EAST WATERWAY OPERABLE UNIT SUPPLEMENTAL REMEDIAL INVESTIGATION/ FEASIBILITY STUDY

QUALITY ASSURANCE PROJECT PLAN: SURFACE SEDIMENT SAMPLING FOR CHEMICAL ANALYSES AND TOXICITY TESTING OF THE EAST WATERWAY

For submittal to:

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Region 10
Seattle, WA

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Title and Approval Page
EW Surface Sediment and Toxicity Testing
Quality Assurance Project Plan

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Acronyms

ACRONYM	Definition
%RSD	percent relative standard deviation
ANSETS	Analytical Services Tracking System
ARI	Analytical Resources, Inc.
BHC	benzene hexachloride
CAS	Columbia Analytical Services, Inc.
CFR	Code of Federal Regulations
COC	chain of custody
COI	chemical of interest
CSL	cleanup screening level
CSM	conceptual site model
CSO	combined sewer overflow
CVAA	cold vapor atomic absorption
DGPS	differential global positioning system
DMMP	Dredged Material Management Program
DO	dissolved oxygen
DQI	data quality indicator
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	US Environmental Protection Agency
ERA	ecological risk assessment
EW	East Waterway
EWG	East Waterway Group
FC	field coordinator
GC/ECD	gas chromatography/electron capture detection
GC/FPD	gas chromatography/flame photometric detection
GC/MS	gas chromatography/mass spectrometry
GC/MS/MS	gas chromatography/mass spectrometry/mass spectrometry
GIS	geographic information system
GPS	global positioning system
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high-density polyethylene
HHRA	human health risk assessment
HRGC/HRMS	high-resolution gas chromatography/high-resolution mass
HSP	health and safety plan
ICP-AES	inductively coupled plasma-atomic emission spectrometry
ICP-MS	inductively coupled plasma-mass spectrometry

ACRONYM	Definition
ID	identification
LCS	laboratory control sample
MIS	multi-increment sampling
MDL	method detection limit
ML	maximum level
MLLW	mean lower low water
MS	matrix spike
MSD	matrix spike duplicate
NAD83	North American Datum 1983
NAS	Northwestern Aquatic Sciences
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PM	project manager
ppt	parts per thousand
PSEP	Puget Sound Estuary Program
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RL	reporting limit
RPD	relative percent difference
SDG	sample delivery group
SIM	selected ion monitoring
SL	screening level
SMS	Washington State Sediment Management Standards
SOP	standard operating procedure
SQS	sediment quality standards
SRI	supplemental remedial investigation
SRM	standard reference material
SVOC	semivolatile organic compound
T-18	Terminal 18
TBT	tributyltin
TM	task manager
TOC	total organic carbon
USCG	US Coast Guard
Windward	Windward Environmental LLC

1 Introduction

This quality assurance project plan (QAPP) describes the quality assurance (QA) objectives, methods, and procedures for sampling surface sediment in the East Waterway (EW), chemically analyzing these samples, and conducting toxicity testing on a subset of these sediment samples. Data from these studies will be used to determine the nature and extent of chemical contamination and to support the ecological risk assessment (ERA) and human health risk assessment (HHRA) for the EW supplemental remedial investigation (SRI). This QAPP presents the study design, including details on project organization, field data collection, laboratory analysis, and data management. This QAPP was prepared in accordance with US Environmental Protection Agency (EPA) guidance for preparing QAPPs (2002).

This plan is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Project Management
- Section 3 – Data Generation and Acquisition
- Section 4 – Assessment and Oversight
- Section 5 – Data Validation and Usability
- Section 6 – References

A health and safety plan (HSP) designed to protect onsite personnel from physical, chemical, and other hazards posed during field sampling activities is included as Appendix A. Field collection forms are included as Appendix B. The derivation of risk-based analytical concentration goals for sediment is presented in Appendix C. Appendix D presents a complete listing of analytes and their detection and reporting limits in sediment.

2 Project Management

This section describes the overall management structure of the project, identifies key personnel, and describes their responsibilities, including field coordination, QA and quality control (QC), laboratory management, and data management. The East Waterway Group (EWG) and EPA will be involved in all aspects of this project, including the discussion, review, and approval of the QAPP and the interpretation of the results of the investigation.

2.1 Project Organization and Team Member Responsibilities

This sampling effort will be performed by Windward Environmental LLC (Windward) for the EWG. The overall project organization and the individuals responsible for the various tasks required for the surface sediment chemistry sample collection and analysis are shown in Figure 2-1. Responsibilities of project team members, as well as laboratory project managers (PMs), are described in the following subsections.

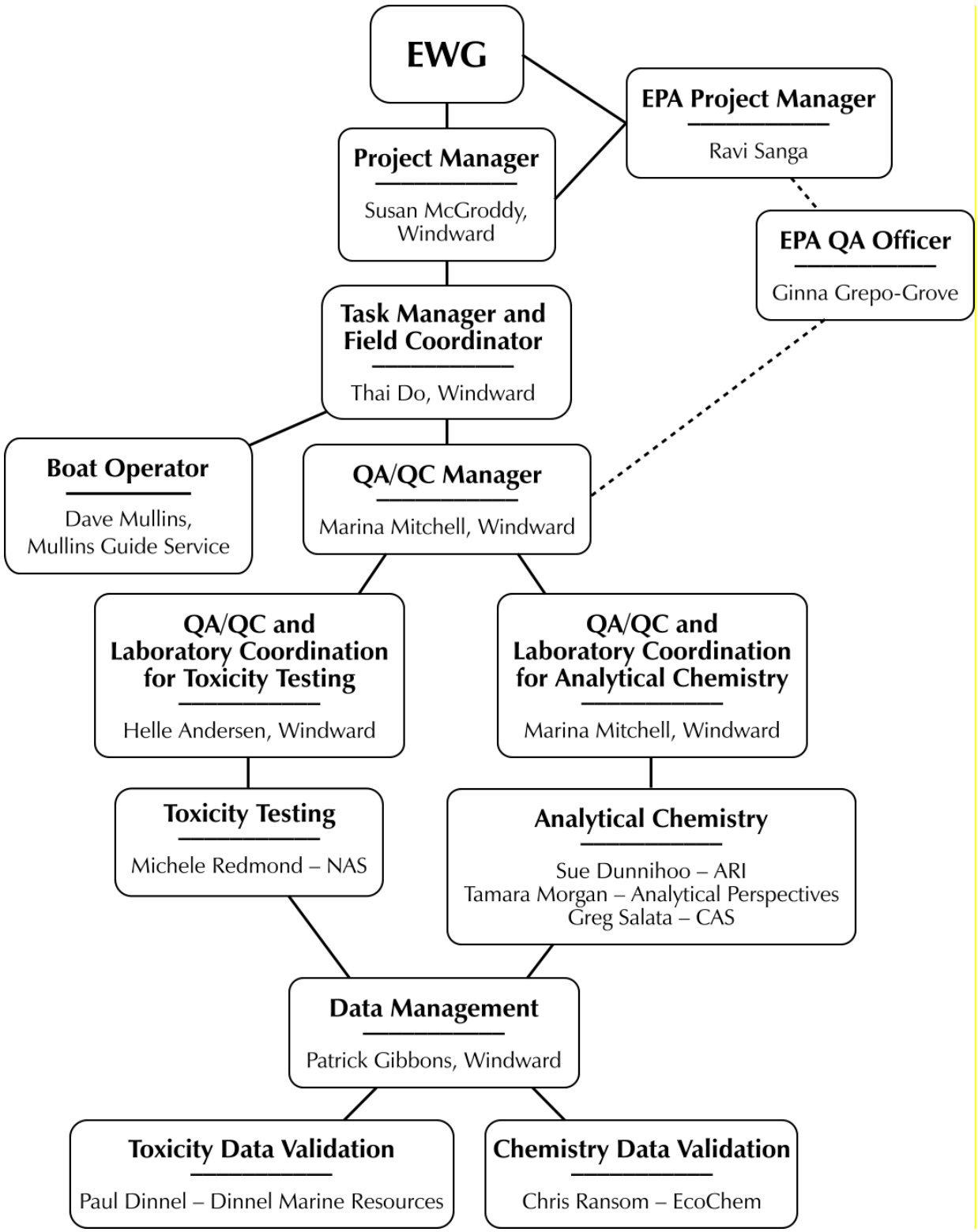

Figure 2-1. Project organization

2.1.1 Project management

EPA will be represented by its PM, Ravi Sanga. Mr. Sanga can be reached as follows:

Mr. Ravi Sanga
US Environmental Protection Agency, Region 10
1200 Sixth Avenue, Suite 900
ECL-111
Seattle, WA 98101-3140
Telephone: 206.553.4092
Facsimile: 206.553.0124
E-mail: Sanga.Ravi@epamail.epa.gov

Susan McGroddy will serve as the Windward PM and will be responsible for overall project coordination, providing oversight on planning and coordination, work plans, all project deliverables, and for the performance of the administrative tasks needed to ensure timely and successful completion of the project. She will also be responsible for coordinating with EWG and EPA on schedule, deliverables, and other administrative details. Dr. McGroddy can be reached as follows:

Dr. Susan McGroddy
Windward Environmental LLC
200 W Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5421
Facsimile: 206.217.0089
E-mail: susanm@windwardenv.com

Thai Do will serve as the Windward task manager (TM). The TM is responsible for project planning and coordination, production of work plans, production of project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. The TM is responsible for communicating with the Windward PM on the progress of project tasks and any deviations from the QAPP. Significant deviations from the QAPP will be further reported to EWG and EPA. Mr. Do can be reached as follows:

Mr. Thai Do
Windward Environmental LLC
200 W Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5407
Facsimile: 206.217.0089
E-mail: thaid@windwardenv.com

2.1.2 Field coordination

Thai Do will serve as the Windward field coordinator (FC). The FC is responsible for managing the field sampling activities and general field and QA/QC oversight. He will ensure that appropriate protocols for sample collection, preservation, and holding times are observed and will oversee delivery of environmental samples to the designated laboratories for chemical analysis.

Dave Mullins will serve as the sampling boat captain. The boat captain is responsible for operating the boat and for decisions related to boating operations. The boat captain will work in close coordination with the FC to ensure that samples are collected consistent with the methods and procedures presented in this QAPP. Mr. Mullins can be reached as follows:

Mr. Dave Mullins
Mullins Guide Service
PO Box 203
Ravensdale, WA 98051
Telephone: 425.743.7266
Mobile: (b) (6) [redacted]
E-mail: (b) (6) [redacted]

2.1.3 Quality assurance/quality control

Marina Mitchell of Windward will serve as QA/QC manager and coordinator for chemical analyses for the project. As the QA/QC manager, she will provide oversight for both the field sampling and laboratory programs, and will supervise data validation and project QA coordination, including coordination with the EPA QA officer, Ginna Grepo-Grove.

Ms. Mitchell can be reached as follows:

Marina Mitchell
Windward Environmental LLC
200 W Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5424
Facsimile: 206.217.0089
E-mail: marinam@windwardenv.com

Ms. Grepo-Grove can be reached as follows:

Ginna Grepo-Grove
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Telephone: 206.553.1632
E-mail: grepo-grove.gina@epa.gov

Helle Andersen of Windward will serve as the QA/QC coordinator for toxicity testing. Ms. Andersen can be reached as follows:

Helle Andersen
Windward Environmental LLC
200 W Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5402
Facsimile: 206.217.0089
E-mail: hellea@windwardenv.com

The QA/QC coordinators will ensure that samples are collected and documented appropriately and coordinate with the analytical and toxicity testing laboratories to ensure that QAPP requirements are followed.

EcoChem Inc., will provide independent third-party review and validation of analytical chemistry data. Chris Ransom will act as the data validation PM and can be reached as follows:

Ms. Chris Ransom
EcoChem Inc.
Dexter Horton Building
710 Second Avenue, Suite 600
Seattle WA 98104
Telephone: 206.233.9332
E-mail: cransom@ecochem.net

Independent third-party review and validation of toxicity testing data will be provided by Paul Dinnel. Dr. Dinnel can be reached as follows:

Paul Dinnel
Dinnel Marine Resources
Shannon Point Marine Center
Anacortes, WA 98221
Telephone: 360.299.8468
E-mail: (b) (6)

2.1.4 Laboratory project management

Analytical Resources, Inc. (ARI), Analytical Perspectives, and Columbia Analytical Services, Inc. (CAS), will perform chemical analyses. Sue Dunnihoo will serve as the laboratory PM for ARI, Tamara Morgan will serve as the laboratory PM for Analytical Perspectives, and Greg Salata (or other qualified personnel) will serve as the laboratory PM for CAS. The laboratory PMs can be reached as follows:

Ms. Susan Dunnihoo
Analytical Resources, Inc.
4611 S 134th Place, Suite 100

Tukwila, WA 98168
Telephone: 206.695.6207
E-mail: sue@arilabs.com

Ms. Tamara Morgan
Analytical Perspectives
2714 Exchange Drive
Wilmington, NC 28405
Telephone: 910.794.1613
Facsimile: 910.794.3919
E-mail: tmorgan@ultratrace.com

Mr. Greg Salata
Columbia Analytical Services, Inc.
1317 S 13th Avenue
Kelso, WA 98626
Telephone: 360.577.7222
Facsimile: 360. 636.1068
E-mail: gsalata@kelso.caslab.com

Helle Andersen of Windward will serve as the laboratory coordinator for the toxicity testing laboratory. Northwestern Aquatic Sciences (NAS) will perform the toxicity testing. Michelle Redmond will serve as the laboratory PM for NAS and can be reached as follows:

Michele Redmond
Northwestern Aquatic Sciences
3814 Yaquina Bay Road, P.O. Box 1437
Newport, OR 97365
Telephone: 541.265.7225
Facsimile: 541.265.2799
E-mail: mredmond@nwaquatic.com

The laboratories will accomplish the following:

- 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 third-party auditors to perform laboratory and data audits

2.1.5 Data management

Mr. Patrick Gibbons will oversee data management to ensure that analytical data are incorporated into the EW database with appropriate qualifiers following acceptance of the data validation. QA/QC of the database entries will ensure accuracy for use in the ERA and HHRA.

2.2 PROBLEM DEFINITION/BACKGROUND

The EW conceptual site model (CSM) and data gaps report (Anchor et al. 2008) identified the need for additional surface sediment samples for chemical analysis and toxicity testing. This section presents the objectives and background information to address these data needs. An overview of the study and its schedule is presented in Section 2.3, and a detailed sampling design is presented in Section 3.1.

2.2.1 Surface sediment sampling and chemical analyses

Collection of additional surface sediment samples for chemical analysis was recommended in the CSM and data gaps report (Anchor et al. 2008) for specific areas of the EW to support the SRI and associated risk assessments . The objective of this study is to fill these remaining data needs. In particular, additional sediment chemistry data are needed to:

- Better understand the areal extent of chemicals of interest (COIs) for which concentrations have exceeded the SQS or the CSL of the SMS[1]
- Provide additional characterization of areas with low sampling density based on data gaps analysis presented in the existing information summary report (Anchor and Windward 2008)
- Further characterize the concentrations and distributions of COIs with relatively low sampling density (e.g., tributyltin [TBT], DDT and dioxins/furans, or with elevated detection limits relative to SQS or CSLs
- Further characterize the nature and extent of chemical concentrations in sediments near potential current or historical chemical sources
- Further characterize the potential for human exposure in intertidal areas below mean higher high water that may be used for recreation or clamming activities

Surface sediment is defined as 0 to 10 cm for the purposes of the SRI/FS. A recent sediment profile imaging survey was conducted in the EW. Preliminary results for apparent redox potential discontinuity depth (relative percent difference [RPD]) and

[1] WAC 173-204. The SQS represent numeric chemical concentrations below which sediments are designated as having no adverse effects on biological resources. At chemical concentrations above the SQS but below the CSL, sediments are designated as having minor adverse effects on biological resources. At chemical concentrations above the CSL, there is a high probability of adverse biological affects.

subsurface feeding voids are presented here to support the use of 0 to 10 cm as the biologically active zone for the EW.

The RPD can be used as an indication of the oxygenated zone, typically caused by biological activity (although some physical disturbance can increase the levels of oxygen in the sediment). For the EW, the minimum RPD was 0.6 cm, the maximum was 5.1 cm, and the mean was 2.1 cm based on a survey of 190 locations throughout the waterway. The subsurface feeding voids can be used as an indication of the maximum depth to which a larger invertebrate may extend during feeding. Subsurface feeding voids were observed in 36 out of the 190 locations surveyed in the EW, with a minimum depth of 2.5 cm, a maximum of 18.3 cm, and a mean of 9.7 cm. Both the RPD and subsurface feeding void data support the use of 0 to 10 cm sediment to characterize the biologically active zone sediment for EW.

