthalates	Other SVOCs	VOCs
BDC-05-23	BDC-05-23	11/3/2016	2	4	-	-	-	-	4
DC-MW-14C	DC-MW-14C	11/2/2016	-	-	-	-	-	-	4
DC-MW-15C	DC-MW-15C	11/2/2016	-	-	-	-	-	-	4
DC-MW-20C	DC-MW-20C	11/2/2016	-	-	-	-	-	-	4
DC-MW-22A	DC-MW-22A	11/2/2016	2	-	-	-	-	-	4
DENW6721-EMW-18S	EMW-18S-121714	12/17/2014	2	16	24	8	3	11	67
Federal Center South FC8	FC8	9/28/2010	-	-	21	-	-	-	1
NGW623	NGW623-031715	3/17/2015	-	16	22	10	3	11	-
NGW623	NGW623-051315	5/13/2015	-	16	22	10	3	11	-
PSCGT-CG-140-30	CG-140-30-0211	2/11/2011	-	-	1	-	-	3	48
PSCGT-CG-151-25	CG-151-25-1010	11/11/2010	-	-	1	-	-	3	48
SB10	SB10	8/8/2014	-	4	1	-	-	3	66
SB12	SB12	8/7/2014	-	4	-	-	-	-	-
SB13	SB13	8/7/2014	-	4	-	-	-	-	-
SB14	SB14	8/7/2014	-	4	1	-	-	3	66
SB15	SB15	4/15/2015	-	7	1	-	-	3	66
SB16	SB16	4/16/2015	-	7	1	-	-	3	66
SB19	SB19	4/20/2015	-	7	1	-	-	3	66
VCNW1511_MW11	VCNW1511_MW11	3/10/2015	-	4	1	-	-	3	66
VCNW1511_MW3	VCNW1511_MW3	3/9/2015	-	4	1	-	-	3	66
VCPNW2268-MW-15	MW-15-0313	3/26/2013	-	6	22	8	-	-	-
VCPNW2268-MW-15	MW-15-0613	6/5/2013	-	6	22	8	-	-	-
VCPNW2268-MW-15	MW-15-0913	9/30/2013	-	6	22	219	-	-	-

Location Name	Sample Name	Sample Date	Conventionals	Metals	PAHs	PCBs	Phthalates	Other SVOCs	VOCs
VCPNW2268-PGG-3	PGG-3-0313	3/26/2013	-	6	22	8	-	-	-
VCPNW2268-PGG-3	PGG-3-0613	6/5/2013	-	6	22	8	-	-	-
VCPNW2268-PGG-3	PGG-3-0913	9/30/2013	-	6	22	8	-	-	-
VCPNW2268-PGG-6	PGG-6-0313	3/26/2013	-	6	22	8	-	-	-
VCPNW2268-PGG-6	PGG-6-0613	6/5/2013	-	6	22	8	-	-	-
VCPNW2268-PGG-6	PGG-6-0913	9/30/2013	-	6	22	222	-	-	-

PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
SVOC – semivolatile organic compound
VOC – volatile organic compound