Twelve investigations have collected surface (0 to 10 cm) sediment samples in the EW since 1995 with a total of 157 surface sediment samples. This dataset is considered suitable for use in the EW SRI/FS (Table 2-1). Only those sediment samples as part of post-dredge monitoring or nature and extent of contamination investigations are included in the SRI/FS. Surface sediment samples collected in areas that were subsequently dredged are excluded from the dataset. The majority of the surface sediment samples characterize 0 to 10 cm; however, two samples were collected from 0 to 1 cm, 22 samples were collected from 0 to 2 cm, and one sample was collected from 0 to 6 cm. Sample locations for each of the historical investigations are provided in Map 2-1.

Two dredge events were completed in 2005, the dredging of the US Coast Guard (USCG) slip (Slip 36) and the Phase 1 removal action in the center of the waterway off of Slip 27. The sediment samples collected after the completion of dredging in Slip 36 represent current surface sediment conditions in this area. However, following the completion of the Phase 1 removal action, a 6-in. layer of sand was placed as an interim action over much of the dredge area. There were surface sediment samples collected after the dredging was complete, prior to the placement of the sand layer (post-dredge monitoring samples) and samples collected following the placement of the sand layer (recontamination monitoring samples). Recontamination monitoring samples have been collected in three sampling events (2006, 2007 and 2008). Sampling locations for both recontamination monitoring and post-dredge monitoring are provided in Map 2-2. The current surface sediment conditions in this area are most accurately represented by the recontamination monitoring dataset. Further investigation of the sediment beneath the sand layer will be conducted as part of the subsurface sediment investigation in 2009. The final remedial decision for this area will be informed by both the surface and subsurface data.

Table 2-1. Sediment characterization investigations conducted in the EW since 1995

Event	Sampling Dates	Collection Method	Analytes[a]	Surface Sediment Samples[b]	TBT Porewater[b]	Bioassays[b]	Source
PSAMP sampling	June 2007	0.1-m^2 van Veen	SMS, dioxins and furans	3	0	0	preliminary data
EW – recontamination monitoring 2007	February 7, 2007	0.1-m^2 van Veen	DMMP	6	0	0	Windward (2008b)
EW – Slip 27	January 10 and 12, 2007	0.1-m^2 van Veen and vibracorer	SMS, pesticides, TBT	7	0	0	Windward (2007a)
EW – recontamination monitoring 2006	January 12, 23, and 24, 2006	0.1-m^2 van Veen	DMMP	5	0	0	Windward (2007b)
USCG (Pier 36-37 slip and Berth Alpha)	May 11, 2005	0.1-m^2 van Veen	SMS	13	0	0	Hart Crowser (2005)
Phase 1A removal post-dredge monitoring	January 25 to March 1, 2005	0.1-m^2 van Veen	SMS, DMMP	52	20	0	Anchor and Windward (2005)
EW/Harbor Island nature and extent – Phases1 and 2	September 25 to 28, 2001	0.1-m^2 van Veen	SMS, DMMP	84[c]	42	40	Windward (2002)
T-18 – post-dredge monitoring	March 29, 2000	0.1-m^2 van Veen	SMS, DMMP	13	7	9	Windward (2001)
Pier 36 – underpier (pier modification?)	October 23 and 24, 1996	ponar grab	SMS	3	0	0	Tetra Tech (1996)
King County CSO 96	September 24 to 30, 1996	0.1-m^2 van Veen	SMS	4	0	4	King County (1996)
King County CSO 95	June 26 to 29, 1995	0.1-m^2 van Veen	SMS	6	0	0	King County (1995)
Harbor Island SRI	March 10 to 23, 1995	0.1-m^2 van Veen and vibracorer	SMS	3	0	1	EVS (1996a, b)

[a] SMS analytes included PCBs, SVOCs,VOCs, metals (arsenic, cadmium, chromium, copper, lead, mercury, silver, zinc), TOC, and grain size. DMMP analytes included PCBs, pesticides, SVOCs, TBT, metals (antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc), TOC, and grain size.

[b] The total number of samples analyzed as part of the original investigation within the proposed EW SRI/FS study boundary, excluding dredged samples and samples that did not meet minimum QA/QC criteria.

[c] Samples were collected from 42 locations within the EW boundary. Unhomogenized sediment for VOC analysis was given a unique sample identifier, different than thecorresponding homogenized sample submitted for other chemical analyses.

CSO – combined sewer overflow

DMMP – Dredged Material Management Program

EW – East Waterway

FS – feasibility study

PCB – polychlorinated biphenyl

PSAMP – Puget Sound Ambient Monitoring Program

QA – quality assurance

QC – quality control

RI – remedial investigation

SMS – Washington State Sediment Management Standards

SRI – supplemental remedial investigation

SVOC – semivolatile organic compound

T-18 – Terminal 18

TBT – tributyltin

TOC – total organic carbon

USACE – US Army Corps of Engineers

VOC – volatile organic compound

There are two dredge events and a piling removal project scheduled to be completed in February, 2009. The area in front of Terminal 30 will be dredged (Map 2-1) and post-dredge monitoring samples will be collected for analysis. In addition, small mounds of material will be removed from an area off the pierhead line of Terminal 18 (T-18) (Map 2-1). Finally, Washington State Department of Natural Resources is conducting a piling removal in the area south of Slip 36.

In addition to the samples collected during the events listed in Table 2-1, composite surface sediment samples were collected as part of the clam survey and benthic invertebrate sampling in July/August and October 2008, respectively (Map 2-3). The composite samples were created from several grab samples and therefore do not represent a specific location. However, the chemical concentrations in the composites samples represent an average concentration for all the locations represented in the composite. The sampling design presented in Section 3.1 is intended to fill remaining data needs for the SRI.

2.2.2 Sediment toxicity testing

The benthic invertebrate community is one of the receptors of concern identified in the ERA (Anchor et al. 2008). In addition, benthic invertebrates are important prey items for fish and wildlife that forage in the EW. Risks to the benthic community will primarily be assessed through comparison of sediment chemical concentrations to the SQS and CSL and by conducting site-specific toxicity testing of sediment samples (Windward 2004b). [2]

As identified in the CSM and data gaps report (Anchor et al. 2008), additional site-specific toxicity testing data are needed to assess risks to benthic invertebrates. The objective of the toxicity testing is to assess potential effects of EW site sediments on benthic invertebrates through the use of site-specific toxicity testing and synoptic sediment chemistry. These standardized tests are surrogate measures to estimate potential effects on benthic organisms in the EW. As per SMS, site-specific toxicity testing supersedes SMS chemical concentration comparisons in cases where the SMS status of the sample differs between the chemical concentrations and the toxicity evaluation . A substantial amount of surface sediment bioassay data has been collected in the EW over the past 13 years (Map 2-4 and Table 2-1), but only five studies have conducted sediment toxicity tests using surface sediments during that time. Therefore, additional site-specific toxicity testing will be conducted.

[2] Risks from TBT will be assessed using a critical tissue approach and evaluation of imposex in neo- and mesogastropods. To supplement the SMS risk evaluation for PCBs and mercury, a critical tissue approach will also be used.

2.3 PROJECT/TASK DESCRIPTION AND SCHEDULE

The sampling of surface sediment will be initiated following EPA's approval of this QAPP. This section provides an overview of the sampling and analysis activities and schedule for the surface sediment investigation. A detailed sampling design is presented in Section 3.1.

Sediment samples will be collected in two rounds in early 2009 for chemical analysis, and a subset of these samples will be tested for site-specific toxicity following SMS guidelines. Sediment will be collected in two rounds for two reasons. First, this approach enables the analytical and toxicity testing laboratories to better accommodate the total number of samples by allowing them to stagger the analyses or tests. Second, this approach makes it possible for the results of the first round of toxicity testing to be considered in determining which samples should be tested for toxicity in the second round (see Section 3.1.3). Within each round, the samples will be divided into groups to enable the laboratory to stagger the initiation of the toxicity tests.

Sediment sampling is scheduled to begin in March 2009. The Round 1 samples will be chemically analyzed at ARI for the analytes specified in Sections 3.1.1 and 3.4.1, with a turn-around time of 3 weeks.[3] Upon receipt of the unvalidated chemical data, EWG and EPA with input from the stakeholders will determine within approximately 1 week which of the samples should be tested for toxicity, based primarily on a comparison of the sediment chemical concentrations with the SQS and CSLs (see Section 3.1.3). Splits of these sediment samples will then be tested for toxicity within the maximum sediment holding times for toxicity tests (8 weeks). The initiation times of the toxicity tests will be staggered in two groups, with each containing 15 to 20 samples (for a total of up to 30 toxicity test samples in the first round). Thirty toxicity tests represent the maximum number of tests that can be initiated within the 4 weeks timeframe which is dictated by sediment holding time (8 weeks), which is reduced by the analytical time (3 weeks) plus 1 week for the selection of bioassay samples.

A second round of sediment sampling is scheduled to begin in June, 2009. Similar to the first round, the Round 2 samples will be chemically analyzed, and unvalidated data will be received within 3 weeks. Upon receipt of these data, along with preliminary results from the Round 1 toxicity testing, EWG and EPA will determine within approximately 1 week which of the Round 2 sediment samples will be tested for toxicity. Splits of these sediment samples will then be tested for toxicity within the maximum sediment holding times for toxicity tests (8 weeks).

[3] The turn-around time may be less than 3 weeks, but 3 weeks is assumed for planning purposes in the event that sediments need secondary cleanup prior to chemical analyses.

PCB congener, dioxin and furan, and high-resolution pesticide analyses will be conducted on composite samples created from the individual grab samples. In addition, these samples will be analyzed for Aroclors. The composite samples will be created following the completion of Round 2. The method for creating subtidal composite samples is detailed in Section 3.1.2. The rational for the creation of intertidal composites is detailed in Section 3.1.3.The composite samples will be created for chemical analysis only and will not be submitted for bioassay testing.

A timeline for each round of testing is presented in Figure 2-2. This timeline is approximate and subject to change but is presented to illustrate the tight time constraints for all parties involved. This schedule allows for the retesting of bivalve larvae and possibly some of the amphipods within the 8-week sediment holding time, if needed due to test QA failures, but will not likely allow for retesting of the polychaete growth test due to the duration of this test (see Section 3.5.2 for rationale for retesting).

ID	Task Name	Start	Finish
1	**Round 1**	**Mon 3/2/09**	**Thu 6/4/09**
2	Round I sediment collection	Mon 3/2/09	Thu 3/12/09
3	Chemical analysis (a)	Tue 3/3/09	Mon 3/30/09
4	Preliminary chemistry results	Tue 3/31/09	Tue 3/31/09
5	Data summary to EWG and EPA	Mon 4/13/09	Mon 4/13/09
6	Meeting with EWG and EPA	Mon 4/20/09	Mon 4/20/09
7	Group A 48-hr bivalve larvae tests	Wed 4/22/09	Thu 4/23/09
8	Group A 10-d amphipod tests	Wed 4/22/09	Fri 5/1/09
9	Group A 20-d polychaete tests	Wed 4/22/09	Mon 5/11/09
10	Group B 48-hr bivalve larvae tests	Mon 4/27/09	Tue 4/28/09
11	Group B 10-d amphipod tests	Mon 4/27/09	Wed 5/6/09
12	Group B 20-d polychaete tests	Mon 4/27/09	Fri 5/15/09
13	Group C 48-hr bivalve larvae tests	Thu 4/30/09	Fri 5/1/09
14	Group C 10-d amphipod tests	Thu 4/30/09	Sun 5/10/09
15	Group C 20-d polychaete tests	Thu 4/30/09	Wed 5/20/09
16	Receive preliminary 48-hr test results	Fri 5/15/09	Fri 5/15/09
17	Receive preliminary 10-d test results	Mon 5/25/09	Mon 5/25/09
18	Receive preliminary 20-d test results	Thu 6/4/09	Thu 6/4/09
19	Sediment holding time for first sediment samples collected	Mon 3/2/09	Thu 5/21/09
20	Sediment holding time for last sediment samples collected	Wed 3/11/09	Mon 6/1/09
21	**Round 2**	**Fri 5/1/09**	**Thu 7/30/09**
22	Round 2 sediment collection	Fri 5/1/09	Sun 5/10/09
23	Chemical analysis (a)	Tue 5/5/09	Thu 6/4/09
24	Preliminary chemistry results	Thu 6/4/09	Thu 6/4/09
25	Data summary to EWG and EPA	Thu 6/11/09	Thu 6/11/09
26	Meeting with EWG and EPA	Thu 6/18/09	Thu 6/18/09
27	Group A 48-hr bivalve larvae tests	Fri 6/19/09	Mon 6/22/09
28	Group A 10-d amphipod tests	Fri 6/19/09	Mon 6/29/09
29	Group A 20-d polychaete tests	Fri 6/19/09	Wed 7/8/09
30	Group B 48-hr bivalve larvae tests	Wed 6/24/09	Thu 6/25/09
31	Group B 10-d amphipod tests	Wed 6/24/09	Thu 7/2/09
32	Group B 20-d polychaete tests	Wed 6/24/09	Tue 7/14/09
33	Group C 48-hr bivalve larvae tests	Sat 6/27/09	Mon 6/29/09
34	Group C 10-d amphipod tests	Sat 6/27/09	Tue 7/7/09
35	Group C 20-d polychaete tests	Sat 6/27/09	Wed 7/15/09
36	Receive preliminary 48-hr test results	Mon 7/13/09	Mon 7/13/09
37	Receive preliminary 10-d test results	Tue 7/21/09	Tue 7/21/09
38	Receive preliminary 20-d test results	Wed 7/29/09	Wed 7/29/09
39	Sediment holding time for first sediment samples collected	Fri 5/1/09	Tue 7/21/09
40	Sediment holding time for last sediment samples collected	Mon 5/11/09	Thu 7/30/09

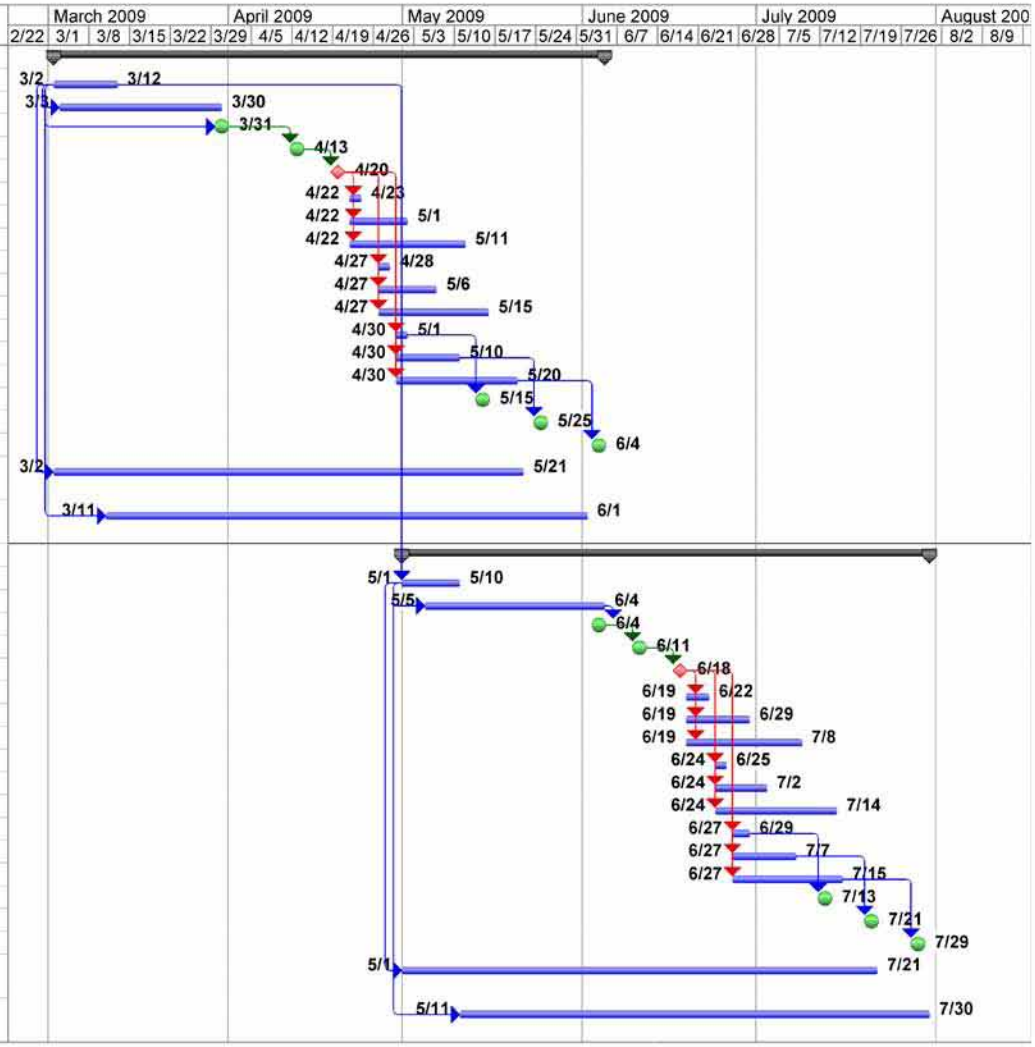

Figure 2-2. Approximate surface sediment testing timeline

One draft data report with the results of the validated chemical analyses and toxicity tests for both rounds will be submitted to EPA approximately 10 weeks after the conclusion of the second round of toxicity testing to allow for data validation and report preparation and review. All PCB congener and dioxin and furan data will be submitted with the data report.

2.4 DATA QUALITY OBJECTIVES AND CRITERIA

The overall data quality objective (DQO) for this project is to develop and implement procedures that will ensure the collection of representative data of known, acceptable, and defensible quality sufficient for use in the SRI/FS. Parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity. These parameters are discussed, and specific data quality indicators (DQIs) for sediment chemistry analysis and toxicity testing are presented in Sections 3.4.1.2 and 3.4.2.2, respectively.

2.5 SPECIAL TRAINING/CERTIFICATION

The Superfund Amendments and Reauthorization Act of 1986 required the Secretary of Labor to issue regulations providing health and safety standards and guidelines for workers engaged in hazardous waste operations. The federal regulation 29CFR1910.120 requires training to provide employees with the knowledge and skills enabling them to perform their jobs safely and with minimum risk to their personal health. All sampling personnel will have completed the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training course and 8-hour refresher courses, as necessary, to meet the Occupational Safety and Health Administration regulations.

2.6 DOCUMENTATION AND RECORDS

The following sections describe documentation and records needed for field observations and laboratory analyses.

2.6.1 Field observations

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

The following forms, included as Appendix B, will also be used to record pertinent information after sample collection:

- Surface sediment collection form
- Protocol modification form

2.6.2 Laboratory records

The various laboratory record requirements for the sediment chemistry data and the sediment toxicity test data are described below. All of the contract laboratories to be used for this investigation are accredited by the Washington State Department of Ecology (Ecology) to conduct the sediment chemical analyses and toxicity tests.

2.6.2.1 Chemistry data for sediment samples

The chemistry laboratory will be responsible for internal checks on sample handling and analytical data reporting and will correct any errors identified during the QA review. The laboratory data package 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 analysis. The summary will include, but not be limited to, a discussion of QC, sample shipment, sample storage, and analytical difficulties. Any problems encountered by the laboratory, and their resolutions, will be documented in the project narrative.
- **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 code and the corresponding laboratory identification code
  - Sample matrix
  - Date of sample extraction/digestion
  - Date and time of analysis
  - Weight and/or volume used for analysis
  - Final dilution volumes or concentration factor for the sample
  - Percent moisture in the samples
  - Identification of the instruments used for analysis
  - Method detection limits (MDLs) and reporting limits (RLs)
  - 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 as that required for the sample results (see above). The laboratory will make no recovery or blank corrections. The required summaries are listed below.
  - 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), RPDs, and retention time for each analyte will be listed, as appropriate. Results for standards analyzed at the RL to determine 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 matrix spike (MS) recovery summary will report the MS or MS duplicate (MSD) recovery data for analyses, as appropriate. The names and concentrations of all compounds added, percent recoveries, and QC limits will be included in the data package. The RPD for all MS/MSD analyses will be reported.
  - The laboratory replicate summary will report the RPD for all laboratory replicate analyses. The QC limits for each compound or analyte will be listed.
  - The standard reference material (SRM) analysis summary will report the results and recoveries of the SRM analyses and list the accuracy, as defined in Section 3.4.2, for each analyte, when available.
  - The laboratory control sample (LCS) analysis summary will report the results of the analyses of the LCS. The QC limits for each compound or analyte will be included in the data package.
  - 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.
- **Original data –** Legible copies of the original data generated by the laboratory will be provided, including the following:
  - Sample preparation, extraction/digestion, and cleanup logs

- Instrument analysis logs for all instruments used on days of calibration and analysis
- Chromatograms for all samples, blanks, calibration standards, MS/MSD, laboratory replicate samples, LCS, and SRM samples for all gas chromatography analyses
- Reconstructed ion chromatograms of target chemicals detected in the field samples and method blanks for all gas chromatography-mass spectrometry (GC/MS) analyses
- Enhanced and unenhanced spectra of target chemicals detected in field samples and method blanks, with associated best-match spectra and background-subtracted spectra, for all GC/MS analyses.
- Quantitation reports for each instrument used, including reports for all samples, blanks, calibrations, MS/MSD, laboratory replicates, LCS, and SRMs

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 is 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, 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.

2.6.2.2 Sediment toxicity test data

The toxicity testing laboratory will be responsible for internal checks on sample handling and analytical data reporting and will correct any errors identified during the QA review (see Section 3.5.2). Close contact will be maintained with the laboratory to resolve any QC problems in a timely manner. The laboratory data package 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 the toxicity testing process. The summary will include, but not be limited to, discussion of QC, sample shipment, and identification difficulties.
- **Records –** Legible copies of the 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 contain the results for each sample analyzed, including the following information:
  - Field sample identification code and the corresponding laboratory identification code
  - Test methods used for toxicity testing and summary statistics
  - Source (including collection location) for all test organisms
  - Source (location) for reference sediment collection
  - Results for survival, growth, abnormalities, water quality parameters, reference toxicants, and summary statistics
  - Original QC checklists
- **QA/QC summary –** The summary will contain the results of the QA/QC procedures, and any corrective actions required.
- **Original data –** Legible copies of the original data generated by the laboratory will be provided, including the following:
  - Original data sheets for survival, growth, and abnormalities for all test replicates
  - Water quality parameters
  - Reference toxicants
  - Summary statistics for all samples

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

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

Field Name	Required or Optional
Event name	required
COC ID	required
Laboratory sample ID	required
Sample collection date and time	required
Test type	required
Replicate number	required
Water quality measurement results	required
Individual replicate and mean and standard deviation data for larval percent mortality	required
Individual replicate and mean and standard deviation data for larval percent abnormality	required
Individual replicate and mean and standard deviation data for larval percent combined mortality and abnormality	required
Larval stocking density, stocking aliquot size, and initial count data for seawater controls	required

Field Name	Required or Optional
Daily amphipod emergence for each replicate and 10-day mean and standard deviation for each treatment	required
10-day amphipod mortality in each replicate and the mean and standard deviation for each treatment	required
Interstitial water salinity values for control, reference, and test sediments for amphipods and polychaetes	required
20-day polychaete survival in each exposure chamber and the mean and standard deviation for each treatment	required
Initial polychaete total biomass (dry weight) for three groups of five worms	required
20-day total polychaete biomass (dry weight) in each exposure chamber and the mean and standard deviation for each treatment	required
20-day polychaete average individual biomass (dry weight) in each exposure chamber and the mean and standard deviation for each treatment	required
Average polychaete individual growth rate (dry weight/day) in each exposure chamber and the mean and standard deviation for each treatment	required
LC50 values for reference toxicants	required
Current control limits for reference toxicants (mean ± 2 standard deviations)	required
Laboratory notes	optional
Laboratory	required

COC – chain of custody

ID – identification

LC50 – concentration that is lethal to 50% of an exposed population

2.6.3 Data reduction

Data reduction is the process by which original data are converted or reduced to a specified format or unit to facilitate the analysis of the data. For example, a final analytical concentration may need to be calculated from a diluted sample result, or mean mortality may need to be calculated from five replicate toxicity test results. Data reduction requires that all aspects of sample preparation that could affect the test result, such as sample volume analyzed or dilutions required, be taken into account in the final result. It is the laboratory analyst's responsibility to reduce the data, which are subjected to further review by the laboratory PM, the Windward PM, the project QA/QC coordinator, and independent reviewers. The data will be generated in a form amenable to review and evaluation. Data reduction may be performed manually or electronically. If performed electronically, all software used must be demonstrated to be true and free from unacceptable error.

During chemical analysis, samples are occasionally diluted after the initial analysis if the estimated concentration curve for one or more of the target analytes is above the calibration curve. In these instances, concentrations from the initial analysis will be identified as the "best result" for all target analytes other than the chemical(s) that was originally above the calibration range. The "best result" for this qualified analyte(s) will be taken from the diluted sample.

2.6.4 Data report

A data report documenting all activities associated with the collection, handling, and analysis of samples, for both chemistry and toxicity testing for both rounds of sampling will be prepared. At a minimum, the following will be included in the data report:

- Summary of all field activities, including descriptions of any deviations from the approved QAPP
- Summary spreadsheet containing information from field forms
- Sediment sampling locations reported in latitude and longitude to the nearest one-tenth of a second and in northing and easting to the nearest foot
- Plan view of the project showing the actual sampling locations
- Documentation of how toxicity testing locations were selected
- Summary of the QA/QC review of the analytical and toxicity test data
- Statistical analysis of the toxicity test data in accordance with SMS rules and papers associated with Sediment Management Annual Review Meetings
- Complete laboratory toxicity test reports (appendices)
- Data validation reports (appendices)
- Results from the analysis of field samples, including the frequency of detection; minimum, maximum, median, and average concentrations (in summary tables and the main body of the report); and appendices with data forms submitted by the laboratories and as crosstab tables produced from Windward's database
- Data will be compared to analytical concentration goals and RLs above the analytical concentration goals will be identified. The reasons that the RLs exceeded the analytical goals will be provided.

Analytical and toxicity test data will be validated within 4 weeks of the receipt of data packages from the laboratories. A draft data report will be submitted to EPA approximately 10 weeks after the validation of the final round of sediment toxicity testing. The final data report will be submitted to EPA following revision of the data report in response to comments. 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 a format compatible with Ecology's Environmental Information Management System, which consists of separate tables for events, locations, samples, and results. Data will also be provided to EPA in Microsoft Access®. Any relevant geographic information system (GIS) files will also be transmitted to EPA.

3 Data Generation and Acquisition

This section describes the collection and handling of sediment samples for chemical analysis and toxicity testing. Elements include sampling design, sampling methods, sample handling and custody requirements, analytical methods, field QA/QC, instrument/equipment testing and frequency, inspection and maintenance, instrument calibration, supply inspection/acceptance, non-direct measurement, and data management.

3.1 SAMPLING DESIGN

This section describes the sampling designs developed to meet the data needs presented in Section 2.2 for the placement of surface sediment samples, the chemical analyses of these samples, and toxicity testing.

3.1.1 Surface sediment samples

This section describes considerations for selecting surface sediment sampling locations. Note that in addition to the sample collection described in this QAPP, 12 composite surface sediment samples were collected in the EW synoptically with benthic invertebrate tissue samples in October 2008, as described in the benthic invertebrate QAPP (Windward 2004a). The benthic invertebrate sediment composites were made up of sediment from locations where benthic invertebrate tissue was found. The sediment samples represent the 0-to-10-cm interval for those locations. Five composite surface sediment samples were also collected in the EW with clams during the clam survey (Windward 2004a), which were collected at all locations where clams were collected. The clam sediment samples were not restricted to the top 10 cm of sediment. The collection of sediment samples with benthic invertebrate and clam tissue samples resulted in a total of 17 additional composite sediment samples (Map 2-3).

Five primary factors were used to determine where additional surface sediment chemistry data would be collected, in addition to the 17 composite surface sediment samples described above. Each of the surface sediment chemistry sampling locations described in Table 3-1 and presented in Map 3-1a and 3-1b is based on the consideration of at least one of five factors; many locations are based on multiple factors. A brief description of the judgment applied for each is provided below.

- **Low historical spatial coverage –** New locations under this consideration were placed in areas with relatively few historical samples. The areas in the southern end of EW in the vicinity of the Spokane Street bridge and near the northern boundary were not well characterized, and several locations were identified in each of these areas.

- **Special use area –** These areas were limited to intertidal habitat that could potentially be used by humans and/or certain ecological receptors (e.g., juvenile Chinook salmon).
- **Proximity to potential chemical sources –** Identification of potential chemical sources was based on existing information and the preliminary source control investigations of waterfront properties and outfalls.
- **Additional characterization of elevated chemical concentrations or reporting limits –** New sampling locations were placed in areas where one or more samples had concentrations or reporting limits in excess of the CSL, or where small groups of samples had concentrations or reporting limits in excess of the SQS. Additional data from nearby locations not previously sampled will provide important information to better characterize these areas.

  The primary reason for detection limits elevated above SMS values is sample dilution due to elevated concentrations of target analytes which results in elevated detection limits for the remainder of the compounds. In the case of pesticides, analytical interferences resulting from the presence of PCB congeners results in elevated reporting limits for the organochlorine pesticides. The additional characterization of areas with detection limits above the SQS or CSL is warranted, particularly in areas with multiple samples with RLs above SMS.
- **Analyte considerations –** Some chemical groups (e.g., TBT, and chlorinated pesticides) have been analyzed less frequently than have SMS chemicals, so additional data collection is warranted to better characterize the distribution of these chemicals. In addition, no surface sediment samples from the EW have been analyzed for PCB congeners, and the dioxin/furan congener data is very limited; three samples were collected and analyzed for these compounds in 2007 under the PSAMP program (Ecology, 2008). Dioxin and furans, PCB congeners, and high-resolution pesticide analyses will be conducted with subtidal composite samples and intertidal multi-increment sampling (MIS) composite samples.

Table 3-1. Proposed surface sediment chemistry sampling locations

Location ID	Sampling Round	Factors Considered in Placing Locations					Rationale or Goal
		Low Spatial Coverage	Special Use Area	Proximity to Potential Chemical Source	Additional Characterization of Elevated Chemical Concentration	Analyte Considerations[a]	
EW09-SS-001	1	X			X		potentially the area of highest flood scour, and bounds historical CSL exceedances
EW09-SS-002	2	X	X	X			intertidal location, area of potential recreational clamming
EW09-SS-003	1	X			X	X	characterize southern end of waterway in the vicinity of elevated PAH and TBT concentrations in historical samples
EW09-SS-004	2	X	X	X			intertidal location, area of potential recreational clamming
EW09-SS-005	1	X			X		historical CSL exceedance for phenol
EW09-SS-006	2	X	X	X	X	X	characterize southern end of waterway in the vicinity of elevated PAH and TBT concentrations in historical samples, proximate to rockfish collection location
EW09-SS-007	2	X	X		X		intertidal location, area of potential recreational clamming
EW09-SS-008	1	X	X	X			intertidal location, area of potential recreational clamming

Location ID	Sampling Round	Factors Considered in Placing Locations					Rationale or Goal
		Low Spatial Coverage	Special Use Area	Proximity to Potential Chemical Source	Additional Characterization of Elevated Chemical Concentration	Analyte Considerations[a]	
EW09-SS-009	2	X			X		potentially the area of highest flood scour, and bounds historical CSL exceedances
EW09-SS-010	2	X	X	X			intertidal location, area of potential recreational clamming
EW09-SS-011	1	X			X	X	characterizes southern end of waterway , reoccupy a location with CSL exceedance for PCBs
EW09-SS-012	2	X			X		potentially the area of highest flood scour, and bounds historical CSL exceedances
EW09-SS-013	1	X		X		X	characterize southern end of waterway, area of elevated TBT porewater concentrations, provides spatial coverage near Outfall 5
EW09-SS-014	1	X			X		reoccupy historical exceedance of the SQS for total PCBs
EW09-SS-015	2	X	X	X		X	intertidal location, area of potential recreational clamming
EW09-SS-016	2	X	X				T-25 area has not been sampled historically, future restoration area, intertidal sample
EW09-SS-017	2	X			X		reoccupy historical exceedance of the SQS for total PCBs

Location ID	Sampling Round	Factors Considered in Placing Locations					Rationale or Goal
		Low Spatial Coverage	Special Use Area	Proximity to Potential Chemical Source	Additional Characterization of Elevated Chemical Concentration	Analyte Considerations[a]	
EW09-SS-018	2	X	X				T-25 area has not been sampled historically, future restoration area, intertidal sample
EW09-SS-019	1	X			X		reoccupy historical exceedance of the SQS for total PCBs
EW09-SS-020	1	X					T-25 area has not been sampled historically, future restoration area,
EW09-SS-021	1	X				X	characterize southern end of waterway, area with total DDT concentrations above the SL
EW09-SS-022[b]	2	X	X	X	X		under-pier sample proximate to rockfish collection location, near historical location with SQS exceedance for PCBs
EW09-SS-023	1	X		X		X	characterize southern end of waterway, area with total DDT concentrations above the SL
EW09-SS-024	1	X			X	X	reoccupy historical location with SQS exceedance for mercury and CSL exceedance for BEHP, area with total DDT concentrations above the SL
EW09-SS-025	1	X			X	X	reoccupy historical location with SQS exceedance for total PCBs

Location ID	Sampling Round	Factors Considered in Placing Locations					Rationale or Goal
		Low Spatial Coverage	Special Use Area	Proximity to Potential Chemical Source	Additional Characterization of Elevated Chemical Concentration	Analyte Considerations[a]	
EW09-SS-026	2	X			X	X	reoccupy historical location with SQS exceedances for total PCBs and mercury
EW09-SS-027[b]	1	X	X	X			under-pier sample proximate to rockfish collection location, near Hinds CSO
EW09-SS-028	2	X		X			spatial coverage near Outfalls 7 and 8
EW09-SS-029	1	X					characterize southern end of waterway
EW09-SS-030	1	X			X		characterize southern end of waterway
EW09-SS-031	1	X					characterize southern end of waterway
EW09-SS-032	1	X					characterize southern end of waterway
EW09-SS-033	1	X			X	X	proximate to historical sample with SQS exceedances for mercury and PCBs, elevated sediment TBT concentrations
EW09-SS-034	1	X		X			near Hanford CSO, near area of SQS and CSL exceedances for mercury, PCBs, BEHP and elevated PAHs
EW09-SS-035	1	X		X			spatial coverage near Outfalls 9 and 10
EW09-SS-036	1					X	reoccupy historical location with SQS exceedance for PCBs. area with elevated TBT concentrations

Location ID	Sampling Round	Factors Considered in Placing Locations					Rationale or Goal
		Low Spatial Coverage	Special Use Area	Proximity to Potential Chemical Source	Additional Characterization of Elevated Chemical Concentration	Analyte Considerations[a]	
EW09-SS-037	2			X			spatial coverage near Hanford CSO
EW09-SS-038[b]	1	X	X	X			under-pier sample proximate to rockfish collection location, near Hanford CSO
EW09-SS-039	2	X					increase spatial coverage in southern portion of the waterway
EW09-SS-040	2	X					increase spatial coverage in southern portion of the waterway
EW09-SS-100[b]	1	X	X	X			under-pier sample proximate to rockfish collection location
EW09-SS-101	1			X			reoccupy historical location near Hanford CSO with CSL exceedances for mercury, PCBs, and BEHP
EW09-SS-102	1	X		X			T-18 location, dredged in 2006, no post-dredge samples
EW09-SS-103	2	X		X	X		location between Hanford CSO and Slip 27 not historically sampled
EW09-SS-104	1	X			X		Slip 27 location, proximate to historical exceedances of CSL for PCBs, PAHs, and mercury
EW09-SS-105	2	X		X	X	X	Slip 27 location, proximate to historical exceedances of CSL for PCBs, PAHs, and mercury

Location ID	Sampling Round	Factors Considered in Placing Locations					Rationale or Goal
		Low Spatial Coverage	Special Use Area	Proximity to Potential Chemical Source	Additional Characterization of Elevated Chemical Concentration	Analyte Considerations[a]	
EW09-SS-106	2	X	X			X	Slip 27 location, intertidal location, elevated sediment TBT, non-detected DDT result above the SL
EW09-SS-107	2	X	X			X	intertidal sample, potential clam collection area, area with elevated sediment TBT concentrations
EW09-SS-108	2	X		X			T-18 location, dredged in 2006, no post-dredge samples
EW09-SS-109	1	X	X		X		spatial coverage in the center of Slip 27, outside of berth dredge area
EW09-SS-110	1	X	X		X		Slip 27 location; proximate to historical exceedances of CSL for PCBs, PAHs, and mercury; associated with rockfish collection
EW09-SS-111	1	X		X			T-18 location near historical location with SQS exceedance for PCBs
EW09-SS-112	2	X	X				Slip 27 location, area previously characterized with 0-to-2-cm samples
EW09-SS-113	1	X			X	X	Slip 27 location; area previously characterized with 0-to-2-cm samples; proximate to historical exceedances of the CSL for PCBs, BEHP, non-detected DDT result above the SL

Location ID	Sampling Round	Factors Considered in Placing Locations					Rationale or Goal
		Low Spatial Coverage	Special Use Area	Proximity to Potential Chemical Source	Additional Characterization of Elevated Chemical Concentration	Analyte Considerations[a]	
EW09-SS-114[b]	1	X	X	X			T-18 under-pier location, co-located with rockfish sample, dredged in 2006 with no post-dredge samples
EW09-SS-115	2	X		X			spatial coverage near Lander
EW09-SS-116	1	X			X		near Stage 1 post-dredge monitoring location with CSL exceedance for mercury and SQS exceedance for PCBs
EW09-SS-117[b,c]	1	X	X	X			under-pier location, near rockfish collection location, near Lander outfall
EW09-SS-118	2	X			X	X	near Stage 1 post-dredge monitoring location with CSL exceedance for mercury and SQS exceedance for PCBs; area with non-detected total DDT results above the SL
EW09-SS-119	1	X			X		near Stage 1 post-dredge monitoring location with CSL exceedance for mercury and SQS exceedance for PCBs
EW09-SS-120	1	X					Stage 1 dredge area not previously sampled
EW09-SS-121	2	X			X		center channel area, which has not been dredged; SQS exceedances for mercury, BEHP, PCBs and elevated TBT in samples from this area

Location ID	Sampling Round	Factors Considered in Placing Locations					Rationale or Goal
		Low Spatial Coverage	Special Use Area	Proximity to Potential Chemical Source	Additional Characterization of Elevated Chemical Concentration	Analyte Considerations[a]	
EW09-SS-122	1	X			X	X	center channel area, which has not been dredged; SQS exceedances for mercury, BEHP, PCBs and elevated TBT in samples from this area
EW09-SS-123	2	X			X	X	center channel area, which has not been dredged; SQS exceedances for mercury, BEHP, PCBs and elevated TBT in samples from this area
EW09-SS-124	2	X		X	X	X	center channel area, which has not been dredged; SQS exceedances for mercury, BEHP, PCBs and elevated TBT in samples from this area
EW09-SS-125	2	X					additional spatial coverage at utility crossing
EW09-SS-126[b]	1	X	X	X			under-pier sample, near rockfish sampling location
EW09-SS-127	1	X			X	X	reoccupy historical location with CSL exceedance for total PCBs
EW09-SS-128	2	X					additional spatial coverage at utility crossing
EW09-SS-129	1	X		X			intertidal location, area not previously sampled
EW09-SS-130	1	X			X		near historical location with CSL exceedance for PCBs and SL exceedance for TBT in porewater

Location ID	Sampling Round	Factors Considered in Placing Locations					Rationale or Goal
		Low Spatial Coverage	Special Use Area	Proximity to Potential Chemical Source	Additional Characterization of Elevated Chemical Concentration	Analyte Considerations[a]	
EW09-SS-131	2	X					near historical location with CSL exceedance for PCBs and SL exceedance for TBT in porewater
EW09-SS-132	1	X	X				post-dredge monitoring location for T-18 dredging
EW09-SS-133	2	X	X				post-dredge monitoring location for T-18 dredging
EW09-SS-134	2	X					further spatial coverage in area that has not been dredged recently
EW09-SS-200	1	X				X	further spatial coverage in area that has not been dredged recently
EW09-SS-201	2	X					further spatial coverage in area that has not been dredged recently
EW09-SS-202	1	X		X			spatial coverage near Outfalls 24 and 25
EW09-SS-203	2	X		X		X	near historical CSL exceedances for total PCBs, area of elevated TBT sediment concentrations
EW09-SS-204	1	X	X			X	intertidal area, proximate to areas of elevated PAH concentrations
EW09-SS-205	2	X		X		X	near historical CSL exceedances for total PCBs, area of elevated TBT sediment concentrations
EW09-SS-206	2	X	X				intertidal area, proximate to areas of elevated PAH concentrations

Location ID	Sampling Round	Factors Considered in Placing Locations					Rationale or Goal
		Low Spatial Coverage	Special Use Area	Proximity to Potential Chemical Source	Additional Characterization of Elevated Chemical Concentration	Analyte Considerations[a]	
EW09-SS-207	1	X		X			spatial coverage near Outfalls 24 and 25
EW09-SS-208	2	X	X	X			intertidal area, proximate to areas of elevated PAH concentrations
EW09-SS-209	2	X			X		spatial coverage near GATX
EW09-SS-210	2	X		X			spatial coverage near Kinder-Morgan facility
EW09-SS-211[b]	1	X	X				T-18 under-pier location near rockfish collection location
EW09-SS-212	2	X					area dredged in Stage 1 event completed in 2000, not previously sampled
EW09-SS-213	2	X		X	X		USCG slip, near location with CSL exceedance for indenopyrene, elevated total PAHs
EW09-SS-214	2	X			X	X	USCG slip, near location with CSL exceedance for acenapthene, elevated total PAHs
EW09-SS-215	2	X				X	USCG slip, area with SQS exceedances for total PCBs
EW09-SS-216	1	X					spatial coverage outside of US Coast Guard facility
EW09-SS-217	1	X					northern boundary location, not previously sampled
EW09-SS-218	1	X				X	northern boundary location, not previously sampled

Location ID	Sampling Round	Factors Considered in Placing Locations					Rationale or Goal
		Low Spatial Coverage	Special Use Area	Proximity to Potential Chemical Source	Additional Characterization of Elevated Chemical Concentration	Analyte Considerations[a]	
EW09-SS-219[b]	1	X	X				under-pier location, near rockfish collection location, near Connecticut Street outfall
EW09-SS-220	1	X					northern boundary location, not previously sampled
EW09-SS-221	2	X					northern boundary location, not previously sampled
EW09-SS-222	2	X					northern boundary location, not previously sampled
EW09-SS-223	2	X					northern boundary location, not previously sampled

[a] Analyte considerations include the need for additional data on specific chemicals or chemical groups,

[b] Underpier samples

[c] Sediment archived from sampling July 22 and 23rd, 2008 in this area (Anchor 2008) will be analyzed in order to characterize sediment prior to 2008-2009 dredging which will be consistent with the exposure of the rockfish collected in the summer of 2008. Sample has been archived frozen and will be analyzed within holding times for all analytes (except mercury).

BBP – butyl benzyl phthalate

BEHP – bis(2-ethylhexyl)phthalate

CSO – combined sewer overflow

DL – detection limit

LPAH – high-molecular-weight polycyclic aromatic hydrocarbon

ML – maximum level

NAPL – non-aqueous phase liquid

PAH – polycyclic aromatic hydrocarbon

PCP – pentachlorophenol

SIM – selected ion monitoring

SL – screening level

SVOC – semivolatile organic compound

T-18 – Terminal 18

TBT – tributyltin

USCG – US Coast Guard

WQC – Water quality criteria

Based on the above considerations, a total of 99 surface sediment samples are the focus of this QAPP and are presented in Table 3-1 and shown on Maps 3-1a and 3-1b (located at end of this document). The sample numbering scheme is based on dividing the waterway into three sections, the sample locations in the southern third of the waterway are numbered 1 to 99, the sample locations in the middle third of the waterway are numbered 100 to 199, and the sample locations in the northern third are numbered 200 to 300. Based on a rate of one field quality control sample per 20 samples collected, 5 field duplicate samples and 5 rinsate blank samples will also be collected. The locations of the field duplicate samples and rinsate blank samples will be selected at the discretion of the FC.

The coordinates and elevations of surface sediment samples proposed for collection as part of the SRI/FS are provided in Table 3-2. The calculated mean nearest neighbor distance from the historical surface sediment sample locations and the proposed surface sediment locations is 106 ft with a range of 0-298 ft which is comparable to the mean nearest neighbor distance for the LDW of 73ft with a range of 1-621ft. Chemicals to be analyzed in each of the 99 surface sediment samples specified in this QAPP are described later in this section (Section 3.1.2).

Table 3-2. Surface sediment sampling location coordinates

Location	Sampling Round	X Coordinate[a]	Y Coordinate[a]	Latitude[b]	Longitude[b]	Estimated Depth Above (+) or Below (-) MLLW (ft)[c]
EW09-SS-001	1	1267030	211463	47.569655	122.345977	na
EW09-SS-002	2	1267119	211479	47.569704	122.345618	na
EW09-SS-003	1	1267015	211559	47.569919	122.346045	na
EW09-SS-004	2	1267174	211679	47.570255	122.345412	na
EW09-SS-005	1	1267065	211700	47.570307	122.345854	na
EW09-SS-006	2	1267010	211801	47.570581	122.346086	na
EW09-SS-007	2	1267344	211945	47.570994	122.344743	na
EW09-SS-008	1	1267006	211959	47.571013	122.346116	na
EW09-SS-009	2	1267171	212029	47.571213	122.345451	na
EW09-SS-010	2	1267383	212081	47.571367	122.344595	na
EW09-SS-011	1	1267088	212098	47.571399	122.345793	na
EW09-SS-012	2	1267217	212146	47.571537	122.345273	na
EW09-SS-013	1	1267077	212278	47.571892	122.345853	-14
EW09-SS-014	1	1267323	212298	47.571960	122.344857	-10
EW09-SS-015	2	1267387	212335	47.572065	122.344599	0
EW09-SS-016	2	1267596	212475	47.572459	122.343766	na
EW09-SS-017	2	1267330	212592	47.572766	122.344852	-34
EW09-SS-018	2	1267697	212791	47.573332	122.343382	na
EW09-SS-019	1	1267466	212736	47.573168	122.344313	-38

Location	Sampling Round	X Coordinate[a]	Y Coordinate[a]	Latitude[b]	Longitude[b]	Estimated Depth Above (+) or Below (-) MLLW (ft)[c]
EW09-SS-020	1	1267599	212819	47.573402	122.343781	-24
EW09-SS-021	1	1267286	212830	47.573415	122.34505	-20
EW09-SS-022	2	1267125	212919	47.573650	122.34571	na
EW09-SS-023	1	1267744	212960	47.573797	122.343204	-48
EW09-SS-024	1	1267409	213064	47.574064	122.34457	-38
EW09-SS-025	1	1267166	213065	47.574054	122.345554	-36
EW09-SS-026	2	1267674	213068	47.574089	122.343497	-40
EW09-SS-027	1	1267846	213088	47.574154	122.342803	na
EW09-SS-028	2	1267073	213157	47.574300	122.345940	-40
EW09-SS-029	1	1267199	213378	47.574914	122.345444	-40
EW09-SS-030	1	1267509	213404	47.575003	122.344192	-44
EW09-SS-031	1	1267796	213552	47.575423	122.343042	-48
EW09-SS-032	1	1267438	213694	47.575792	122.344501	-44
EW09-SS-033	1	1267168	213772	47.575992	122.345602	-40
EW09-SS-034	1	1267730	213822	47.576159	122.343330	-52
EW09-SS-035	1	1267081	213932	47.576425	122.345967	-40
EW09-SS-036	1	1267451	213969	47.576547	122.344472	-44
EW09-SS-037	2	1267626	214038	47.576744	122.343770	-48
EW09-SS-038	1	1267842	214046	47.576780	122.342895	-28
EW09-SS-039	2	1267162	212555	47.572655	122.345532	-14
EW09-SS-040	2	1267752	213333	47.574821	122.343203	-46
EW09-SS-100	1	1267027	214201	47.577159	122.34621	-24
EW09-SS-101	1	1267835	214262	47.577371	122.342939	-36
EW09-SS-102	1	1267150	214469	47.577900	122.345729	-52
EW09-SS-103	2	1267787	214525	47.578089	122.343154	-50
EW09-SS-104	1	1268359	214566	47.578233	122.340841	-20
EW09-SS-105	2	1268392	214696	47.578589	122.340716	-38
EW09-SS-106	2	1268158	214725	47.578657	122.341669	na
EW09-SS-107	2	1267935	214849	47.578985	122.342583	1
EW09-SS-108	2	1267146	214907	47.579103	122.345780	-52
EW09-SS-109	1	1268102	214916	47.579178	122.341910	-36
EW09-SS-110	1	1268241	215015	47.579457	122.341354	-18
EW09-SS-111	1	1267196	215035	47.579455	122.345589	-54
EW09-SS-112	2	1267987	215125	47.579744	122.342393	-40
EW09-SS-113	1	1267798	215150	47.579803	122.343160	-36
EW09-SS-114	1	1267049	215411	47.580476	122.346216	-20
EW09-SS-115	2	1267805	215433	47.580578	122.343156	-46
EW09-SS-116	1	1267257	215759	47.581443	122.345400	-54

Location	Sampling Round	X Coordinate[a]	Y Coordinate[a]	Latitude[b]	Longitude[b]	Estimated Depth Above (+) or Below (-) MLLW (ft)[c]
EW09-SS-117	1	1267889	215855	47.581741	122.342849	-24
EW09-SS-118	2	1267363	215923	47.581897	122.344985	-54
EW09-SS-119	1	1267535	216180	47.582611	122.344309	-54
EW09-SS-120	1	1267238	216343	47.583043	122.345523	-54
EW09-SS-121	2	1267499	216420	47.583267	122.344473	-54
EW09-SS-122	1	1267192	216667	47.583929	122.345737	-52
EW09-SS-123	2	1267534	216741	47.584149	122.344355	-54
EW09-SS-124	2	1267335	216885	47.584534	122.345173	-58
EW09-SS-125	2	1267276	217256	47.585546	122.345444	-58
EW09-SS-126	1	1267086	217296	47.585647	122.346214	-24
EW09-SS-127	1	1267422	217317	47.585722	122.344855	-56
EW09-SS-128	2	1267627	217355	47.585838	122.344029	-56
EW09-SS-129	1	1267910	217491	47.586226	122.342893	-28
EW09-SS-130	1	1267279	217523	47.586278	122.345452	-56
EW09-SS-131	2	1267490	217547	47.586355	122.344598	-56
EW09-SS-132	1	1267117	215721	47.58133	122.345966	-46
EW09-SS-133	2	1267097	214637	47.578359	122.345961	na
EW09-SS-134	2	1267658	217679	47.592209	122.344088	-54
EW09-SS-200	1	1267828	217834	47.587160	122.343254	-36
EW09-SS-201	2	1267454	217834	47.58714	122.344765	-54
EW09-SS-202	1	1267156	217860	47.587195	122.345975	-52
EW09-SS-203	2	1267252	218104	47.587871	122.345608	-60
EW09-SS-204	1	1267802	218285	47.588395	122.343392	-42
EW09-SS-205	2	1267257	218379	47.588623	122.345609	-56
EW09-SS-206	2	1267911	218526	47.589063	122.342971	na
EW09-SS-207	1	1267172	218574	47.589155	122.345967	-52
EW09-SS-208	2	1268027	218687	47.589508	122.342514	na
EW09-SS-209	2	1267826	218789	47.589779	122.343335	-38
EW09-SS-210	2	1267238	218821	47.589834	122.345721	-54
EW09-SS-211	1	1267133	218823	47.589835	122.346148	-32
EW09-SS-212	2	1267657	218838	47.589904	122.344024	-56
EW09-SS-213	2	1268348	218906	47.590128	122.341230	-36
EW09-SS-214	2	1268121	218951	47.590237	122.342152	-38
EW09-SS-215	2	1268990	218971	47.590340	122.338634	na
EW09-SS-216	1	1267849	219059	47.590520	122.343265	-42
EW09-SS-217	1	1267274	219269	47.591066	122.345611	-56
EW09-SS-218	1	1267443	219327	47.591234	122.344932	-56
EW09-SS-219	1	1267974	219385	47.591420	122.342784	-26

Location	Sampling Round	X Coordinate[a]	Y Coordinate[a]	Latitude[b]	Longitude[b]	Estimated Depth Above (+) or Below (-) MLLW (ft)[c]
EW09-SS-220	1	1267776	219554	47.591872	122.343598	-54
EW09-SS-221	2	1267683	219341	47.591284	122.343960	-54
EW09-SS-222	2	1267915	219529	47.591812	122.343034	-49
EW09-SS-223	2	1267927	219710	47.592309	122.343000	na

[a] Coordinates are in Washington State Plane N, NAD83, US ft.

[b] Coordinates are in decimal degrees, NAD83.

[c] Depth estimated from recent bathymetry data (Windward and DEA 2004).

MLLW – mean lower low water

na – not applicable (due to no bathymetry data at these locations)

3.1.2 Subtidal composite sampling

In addition to the discrete surface sediment grab samples described above, subtidal composite sediment samples will be collected for the analysis of dioxins and furans and PCB congeners, and high resolution pesticide analysis. There are very limited existing surface sediment data for dioxins and furans and no data for PCB congeners in surface sediment in the EW. The assessment of risks due to direct contact resulting from netfishing will be evaluated on a site wide basis, as is appropriate given the nature of this activity and the size of the EW. A site wide evaluation of netfishing for EW is consistent with the selection of a site wide scale for evaluation of netfishing for the LDW(EPA 2006) which is larger than EW. Therefore, estimation of PCB TEQ and dioxin/furan TEQ risks associated with netfishing requires an estimate of the site-wide exposure to dioxins and furans and PCB TEQ congeners. The advantage of analyzing composite rather than individual grabs is that each composite sample integrates a larger area and provides a better estimate of the average concentration within the area.

The site has been divided into 13 areas for the creation of composites (Map 3-6). An aliquot of sediment will be reserved from a minimum of 8 grabs will be used to create a single composite for each area. The results from the analysis of the 13 areas can be used to calculate site-wide exposure based on the 95th UCL for direct contact exposure for netfishing as well as sediment ingestion for wildlife.

The method chosen for computation of a subtidal sediment 95th UCL will follow EPA guidance. Use of a 95th UCL rather than an average will compensate for uncertainty in the dioxin/furan TEA in subtidal sediments. Further, even though the subtidal sampling approach is not MIS sampling, the compositing approach taken will result in a better understanding of the dioxin/furan TEQ in sediments than would have occurred if only a few individual grabs had been taken. The number of subtidal composite samples taken for the EW project reflects a balance between the cost of sample collection and the need to obtain sufficient information to conduct the risk assessment. Both the intertidal and subtidal efforts are designed to produce estimates

of the average concentration of contaminants in relevant exposure units, though they differ in approach.

In order to ensure that the entire site area is represented in the composite samples, an additional 19 grab samples have been located to provide coverage in areas in which surface grabs were not proposed due to the availability of historical data for SMS chemicals in these areas (i.e., the Phase 1 dredged area). These grabs will be collected during the Round 2 sampling and will only be used for subtidal composite samples.

Sediment from all the Round 1 samples will be archived until the completion of the Round 2 sampling at which time the composite samples will be created from all the sample locations.

3.1.3 Multi-increment sampling in intertidal areas

In addition to the nine grab samples proposed for the intertidal areas (Sample 2, 4, 7, 10, 16, 18, 106, 107, and 208), additional sampling will be conducted in order to create MIS samples to be used to characterize the exposure of humans due to direct contact with intertidal sediments (tribal clamming, 7 –days-per year clamming, and habitat restoration). MIS has been developed by EPA in the context of soil screening guidance (USEPA 2006). Simply, it is a method for pooling individual increments within a decision unit to create a multi-incremental (composite) sample.

Each MIS sample is created from samples collected at 30 locations. In order to assess the variability around the result, multiple samples from the same decision unit should be created (USEPA 2006). There will be two MIS approaches employed for intertidal exposure evaluation. One will be for tribal clamming and habitat restoration and the other will be for 7-days-per-year clamming.

Given the frequency assumed for the reasonably maximally exposed tribal clamming scenarios (120 days per year) and habitat restoration worker (15 days per year) and the limited size of EW intertidal areas, direct contact exposure for tribal clamming and habitat restoration will be evaluated on a site-wide basis. This is consistent with the decision to evaluate tribal clamming exposure on a site-wide basis for the LDW (EPA 2006), which has much more extensive intertidal areas than the EW. For the EW, three MIS composites are proposed for the site-wide intertidal sediments. The variance calculated from the three samples can be used to calculate a confidence interval around the mean result. This will require a minimum total of 90 locations throughout the EW based on a systematic random sampling design. In addition, one MIS composite will be created to characterize the intertidal area for the 7-days-per-year recreational clamming scenario, which will include only areas of the intertidal zone which are accessible to the public from upland areas or can be reached by walking along the intertidal zone at low tide (Windward 2008a). The locations for the individual samples within the intertidal areas as well as the protocols to be used in creating the MIS sample will be provided in an addendum to this QAPP. The intertidal sampling will be conducted as a component of the Round 2 sampling. The

addendum will be provided to EPA and stakeholders and approved by EPA prior to the commencement of the Round 2 sampling.

The purpose of the MIS samples will be to estimate the average intertidal concentrations of all COCs for direct-contact scenarios. Individual grab samples collected within the intertidal area will be assessed for the purposes of the benthic risk evaluation.

3.1.4 Chemical analyses of surface sediment grab samples

Chemical data collected from the locations listed in Table 3-1 will satisfy multiple objectives and will be used for multiple purposes in the EW SRI. including the characterization of the nature and extent of sediment chemical concentrations and providing the sediment data necessary to characterize human and ecological exposure within EW**.**

Existing data do not fully address all SMS compounds or all chemicals relevant to the HHRA and the ERA. Therefore, each sample will be analyzed for multiple chemicals. At a minimum, every surface sediment grab sample from the EW will be analyzed for all SMS chemicals and conventional parameters. In addition, samples from select locations will be analyzed for additional chemicals (i.e., organochlorine pesticides, and butyltins) as described in this section. The conventional parameters to be analyzed are sediment grain size, TOC, total sulfides, ammonia, and total solids. Grain-size data will be useful in the interpretation of sediment transport and are needed for additional habitat characterization and the selection of appropriate toxicity test species and associated reference samples. TOC data are needed to calculate organic carbon normalized concentrations of some organic compounds so that they can be compared to the SQS or CSL.

Sulfides and ammonia may adversely affect some bioassay test organisms, so data are needed for these parameters in samples that will be tested for toxicity to correctly interpret the results. NAS will analyze ammonia in the bulk sediment and sulfides in the overlying water that will be added to the sediment sample at the laboratory. Reference samples used in toxicity testing will also be analyzed for grain size, TOC, total sulfides, and ammonia. Total solids data are needed to correctly report sediment chemistry data on a dry weight basis.

Some samples will also be analyzed for specific chemicals or chemical groups that have been analyzed less frequently than SMS chemicals in the EW. Table 3-3 provides the rationale for analyzing organochlorine pesticides and/or bulk TBT in sediment, in addition to SMS chemicals, at specific locations. The grab samples will be analyzed for pesticides using EPA method 8082. This method is prone to analytical interference due to the presence of PCB congeners. The results will be used to assess benthic risk due to exposure to pesticides. The composite samples (subtidal and intertidal) will be analyzed using a high-resolution pesticide method, which can quantify the pesticide concentrations without interference from PCB pesticides. The results from the

composite samples will be used to assess risk to humans and wildlife due to exposure to sediment pesticide concentrations.

Table 3-4. Surface sediment chemistry analyses

Sampling Round	Location	SMS Chemicals[a]	Organo-chlorine Pesticides[b]	TBT[c]	Rationale
1	EW09-SS-001	X			
2	EW09-SS-002	X			
1	EW09-SS-003	X		X	area with limited sediment TBT data[d]
2	EW09-SS-004	X		X	area with limited sediment TBT data[d]
1	EW09-SS-005	X			
2	EW09-SS-006	X		X	area with limited sediment TBT data[d]
2	EW09-SS-007	X			
1	EW09-SS-008	X	X		area with limited pesticide data
2	EW09-SS-009	X			
2	EW09-SS-010	X		X	area with limited sediment TBT data
1	EW09-SS-011	X	X		reoccupy location with nondetected exceedance of the SL for total DDTs
2	EW09-SS-012	X			
1	EW09-SS-013	X	X	X	area with limited sediment TBT and pesticide data
1	EW09-SS-014	X			
2	EW09-SS-015	X	X		area with limited pesticide data
2	EW09-SS-016	X			
2	EW09-SS-017	X			
2	EW09-SS-018	X			
1	EW09-SS-019	X			
1	EW09-SS-020	X			
1	EW09-SS-021	X	X		area with limited pesticide data
2	EW09-SS-022	X		X	area with limited sediment TBT data
1	EW09-SS-023	X	X		area with limited pesticide data
1	EW09-SS-024	X		X	reoccupy location with porewater TBT above the SL
1	EW09-SS-025	X			
2	EW09-SS-026	X			
1	EW09-SS-027	X			
2	EW09-SS-028	X			
1	EW09-SS-029	X		X	area with limited sediment TBT data
1	EW09-SS-030	X	X	X	area with limited pesticide and sediment TBT data
1	EW09-SS-031	X			
1	EW09-SS-032	X			

Sampling Round	Location	SMS Chemicals[a]	Organo-chlorine Pesticides[b]	TBT[c]	Rationale
1	EW09-SS-033	X	X	X	area with limited pesticide and sediment TBT data[c]
1	EW09-SS-034	X		X	area with limited sediment TBT data
1	EW09-SS-035	X			
1	EW09-SS-036	X		X	proximate to location with elevated sediment TBT
2	EW09-SS-037	X			
1	EW09-SS-038	X	X		proximate to detected exceedances of the SL for total DDTs
2	EW09-SS-039	X			
2	EW09-SS-040	X			
1	EW09-SS-100	X			
1	EW09-SS-101	X			
1	EW09-SS-102	X			
2	EW09-SS-103	X			
1	EW09-SS-104	X			
2	EW09-SS-105	X	X	X	limited sediment TBT and pesticide data in Slip 27
2	EW09-SS-106	X	X	X	limited sediment TBT and pesticide data in Slip 27
2	EW09-SS-107	X		X	proximate to location with elevated sediment TBT
2	EW09-SS-108	X		X	area with limited sediment TBT data
1	EW09-SS-109	X			limited sediment TBT and pesticide data in Slip 27
1	EW09-SS-110	X	X		limited pesticide data in Slip 27
1	EW09-SS-111	X			
2	EW09-SS-112	X			
1	EW09-SS-113	X	X	X	limited sediment TBT and pesticide data in Slip 27
1	EW09-SS-114	X			
2	EW09-SS-115	X		X	area with limited sediment TBT data
1	EW09-SS-116	X			
1	EW09-SS-117	X	X		area with limited pesticide data
2	EW09-SS-118	X	X	X	near three locations with non-detected total DDT above the SL, area with limited sediment TBT data
1	EW09-SS-119	X		X	area with limited sediment TBT data
1	EW09-SS-120	X			
2	EW09-SS-121	X			
1	EW09-SS-122	X	X	X	area with limited sediment pesticide and TBT data,
2	EW09-SS-123	X	X	X	area with limited sediment pesticide and TBT data,

Sampling Round	Location	SMS Chemicals[a]	Organo-chlorine Pesticides[b]	TBT[c]	Rationale
2	EW09-SS-124	X	X	X	area with limited sediment pesticide and TBT data,
2	EW09-SS-125	X			
1	EW09-SS-126	X			
1	EW09-SS-127	X		X	reoccupy location with elevated sediment TBT concentration
2	EW09-SS-128	X			
1	EW09-SS-129	X	X	X	near location with nondetected SL exceedance for total DDTs
1	EW09-SS-130	X			
2	EW09-SS-131	X			
1	EW09-SS-132	X			
2	EW09-SS-133	X		X	area with limited sediment TBT data
2	EW09-SS-134	X			
1	EW09-SS-200	X	X	X	area with limited sediment TBT data, historical nondetected SL exceedances for total DDTs
2	EW09-SS-201	X		X	area with limited sediment TBT data
1	EW09-SS-202	X			
2	EW09-SS-203	X	X	X	near locations with nondetected exceedances for total DDTs, area with no sediment TBT data
1	EW09-SS-204	X	X	X	near locations with nondetectedSL exceedance for total DDTs, area with no sediment TBT data
2	EW09-SS-205	X	X	X	near locations with nondetected exceedances for total DDTs, with no sediment TBT data
2	EW09-SS-206	X	X		near location with nondetected SL exceedances for total DDTs
1	EW09-SS-207	X		X	area with limited sediment TBT data
2	EW09-SS-208	X	X		near location with SL exceedance for total DDTs
2	EW09-SS-209	X			
2	EW09-SS-210	X			
1	EW09-SS-211	X			
2	EW09-SS-212	X		X	area with limited sediment TBT data
2	EW09-SS-213	X	X		area with limited pesticide data
2	EW09-SS-214	X		X	area with limited sediment TBT data
2	EW09-SS-215	X		X	area with limited sediment TBT data
1	EW09-SS-216	X		X	area with limited sediment TBT data
1	EW09-SS-217	X			
1	EW09-SS-218	X		X	area with limited sediment TBT data
1	EW09-SS-219	X			
1	EW09-SS-220	X	X	X	area with no historical pesticide or TBT data
2	EW09-SS-221	X			
2	EW09-SS-222	X			
2	EW09-SS-223	X			

Sampling Round	Location	SMS Chemicals[a]	Organo-chlorine Pesticides[b]	TBT[c]	Rationale
	Total	99	**27**	**38**	
	Round 1	55	**16**	**19**	
	Round 2	44	**11**	**19**	

[a] All samples will be analyzed for all SMS chemicals at a minimum. A subset of samples will be analyzed for additional chemical groups as indicated in this table.

[b] Pesticides results for discrete samples will be used in the eco-risk evaluation, the results of the high-res analysis of the subtidal composite samples will be used in the human health risk assessment.

[c] TBT will be analyzed in bulk sediment and will not be analyzed in interstitial water.

[d] Historical data that was not of sufficient quality to be included in the SRI/FS dataset included elevated sediment TBT concentrations near these locations.

ML – maximum level
PCB – polychlorinated biphenyl
SL – screening level
SMS – Washington State Sediment Management Standards
SQS – sediment quality standards
TBT – tributyltin

All sample locations are shown in Maps 3-1a and 3-1b with the SMS exceedances in the historical dataset. Sample locations proposed for TBT analysis are presented in Map 3-3a and 3-3b. Sample locations proposed for pesticide analysis are presented in Map 3-4a and 3-4b with the historical total DDT data.

The selection of samples to be analyzed for these additional chemicals or chemical groups will be based on the following general considerations: the existence of data that show elevated concentrations of these chemicals or chemical groups in surface sediment samples from surrounding locations or the presence of relatively large areas where no such data exist. Considerations specific to each chemical or chemical group are described below. In addition, following the review of the Round 1 data, additional samples may be proposed for specific analytes such as TBT as determined in consultation with EPA and trustee agencies.

TBT

Reconnaissance-level data for TBT have previously been collected and analyzed at approximately 26 locations within the EW, as shown in Map 3-3a and 3-3b. The primary considerations for selecting locations for TBT sampling in the EW are to provide spatial coverage throughout the waterway, as well as additional characterization in areas with elevated TBT concentrations and proximity to potential TBT sources. Thirty-five additional surface sediment sampling locations have been selected for bulk TBT analysis in sediment (Map 3-2a and 3-2b). TBT will not be analyzed in the porewater. Porewater data within the waterway was collected primarily for DMMP characterization of sediments proposed for dredged material disposal. The risk associated with exposure to TBT for the benthos will be assessed using a tissue-residue approach (Windward and Anchor 2008).

Organochlorine Pesticides

Approximately 110 locations that were sampled for chlorinated pesticides (e.g., DDT) are included in the historical chemistry database that will be used in the SRI. Some

spatial data gaps in the overall characterization of the EW remain, and some areas with elevated concentrations of DDT, which is generally used as a surrogate for chlorinated pesticides for the purposes of this QAPP, warrant additional characterization. As presented in Table 3-4 and shown on Maps 3-3a and 3-3b, 27 of the 99 surface sediment sampling locations will be analyzed for chlorinated pesticides. The considerations used to identify locations for pesticide analysis include proximity to previously sampled location with either a maximum level (ML) or screening level (SL)[4] exceedance for total DDTs based on a detected result or reporting limit associated with a nondetected result and the existence of a pesticide spatial data gap. The analysis of organochlorine pesticides has likely been complicated by the presence of PCBs in the samples. The presence of PCBs frequently results in elevated RLs as well as the false identification of pesticides in samples containing PCBs.

3.1.4 cPAHs and Arsenic

Carcinogenic PAHs (cPAHs) and arsenic are chemicals that were sediment COCs for the LDW. The existing surface sediment data for cPAHs (Map 3-4a and 3-4b) and arsenic (Map 3-5a and 3-5b) are presented on a concentration basis because there is no SMS value for cPAHs and all the surface sediment arsenic concentrations in EW are below the arsenic SQS value.

3.1.5 Chemical analyses of subtidal composite sediment samples

Subtidal composite samples will only be analyzed for dioxins and furans, PCB congeners, PCB Aroclors and pesticides by the high resolution method. The sediment concentrations of these analytes will be used in the assessment of the TEQ and pesticide risks to humans due to direct contact resulting from netfishing throughout the waterway. In addition, TEQ and pesticide risks resulting from the ingestion of sediment by fish and wildlife will be characterized with these data.

3.1.6 Chemical analyses of intertidal MIS sediment samples

Intertidal MIS samples will be analyzed for the complete SMS list as well as dioxins and furans, PCB congeners, and pesticides by the high resolution method. The data will be used in the assessment of risk to humans due to direct contact resulting from clamming (tribal and 7-day clamming) and habitat restoration work. The direct contact exposure is an average over the intertidal sediment throughout the entire waterway for the tribal clamming scenario and the habitat restoration worker scenario. The 7-day clamming scenario requires an average exposure over a smaller area. The average of limited number of intertidal grab samples would provide a highly uncertain estimate

[4] The SL and ML are part of the Dredged Material Management Program (DMMP) sediment quality guidelines. These values are used for the evaluation of DDT because no SQS or CSL exists for this chemical.

of the area-wide average. The MIS approach integrates a large number of samples and reduces the uncertainty associated with the estimate of the area-wide average.

3.1.7 Summary of proposed surface sediment samples by analyte

Table 3-5 summarizes the number of surface sediment samples in the dataset for all chemical classes and provides the number of proposed surface sediment samples. The proposed samples include surface sediment grab samples, subtidal composite samples and intertidal MIS samples.

Table 3-5 Summary of existing data and proposed sediment samples

Chemical Class	Existing Surface Sediment Samples	Proposed Surface Sediment Samples
Metals and Trace Elements		
Antimony	49	103[a]
Arsenic	111	103[a]
Cadmium	102	103[a]
Chromium	108	103[a]
Cobalt	6	103[a]
Copper	111	103[a]
Lead	111	103[a]
Mercury	151	103[a]
Molybdenum	5	103[a]
Nickel	92	103[a]
Selenium	14	103[a]
Silver	102	103[a]
Thallium	13	103[a]
Vanadium	6	103[a]
Zinc	111	103[a]
Organometals (TBT)	23 (TBT)	38
PAHs[a]	136	103[a]
Phthalates[a]	122-123	103[a]
Other SVOCs[a]	9-147	103[a]
Total PCBs (Aroclors)	160	115[b]
Total PCBs (congeners)	none	17[c]
Pesticides[a]	DDTs – 110 samples other pesticides – 5-51 samples	44[b]
Dioxins and Furans	3 PSAMP samples	17[c]

[a] Includes 95 surface sediment grab samples and 4 intertidal sediment MIS samples

[b] Includes surface sediment grabs and 4 intertidal MIS samples and 13 subtidal composite samples

[c] Includes 4 intertidal MIS samples and 13 subtidal composite samples

3.1.5 Sediment toxicity testing

Site-specific toxicity testing facilitates the assessment of risk to the benthic invertebrate community through the direct measurement of toxicity in standardized laboratory toxicity tests. Toxicity tests will be conducted following the SMS guidance regarding toxicity testing using sediment samples from locations with SQS or CSL exceedances. The identification of locations for toxicity testing will be made in consultation with EPA and the stakeholders. The bioassay testing is being conducted in accordance with the state SMS standards. The results of the bioassay testing are a line of evidence in the assessment of risk to benthic communities in the ERA. The benthic toxicity data do not address risk associated with bioaccumulative chemicals in fish tissue or human health risks. Sediment toxicity testing will not be conducted on the sediment samples collected by divers at the underpier locations due to the limited sample volume that can be collected using hand cores.

Sediment toxicity is the primary line of evidence for assessing risks to the benthic invertebrate community. This LOE will be based on both predictions and measures of toxicity. Surface sediment chemistry results will be compared to the effects-based SMS to assess the likelihood that sediment-bound contaminants are impacting benthic invertebrates. Chemistry results below the Sediment Quality Standard (SQS) will be interpreted as unlikely to cause a deleterious effect; concentrations above the Cleanup Screening Level (CSL) will identify samples that have a high likelihood of impacts to the benthic community. Sediment concentrations between the SQS and CSL will be indicative of a potential for moderate impacts. Laboratory bioassays will assess toxicity to representative species of the benthic community and will provide direct evidence of toxicity (assuming test conditions and other environmental factors are controlled for). The selection of bioassay test locations will focus on areas where moderate impacts are predicted; results at these locations will take precedence over chemistry results for the purposes of the benthic risk assessment.

Two rounds of surface sediment sampling for toxicity testing will be conducted. As discussed in Section 2.3, sediment will be collected in two rounds so that the analytical and toxicity testing laboratories can better accommodate the total number of samples and the results of the first round of toxicity testing can be used in determining which samples should be tested for toxicity in the second round, as discussed below.

Fifty five locations will be sampled for sediment chemistry in the first round of sampling. These locations have been selected to provide spatial coverage throughout the waterway and to inform the placement of Round 2 locations in areas that have not been previously sampled (i.e. the northern boundary area). Sufficient sediment will be collected at each location to conduct both chemical analyses and toxicity testing. Sediment samples will be homogenized, and split samples will be created for each location. Split samples will be submitted to ARI for the analysis of chemicals specified in Table 3-3 and for archiving for the creation of composite samples for dioxins and

furans and PCB congeners (see Section 3.1.2). Additional split samples will be sent to NAS for toxicity testing.

When the chemical data from the Round 1 sampling locations are received from ARI, the unvalidated data will be evaluated by EWG and EPA, who will meet approximately 1 week after receipt of the data to determine which locations will be tested for toxicity to benthic invertebrates. Locations will be selected based on several considerations:

- Toxicity tests will be not be conducted at the sediment locations with no exceedances of the SQS unless a unique sample matrix is identified that would warrant toxicity testing
- Toxicity tests will be conducted primarily at locations with SQS exceedances. Locations with CSL exceedances will be considered and selected for testing based on the specific chemical exceeding the CSL.
- Locations with a high likelihood of failing toxicity tests based on chemistry results will not be submitted for toxicity testing and risks will be based on the chemistry results.
- Proximity of sampling locations to others with similar chemical groups that exceed SQS
- Proximity to potential or known sources.

The toxicity laboratories will be informed of which samples to test, and the chemical data for all locations will then be submitted for validation. SMS biological effects criteria will be used to identify exceedances of individual tests as well as the overall exceedance for the location (PSEP 1995).

The surface sediment sampling locations not sampled in Round 1 will be sampled in Round 2 approximately 8 weeks after the first round of sampling. The results of the Round 1 sampling will be reviewed prior to the Round 2 sampling in order to ensure that the Round 2 locations are appropriate given the Round 1 results. Any amendments to the sampling design will be documented in a QAPP amendment. When the chemical data from this second round of sampling are available, locations for the second round of toxicity testing will be selected in consultation with EPA based on a comparison of chemical concentrations to the SQS and CSLs, and the results of the first round of toxicity testing. Thus, if any relationships between observed toxicity and sediment chemistry are identified in the first round of toxicity testing, this information can be used to select the most appropriate locations for the second round of toxicity testing.

3.2 SAMPLING METHODS

This section describes the methods for surface sediment sampling. There may be contingencies during field activities that require modification of the general procedures outlined below. The modification of procedures will be at the discretion of

the FC after consultation with the Windward PM and the boat operator, if applicable. EPA will be consulted immediately in the event that significant deviation from the sampling design is required (e.g., significant relocation of a sample). All modifications will be recorded in the field logbook and on the protocol modification form.

3.2.1 Identification scheme for all locations and samples

Each surface sediment sampling location will be assigned a unique alphanumeric location identification (ID) number. The first characters of the location ID are "EW" to identify the EW project area, or "CI" to indicate Carr Inlet (reference location for toxicity samples). The project area designation is followed by "09" to identify the year in which the sample was collected. The next characters are "SS" to indicate the type of sample collected (surface sediment), followed by a consecutive number identifying the specific location within the EW or Carr Inlet.

The sample ID will be similar to the location ID but will include"CS" to identify subtidal composite samples and "MS" to identify the intertidal MIS sample and a suffix of "010" to indicate that sediment sample is from the 0-to-10-cm depth interval. For example, the sediment sample collected at location EW09-SS-001 will be identified as EW09-SS-001-010. Field duplicates will be identified using location numbers starting with 300. For example, the field duplicate at EW09-SS-001 would be identified as EW09-SS-300-010.

Rinsate blanks, as described in Section 3.5.1, will be assigned the same characters as the sampling location identifier, followed by the identifier "RB." For example, the rinsate blank collected at EW09-SS-001 would be EW09-SS-001-RB.

3.2.2 Location positioning

Target sampling locations will be located using a Trimble NT300D differential global positioning system (DGPS). The DGPS includes a global positioning system (GPS) receiver unit onboard the sampling vessel and a USCG beacon differential receiver. The GPS unit will receive radio broadcasts of GPS signals from satellites. The USCG beacon receiver will acquire corrections to the GPS signals to produce positioning accuracy to within 1 to 2 m.

Northing and easting coordinates of the vessel will be updated every second and displayed directly on a computer onboard the vessel. The coordinates will then be processed in real time and stored at the time of sampling using the positioning data management software package. Washington State Plane Coordinates, North, North American Datum 1983 (NAD83) will be used for the horizontal datum. The vertical datum will be National Ocean Service mean lower low water (MLLW) datum. Vertical control will be provided by the ship's depth finder and corrected for tidal influence after sampling has been completed. Tidal elevation will be determined by calling the National Ocean Service for data from their automated tide gage located at Pier 54. At intertidal locations sampled on shore at low tide, vertical elevations will be estimated

by noting the tide level at the time of sampling, along with the approximate elevation of the sampling location relative to the water level.

To ensure the accuracy of the navigation system, a checkpoint will be located at a known point such as a pier face, dock, piling, or similar structure that is accessible by the sampling vessel. At the beginning and end of each day, the vessel will be stationed at the check point, a GPS position reading will be taken, and the reading will be compared with the known land-survey coordinates. The two position readings should agree, within the limits of survey vessel operational mobility, to within 1 to 2 m.

3.2.3 Surface sediment collection

Surface sediment grab sample collection

Surface sediment grab sample collection and processing will follow standardized procedures for the Puget Sound area that have been developed by the Puget Sound Estuary Program (PSEP) (1997). Surface sediments will be collected from each location shown in Map 3-1a and 3-1b using a double 0.1-m^2 van Veen grab sampler from a sampling vessel, if feasible. Some intertidal locations may be too shallow to access from the sampling vessel, in which case surface sediments will be sampled from the shoreline during low tide (e.g., EW09-SS-004, EW09-SS-005, EW0-SS-006, EW09-SS-007, and EW09-SS-008).

Sediment from the 0-to-10-cm depth interval will be collected to represent the biologically active horizon and to allow a direct comparison with sediment collected during previous surface sediment studies in the EW. Sediment grab samples that are comprised of gravel will be rejected. Multiple grab samples at a given location are likely to be necessary so that sufficient sediment volume is available for toxicity testing.

The surface sediment samples will be collected using a double van Veen grab sampler as described in the following steps:

Using GPS, maneuver the sampling vessel to the sampling location.

1. Open the grab sampler jaws to the deployment position.
2. Guide the sampler overboard until it is clear of the vessel.
3. Using GPS, position the sampling vessel such that the GPS receiver is within 1 to 2 m of the target sampling location.
4. Lower the sampler through the water column to the bottom at a speed of approximately 0.3 m/s.
5. Record the GPS location of the boat when the sampler reaches the bottom.
6. Record the water depth and time.
7. Retrieve the sampler, raising it at approximately 0.3 m/s.

8. Guide the sampler aboard the vessel and place it on the work stand on the deck, taking care to avoid jostling that might disturb the integrity of the sample.
9. Examine the sample using the following sediment acceptance criteria:
    - Sample is contains sediment, samples that are predominately gravel will be rejected.
    - Sediment is not extruded from the upper face of the sampler.
    - Overlying water is present (indicating minimal leakage).
    - The sediment surface is relatively flat (indicating minimal disturbance or winnowing).
    - A penetration depth of at least 11 cm has been achieved.

If these sample acceptance criteria are not met, the sample will be rejected. If an acceptable grab sample cannot be obtained in three attempts, the sampling location will be moved as close as possible to the original target location but no further than 10 m away. If it is not possible to obtain a sample at this second location, EPA will be consulted to discuss repositioning the station.

After sample acceptance, the following observations will be noted in the field logbook:

- GPS location
- Depth as read by the boat's depth sounder
- Gross characteristics of the surficial sediment, including texture, color, biological structures, odor, and presence of debris or oily sheen
- Gross characteristics of the vertical profile (i.e., changes in sediment characteristics and redox layer, if visible)
- Maximum penetration depth (nearest 0.5 cm)
- Comments relative to sample quality

For intertidal locations that must be sampled from the shoreline, sediment will be collected by scooping sediment from a depth of 10 cm with a dedicated, clean, stainless steel spoon.

A minimum of 7 L of sediment will be collected at each location. Sediment for sulfide analysis will be removed from the first grab sample (prior to homogenization in order to reduce sulfide loss from volatilization) and placed, leaving no headspace, into the appropriate sample container with preservative, prior to the homogenization of the remaining sediments. The remaining sediment from the first grab and subsequent grabs at each location will be transferred directly from the sampler into a pre-cleaned stainless steel bowl or cauldron and stirred with a dedicated clean, stainless steel spoon or spatula until texture and color homogeneity have been achieved (PSEP 1997). For intertidal samples collected by hand at low tide, sediment from the 0-to-10-cm depth will be spooned by hand into a pre-cleaned stainless steel bowl or cauldron and

homogenized as described above. Any large non-sediment items such as rocks, shells, wood chips, or organisms (e.g., clams) will be removed prior to homogenization. Homogenized sediment will then be split into the appropriate sample containers as described in Sections 3.1.3 and 3.3.1. Excess sediment will be returned to the sampling location. For decontamination procedures between collection activities, see Section 3.2.5.

Following homogenization the analytical chemistry jars will be filled including the volume of sample reserved for subtidal compositing or intertidal MIS compoisings. Then, the remaining homogenized sediment will fill the bioassay jars. All jars will be stored in coolers and transported to the laboratory at the end of the sampling day. The bioassay samples will be stored refrigerated in the dark pending the initiation of the bioassay sampling.

Diver-collected samples

Divers will be used to collect hand cores at eight underpier locations (locations 27,100, 11, 114, 117, 126, 211, and 219). The hand cores are 20cm in diameter and 35 cm long. The sample location is marked from the vessel with a marker buoy. A single, line-tended diver descends with the sampler, removes the sliding door from the base of the sampler, and opens a vent at the top. The diver works the tool into the sediment until it is flush with the mudline. By excavating a small trough beside the sampler, the sliding door can be inserted without disturbing the sample.

A minimum volume of 2 L of sediment will be collected at each location. Sediment from the 0-to-10-cm depth will be spooned by hand into a pre-cleaned stainless steel bowl or cauldron and homogenized with a clean, stainless steel spoon or spatula until texture and color homogeneity have been achieved (PSEP 1997).

3.2.4 Field equipment

The following items will be needed in the field for sediment collection:

- QAPP
- Field collection forms
- Study area maps
- Field notebooks and pens/pencils/Sharpies®
- Cellular phone
- Digital camera
- GPS
- Batteries
- Stainless steel bowls and spoons
- Stainless steel ruler

- Rubber tubing/turkey basters (used to decant surface water from van Veen sampler)
- Alconox® detergent
- Scrub brushes
- Distilled water
- Spray bottles for distilled water
- Coolers
- Powder-free nitrile exam gloves and rubber work gloves
- Boots or waders
- Duct tape
- Zip-lock bags
- Aluminum foil
- Paper towels
- First aid kit
- Double 0.1-m2 van Veen grab sampler
- Wet ice or frozen gel packs
- Personal flotation devices
- Hard hats
- Safety glasses
- Foul weather gear (rain jacket/pants)
- Waterproof labels
- Clear packing tape
- Box cutters
- Bubble wrap
- COC forms
- Flashlights and temporary work lights
- Sample jars
- Custody seals

Prior to mobilization, these lists will be consulted to ensure all equipment is available and pre-cleaned. As part of the mobilization process, each item will be double-checked by the FC.

3.2.5 Decontamination procedures

All sediment sampling and homogenizing equipment, including the mixing bowl and stainless steel implements, will be decontaminated between sampling stations following PSEP guidelines (1997) and the following procedures:

1. Rinse with site water and wash with a scrub brush until free of sediment.
2. Wash with phosphate-free detergent.
3. Rinse with site water.
4. Rinse with distilled water.

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

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

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

3.2.6 Field-generated waste disposal

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

3.3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

This section describes how individual samples will be processed, labeled, tracked, stored, and transported to the laboratory for analysis. In addition, this section describes sample custody procedures and shipping requirements. Sample custody is a critical aspect of environmental investigation. Sample possession and handling must be traceable from the time of sample collection through laboratory analyses until Windward authorizes sample disposal.

3.3.1 Sample handling procedures

Sediment samples for chemical analyses will be placed in appropriately sized, pre-cleaned, labeled, wide-mouth glass jars and capped with Teflon®-lined lids (Table 3-4); high-density polyethylene (HDPE) jars are suitable for grain size and

toxicity testing. Sediment submitted for toxicity testing will be obtained from the same homogenate as the sediment submitted for bulk chemical analysis. The homogenized sediment will be placed into five I-Chem 1-L HDPE wide-mouth jars. All sediment sample containers will be filled leaving a minimum of 1 cm of headspace to prevent breakage during shipping and storage. Sediment for ammonia and total sulfides analysis at NAS will be collected at the time of test initiation from a separate beaker treated in the same manner as test beakers prior to test initiation. Prior to shipment, each glass container will be wrapped in bubble wrap and placed in a cooler with wet ice or frozen gel packs.

Table 3-4. Sample containers and laboratories conducting chemical analyses

PARAMETER	CONTAINER	LABORATORY
Sediment Samples		
PCB congeners and dioxins/furans	8-oz glass jar	Analytical Perspectives
PCBs (as Aroclors), organochlorine pesticides, and SVOCs	16-oz glass jar	ARI
Metals, including mercury, butyltins, TOC, and total solids	16-oz glass jar	ARI
Grain size	16-oz glass or HDPE jar	ARI
Toxicity testing, including ammonia and total sulfides[a]	five 1-L HDPE wide-mouth jars	NAS
Total sulfides (preserved)[c]	2-oz wide-mouth glass jar (no headspace, preserved with zinc acetate)	ARI
Ammonia[c]	4-oz wide-mouth glass jar	ARI
Aqueous Samples (rinsate blanks)		
PCBs (as Aroclors), SVOCs, organochlorine pesticides, and butyltins	eight 500-mL amber glass jars	ARI
Metals, including mercury	500-mL HDPE jar (preserved with nitric acid)	ARI

[a] In addition to the analyses of ammonia and total sulfides conducted by ARI on sediment samples preserved at the time of sampling, ammonia and total sulfides will be analyzed by NAS in sediment used for toxicity testing at the time of test initiation. The total sulfides and ammonia data provided by ARI will be selected as the best results for these chemicals, and will be presented in the final data report tables. The sulfides and ammonia data provided by NAS will be used only to interpret the observed toxicity results and/or to influence analytical procedures used by NAS. The ARI data will be incorporated into the SRI/FS dataset for these chemicals because all field preservation and holding time requirements will be met for the samples submitted to ARI.

ARI – Analytical Resources, Inc.
HDPE – high-density polyethylene
NAS – Northwestern Aquatic Sciences
PCB – polychlorinated biphenyl
SVOC – semivolatile organic compound
TOC – total organic carbon

Sample labels will be waterproof and self-adhering. Each sample label will contain the project name, sample ID, preservation technique, type of analysis, date and time of collection, and initials of the person(s) preparing the sample. A completed sample label will be affixed to each sample container. The labels will be covered with clear tape immediately after they have been completed to protect them from being stained or spoiled from water and sediment.

3.3.2 Sample custody procedures

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

- Project name and unique sample number
- Sample collection date and time
- Any special notations on sample characteristics or problems
- Initials of the individual collecting the sample
- Date sample was sent to the laboratory
- Shipping company name and waybill number

The FC will be responsible for all sample tracking and custody procedures for samples in the field. The FC will be responsible for final sample inventory and will maintain sample custody documentation. The FC will also complete COC forms prior to removing samples from the sampling area. At the end of each day, and prior to transfer, COC entries will be made for all samples. Information on the labels will be checked against sample log entries, and sample tracking forms and samples will be recounted. COC forms will accompany all samples. The COC forms will be signed at each point of transfer. Copies of all COC forms will be retained and included as appendices to QA/QC reports and data reports. Sediment samples will be shipped in sealed coolers to the analytical laboratories. The FC will ensure that the laboratory has accepted delivery of the shipment at the specified time.

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

At each laboratory, a unique sample identifier 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 name/initials of individuals responsible for performing the analyses, dates of sample extraction/preparation and analysis, and the type of analysis being performed.

3.3.3 Shipping requirements

Coolers with sediment samples for chemical, toxicity, and grain-size analysis will be shipped overnight or hand-delivered to the appropriate analytical and toxicity testing laboratory. The temperature inside the cooler(s) containing chemistry samples will be checked upon receipt at the laboratory using certified thermometers or infrared devices. Each cooler shipped to AP and NAS will contain temperature blanks so that the cooler temperature can be measured upon receipt at the laboratory. Infrared thermometers will be used at ARI to measure cooler temperature. The laboratories will specifically note any coolers that do not contain ice packs (ice or frozen gel packs) or are not sufficiently cold upon receipt (i.e., 4 ° ± 2 °C for samples delivered to ARI or NAS or < 0 °C for frozen sediment samples delivered to Analytical Perspectives). Each sample will be assigned a unique laboratory number, and samples will be grouped in appropriate sample delivery groups (SDGs). Samples for toxicity testing will be stored in a refrigerator at the toxicity testing laboratories until a decision is made regarding which sediments to test. The laboratories will not dispose of the environmental samples for this project until notified in writing by the project QA/QC coordinator.

3.4 ANALYTICAL METHODS

This section discusses standard methods and DQIs for chemical analyses and toxicity testing. A summary of the analyses to be conducted is presented in Table 3-5.

Table 3-5. Procedures to be conducted at each analytical laboratory

ARI	ANALYTICAL PERSPECTIVES	CAS	NAS
PCB Aroclors SVOCs (including PAHs and low level SVOCs by SIM) Metals including mercury TOC, total solids, grain size, ammonia, total sulfides Organochlorine pesticides (subset of samples) Butyltins (subset of samples)	PCB congeners (subset of samples) Dioxins and furans (subset of samples)	Potential GC/MS/MS confirmation analysis of pesticides[a]	Toxicity testing

[a] GC/MS/MS pesticide analysis may be conducted on a subset of samples at CAS if pesticides are detected in the analyses conducted at ARI.

ARI – Analytical Resources, Inc.

CAS – Columbia Analytical Services, Inc.

GC/MS/MS – gas chromatography/mass spectrometry/mass spectrometry

NAS – Northwestern Aquatic Sciences

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

SVOC – semivolatile organic compound

TOC – total organic carbon

3.4.1 Chemical analysis of sediment

All samples will be analyzed for PCB Aroclors; SVOCs; total metals, including mercury; grain size; total solids; and TOC. A subset of samples will be analyzed for organochlorine pesticides, butyltins, PCB congeners, and dioxins/furans. If pesticides

are detected in the initial analysis at ARI, the samples may be analyzed by CAS for confirmation using GC/MS/MS.

3.4.1.1 Laboratory methods and sample handling requirements

In addition to the analyses specified, additional sediment from each sample will be archived frozen at ARI in the event that additional chemical analyses are necessary. Analytical methods and sample handling requirements are presented in Table 3-6.

Table 3-6. Laboratory chemistry analytical methods and sample handling requirements

Parameter	Method	Reference	Sample Holding Time[a]	Preservative
Sediment Samples				
PCBs as Aroclors	GC/ECD	EPA 8082	14 days to extract, 40 days to analyze[b]	cool/0 – 6 °C
PCB congeners[c]	HRGC/HRMS	EPA 1668	1 year to extract, 40 days to analyze	freeze/-20 °C
Dioxins and furans	HRGC/HRMS	EPA 1613B	1 year to extract, 40 days to analyze	freeze/-20 °C
Organochlorine pesticides[d]	GC/ECD	EPA 8081A	14 days to extract, 40 days to analyze[b]	cool/0 – 6 °C
Organochlorine pesticides[d]	GC/MS/MS	EPA 1699 (modified)	14 days to extract, 40 days to analyze[b]	cool/0 – 6 °C
SVOCs (including PAHs)[e]	GC/MS	EPA 8270D	14 days to extract, 40 days to analyze[b]	cool/0 – 6 °C
Selected SVOCs[f]	GC/MS-SIM	EPA 8270D-SIM	14 days to extract, 40 days to analyze[b]	cool/0 – 6 °C
Mercury	CVAA	EPA 7471A	28 days[g]	cool/0 – 6 °C
Other metals[h]	ICP-AES and ICP-MS	EPA 6010B and EPA 6020	6 months	cool/0 – 6 °C
Tributyltin, dibutyltin, monobutyltin (as ions)	GC/FPD	Krone et al. (1989)	14 days to extract, 40 days to analyze[b]	cool/0 – 6 °C
Grain size	sieve/pipette	PSEP (1986)	6 months	cool/0 – 6 °C
TOC	combustion	Plumb (1981)	14 days[g]	cool/0 – 6 °C
Total solids	oven-dried	PSEP (1986)	7 days[g]	cool/0 – 6 °C
Total sulfides	spectro-photometric	EPA 376.2	7 days	2 ml 2N zinc acetate cool/0 – 6 °C
Ammonia	automated phenate	EPA 350.1	28 days	cool/0 – 6 °C
Aqueous Samples (rinsate blanks)				
PCBs as Aroclors	GC/ECD	EPA 8082	7 days to extract, 40 days to analyze	cool/0 – 6 °C
Organochlorine pesticides[d]	GC/ECD	EPA 8081A	7 days to extract, 40 days to analyze	cool/0 – 6 °C
SVOCs (including PAHs)[e]	GC/MS	EPA 8270D	7 days to extract, 40 days to analyze	cool/0 – 6 °C
Selected SVOCs[f]	GC/MS-SIM	EPA 8270D-SIM	7 days to extract, 40 days to analyze	cool/0 – 6 °C

PARAMETER	METHOD	REFERENCE	SAMPLE HOLDING TIME[a]	PRESERVATIVE
Mercury	CVAA	EPA 7471A	28 days	cool/0 – 6 °C
Other metals[h]	ICP-AES and ICP-MS	EPA 6010B and EPA 6020	6 months	cool/0 – 6 °C
Tributyltin, dibutyltin, monobutyltin (as ions)	GC/FPD	Krone et al. (1989)	7 days to extract, 40 days to analyze	cool/0 – 6 °C

[a] All samples will be archived frozen at the laboratory until the Windward PM authorizes their disposal.

[b] Sediment can also be frozen to increase the holding time to 1 year extraction. Aqueous rinsate blanks have a maximum holding time of 7 days to extract and 40 days to analyze and will be stored at 0 to 6 °C.

[c] Complete list of 209 congeners.

[d] Target pesticides include: 4,4′-DDT, 4,4′-DDE, 4,4′-DDD, 2,4′-DDT, 2,4′-DDE, 2,4′-DDD, aldrin, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC, oxychlordane, alpha- and gamma-chlordane, cis- and trans-nonachlor, dieldrin, endosulfan, endosulfan sulfate, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene, methoxychlor, mirex, and toxaphene. Detected pesticides may be confirmed by EPA 1699 (modified) using GC/MS/MS.

[e] Target PAHs include: anthracene, pyrene, dibenzofuran, benzo(g,h,i)perylene, benzo(e)pyrene, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, fluoranthene, benzo(k)fluoranthene, acenaphthylene, chrysene, benzo(a)pyrene, dibenz(a,h)anthracene, benz(a)anthracene, acenaphthene, phenanthrene, fluorene, 1-methylnaphthalene, naphthalene, and 2-methylnaphthalene.

[f] Selected SVOCs include: 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 2,4-dimethylphenol, 2-methylphenol, benzyl alcohol, butyl benzyl phthalate, di-ethyl phthalate, di-methyl phthalate, hexachlorobenzene, hexachlorobutadiene, n-nitrosodimethylamine, n-nitrosodiphenylamine, n-nitrosodi-n-propylamine, and pentachlorophenol.

[g] Sediment may be frozen, with a maximum holding time of 6 months.

[h] Sediment may be frozen, with a maximum holding time of 1 year. Aqueous rinsate blanks will be preserved with nitric acid. Metals include arsenic, antimony, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc.

BHC – benzene hexachloride

CVAA – cold vapor atomic absorption

GC/ECD – gas chromatography electron capture detection

GC/FPD – gas chromatography flame photometric detection

GC/MS – gas chromatography mass spectrometry

GC/MS/MS – gas chromatography/mass spectrometry/mass spectrometry

HRGC/HRMS – high resolution gas chromatography/high resolution mass spectrometry

ICP-AES – inductively coupled plasma atomic emission spectrometry

ICP-MS – inductively coupled plasma mass spectrometry

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

PSEP – Puget Sound Estuary Program

SIM – selected ion monitoring

SVOC – semivolatile organic compound

TOC – total organic carbon

3.4.1.2 Data quality indicators

The parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity. Table 3-7 list specific DQIs for the laboratory analyses of all samples. Target MDLs and RLs are presented in

Appendix C. These parameters are discussed in greater detail in the following sections.

Table 3-7. Data quality indicators for sediment analyses

Parameter	Precision (Laboratory Replicates)	Accuracy		Completeness
		Instrument Calibration (% Difference)	Spiked Samples (% Recovery)	
PCBs as Aroclors	±50%	±25	laboratory QC limits[a]	95%
Organochlorine pesticides	±50%	±25	laboratory QC limits[a]	95%
SVOCs (including PAHs and low-level SVOCs by SIM)	±50%	±25	laboratory QC limits[a]	95%
PCB congeners	±50%	±15	laboratory QC limits[a]	95%
Dioxins and furans	±50%	±25	laboratory QC limits[a]	95%
Mercury	±30%	±20	75 – 125	95%
Other metals	±30%	±10	75 – 125	95%
Butyltins	±50%	±15	laboratory QC limits[a]	95%
TOC	±30%	na	laboratory QC limits[a]	95%
Grain size	±30%	na	na	95%
Total solids	±20%	na	na	95%
Total sulfides	±20%	±20	75 – 125	95%
Ammonia	±20%	±20	75 – 125	95%

[a] The laboratory's performance-based control limits that are in effect at the time of analysis will be used as accuracy limits for LCS, MS/MSD, and ongoing precision and accuracy samples.

LCS – laboratory control sample
MS – matrix spike
MSD – matrix spike duplicate
na – not applicable
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
QC – quality control
SIM – selected ion monitoring
SVOC – semivolatile organic compound
TOC – total organic carbon

Precision

Precision is the measure of the reproducibility among individual measurements of the same property, usually under similar conditions, such as multiple measurements of the same sample. Precision is assessed by performing multiple analyses on a sample and is expressed as an RPD when duplicate analyses are performed and as %RSD when more than two analyses are performed on the same sample (e.g., triplicates). Precision is assessed through laboratory duplicate analyses (i.e., laboratory replicate samples, MS/MSD, LCS duplicates) for all parameters except when reference materials are not available or spiking of the matrix is inappropriate. In these cases, precision is assessed through laboratory triplicate analyses. Precision measurements can be affected by the nearness of a chemical concentration to the MDL, where the percent error (expressed as either %RSD or RPD) increases. The DQI for precision varies depending on the analyte (Table 3-7). The equations used to express precision are as follows:

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

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

where:

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

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

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, LCS, and ongoing precision and accuracy sample analyses. The DQI for accuracy varies, depending on the analyte (Table 3-7). The equation used to express accuracy for spiked samples is as follows:

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

Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition. The sampling approach was designed to address the specific objectives described in Section 2.2. Assuming those objectives are met, the samples collected should be considered adequately representative of the environmental conditions they are intended to characterize.

Comparability

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

Completeness

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

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

The DQI for completeness for all components of this project is 95%. Data that have been qualified as estimated because the QC criteria have not been 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.

Sensitivity

Analytical sensitivity is a measure of both the ability of the analytical method to detect the analyte and the concentration that can be reliably quantified. The minimum concentration of the analyte that can be detected is the MDL. The minimum concentration that can be reliably quantified is the RL. Laboratories use both MDLs and RLs for reporting analyte concentrations, and both values will be used as measures of sensitivity for each analysis.

The MDL is defined as the lowest concentration of an analyte or compound that a method can detect in either a sample or a blank with 99% confidence. ARI and CAS determine MDLs using standard procedures outlined in 40 CFR 136, in which seven or more replicate samples are fortified at 1 to 5 times (but not to exceed 10 times) the expected MDL concentration. The MDL is then determined by calculating the standard deviation of the replicates and multiplying by the Student's t-factor (e.g., 3.14 for seven replicates). Analytical Perspectives calculates an estimated detection limit, which is based on the signal-to-noise ratio of the instrument during analysis. The laboratories must submit an initial demonstration of MDLs to EPA prior to sample collection.

RLs are equal to or greater than the lower calibration limit defined by the lowest concentration on the calibration curve. The RLs, MDLs, and estimated detection limits that are reported for each sample are adjusted based on the amount of sample extracted, dilution factors, and percent moisture.

All laboratories will report detected concentrations above the RL without qualification and will report detected concentrations between the MDL (ARI and CAS) or estimated detection limit (Analytical Perspectives) and the RL with a J-qualifier indicating the concentration is an estimated value. The target RLs and MDLs are presented in Appendix C. Appendix D presents a detailed evaluation of whether MDLs and RLs for sediment samples are sufficiently sensitive to meet the needs of the ERA and HHRA.

3.4.2 Sediment toxicity testing

Laboratory methods, sample handling, and DQIs for the sediment samples collected for toxicity testing are described in this section.

3.4.2.1 Laboratory methods and sample handling

Sediment submitted for toxicity testing will be obtained from the same homogenate as the sediment submitted for bulk chemical analyses. The homogenized sediment will be placed into five-1L HDPE wide-mouth jars and shipped to NAS at 0 to 6°C as

collected for toxicity testing. These sediment volumes include sufficient sediment to perform retesting, if needed. Any headspace will be filled with nitrogen upon arrival at the laboratory. The sediment samples will be stored in the dark at 4 °C ± 2 °C. The toxicity tests will be initiated within 8 weeks of sample collection.

Three standard SMS sediment toxicity tests will be conducted on each sample collected from locations identified for toxicity testing. These tests are:

- Acute 10-day amphipod mortality test (*Rhepoxynius abronius, Ampelisca abdita,* or *Eohaustorius estuarius*)
- Acute 48-to-96-hour larvae combined mortality and abnormality test (*Mytilus galloprovincialis* [bivalve], *Crassostrea gigas* [bivalve], *Dendraster excentricus* [echinoderm], *Stronglyocentrotus droebachiensis* [echinoderm], or *Stronglyocentrotus purpuratus* [echinoderm])
- Chronic 20-day juvenile polychaete survival and growth test (*Neanthes arenaceodentata*)

Biological testing will be conducted according to *Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments* (PSEP 1995).. In addition, the polychaete and amphipod tests will be modified for potential low salinity as described later in this section.

Short-term adverse effects of potentially contaminated sediments will be evaluated by measuring the survival of adult amphipods. *Rhepoxynius abronius* is commonly used for the testing of Puget Sound sediments with coarser grain size (< 60% fines). In sediments with high percent fines (> 60%), *Ampelisca abdita* or *Eohaustorius estuarius* will be used. *A. abdita* is the preferred organism for the testing of sediments with high clay (> 20 %) content, and *E. estuarius* is the preferred test organism if the interstitial salinity is below 25 parts per thousand (ppt) and clay is < 20%. The appropriate test species will be determined in consultation with NAS and EPA based on sediment grain size data. Amphipods will be exposed to the EW sediments and reference sediments for a 10-day period. The test will be performed according to the procedures and QA/QC performance standards described in PSEP (1995), with survival as the primary endpoint.

The salinity of interstitial sediments from the EW will be evaluated to ensure that the salinity of the test sediment will be equilibrated with the overlying water by mixing the sediment with overlying seawater at the appropriate test salinity prior to initiating the test (PSEP 1995). Mixing the sediment with the bioassay water, which constitutes the overlying water, ensures that the salinity of test sediments equilibrates quickly and is in equilibrium with the overlying water when the organisms are added the following day. This will provide the preferred salinity of at least 20 ppt and a more consistent salinity for all tests. This procedure will be done only on those sediment samples in which the interstitial salinity is below 20 ppt.

Three endpoints are assessed in larvae after a 48-hour exposure period: mortality, abnormal development, and combined mortality and abnormality. Larvae of *Mytilus galloprovincialis* is the preferred test organisms for this study. If *M. galloprovincialis* in spawning condition is unavailable, the echinoderm *Dendraster excentricus* will be used. If either of these species is unavailable, an alternative species, *Stronglyocentrotus droebachiensis (*echinoderm), *Stronglyocentrotus purpuratus (*echinoderm), or *Crassostrea gigas (*bivalve), will be used. However, *Crassostrea gigas* should not be used in sediment with high percentage of fines, which can cause difficulty with oyster larvae testing. Test protocols and QA/QC performance standards will be in accordance with PSEP (1995). All beakers will be aerated to maintain correct levels of saturation throughout the tests.

The juvenile polychaete sublethal bioassay is used to characterize the toxicity of marine sediments based on worm growth. The target initial worm weight for test organisms will be 0.5 mg (dry weight) and not less than 0.25 mg (dry weight). Parameters measured after the 20-day sediment exposure are survival and growth in juvenile polychaetes *(Neanthes arenaceodentata).* The test will be performed according to the procedures and QA/QC performance standards described in PSEP protocols (1995) and Johns et al. (1990). The salinity of interstitial sediments from the EW may vary, so the salinity of the test sediment will be equilibrated with the overlying water by mixing the sediment with overlying seawater at the appropriate test salinity prior to test initiation (PSEP 1995). Mixing the sediment with the bioassay water, which constitutes the overlying water, ensures that the salinity of test sediments equilibrates quickly and is in equilibrium with the overlying water when the organisms are added the following day. This will provide the preferred salinity of at least 20 ppt and a more consistent salinity for all tests. This procedure will be done only on those sediment samples in which the interstitial salinity is below 20 ppt.

Toxicity testing protocols require that test sediments be matched and tested simultaneously with appropriate reference sediment to factor out sediment grain-size and TOC effects on bioassay organisms. Three reference sediment samples will be collected from the northern end of Carr Inlet, corresponding to the following ranges of percent fines: 70 to 90%, 40 to 60%, and 10 to 30%. Additional sediment from the three reference sites will be archived in case chemical analyses are needed at a later date. Charlie Eaton (Biomarine Enterprises) will collect the reference sediment samples using the extensive database he has compiled on specific coordinates associated with these grain size ranges. TOC content will also be matched to the test sediments as closely as possible (PSEP 1995). Each reference sediment sample will be tested for toxicity using the same three test organisms. The appropriate reference sediment for each EW test sediment sample will be determined after reviewing the results of TOC and grain-size analyses for those samples.

Ammonia and sulfides unrelated to anthropogenic chemicals may cause toxic effects in amphipods and polychaetes (DMMP 2004). False positive toxicity results caused by increased concentrations of ammonia and total sulfides confound the interpretation of

the toxicity tests. Thus, positive control tests for ammonia will be conducted. Positive controls with sulfides cannot be conducted because sulfides will not remain soluble in an aerobic water-only test. In addition, ammonia and total sulfides will be analyzed in sediment porewater from a separate beaker at the beginning of each test, and in overlying water at the start and end of each test.

3.4.2.2 Data quality indicators

DQIs for sediment toxicity tests, shown in Table 3-8, are based on guidelines given in:

- *Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments* (PSEP 1995)
- Standard Test Method for Conducting Acute, Chronic, and Life-cycle Aquatic Toxicity Tests with Polychaetous Annelids (ASTM 2003a)
- Standard Test Method for Conducting Static Acute Toxicity Tests Starting with Embryos of Four Species of Saltwater Bivalve Molluscs (ASTM 2003b)
- Standard Test Method for Measuring the Toxicity of Sediment-Associated Contaminants with Estuarine and Marine Invertebrates (ASTM 2003c)

Compliance with these indicators will be confirmed by the toxicity testing laboratory and by the toxicity testing data validator.

Table 3-8. Data quality indicators for sediment toxicity testing

TOXICITY TEST	DATA QUALITY INDICATOR
Acute 10-day amphipod mortality test	Mean mortality in the negative control must be ≤ 10%; individual replicate mortality must not exceed 20%. Mean mortality in reference sediments must be ≤ 25%. All organisms in a test must be from the same source. The mean of the daily test temperature must be within ± 1°C of 15°C. Test must be conducted under continuous light. Dissolved oxygen, pH, and salinity must be within the acceptable ranges established by the protocol. All test chambers must be identical and contain the same amount of sediment and overlying water. The LC50 for a positive control test must be within the mean LC50 ±2 standard deviations of the control chart.

TOXICITY TEST	DATA QUALITY INDICATOR
Acute 48-hr larvae combined mortality and abnormality test	Mean effective mortality (combined mortality and abnormal development) in the negative control must be ≤ 30%. Mean number of normal developed larvae in the reference sediment divided by the mean number of normal developed larvae in the negative control must be ≥ 65%. All organisms in a test must be from the same source. The mean of the daily test temperature must be within ± 1°C of 15°C Test must be conducted under a light cycle of 14 hours light to 10 hours darkness. Dissolved oxygen, pH, and salinity must be within the acceptable ranges established by the protocol. All test chambers must be identical and contain the same amount of sediment and overlying water. The EC50 for a positive control test must be within the mean EC50 ±2 standard deviations of the control chart.
Chronic 20-day juvenile polychaete survival and growth test with *Neanthes arenaceodentata*	Mean juvenile polychaete weight must be between 0.5 and 1.0 mg at test initiation. Test initiation with a mean polychaete weight less than 0.25 mg is considered a QA/QC failure. Mean mortality in the negative control must be ≤ 10%. A target performance growth rate has been set at 0.72 mg/individual/day by the SMS program. A growth rate below 0.38 mg/individual/day is considered to be a QA/QC failure. All organisms in a test must be from the same source. The mean of the daily test temperature must be within ± 1°C of 20°C. Test must be conducted under continuous light. Dissolved oxygen, pH, and salinity must be within the acceptable ranges established by the protocol. All test chambers must be identical and contain the same amount of sediment and overlying water. The EC50 for a positive control test must be within the mean EC50 ±2 standard deviations of the control chart.

C – centigrade

EC50 – concentration that causes a non-lethal effect in 50% of an exposed population

LC50 – concentration that is lethal to 50% of an exposed population

QA – quality assurance

QC – quality control

3.5 QUALITY ASSURANCE/QUALITY CONTROL

The QA/QC criteria for the field and laboratory analyses are described below.

3.5.1 Field QC samples

Field duplicate samples will be collected to evaluate the variability attributable to sample homogenization and subsequent sample handling. Field duplicate samples will be collected from the same homogenized material as the original sample and analyzed as a separate sample; this type of field QA/QC sample is also referred to as a

field split sample (PSEP 1997). A minimum of one field duplicate sample will be analyzed for every 20 samples.

In addition, rinsate blanks will be collected from sampling equipment at a rate of 1 per 20 samples. Rinsate blank samples will be analyzed for PCB Aroclors, organochlorine pesticides, SVOCS, mercury, other metals, and butyltins.

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

3.5.2 Sediment toxicity testing QC criteria

All three sediment toxicity tests will incorporate standard QA/QC procedures to ensure that the test results are valid. Standard QA/QC procedures include the use of a negative control, a positive control, reference sediment samples, and measurement of water quality during testing.

The negative control will be a test using a clean, inert material and the same diluent seawater used in testing sediment toxicity. For the toxicity tests, the negative control will be sand collected from Yaquina Bay. Yaquina Bay has been used successfully as a negative control and is the sediment collection site for the amphipods used in the test.

For the positive control, a reference toxicant will be used to establish the relative sensitivity of the test organism. The positive control for sediment tests is typically conducted with diluent seawater and without sediment. Reference toxicants are often used in positive controls. Copper sulfate will be used as the reference toxicant in the larval tests. Cadmium chloride will be used as the reference toxicant for the amphipod and juvenile polychaete tests. In addition to the positive controls with reference toxicants, positive controls using ammonia (water exposure only) will also be performed for each test species.

Reference sediment will also be included with each toxicity test series. Reference sediments provide toxicity data that can be used to separate toxicant effects from unrelated effects, such as those of sediment grain size. They are also used in statistical comparisons to determine whether test sediments are toxic. Sediment samples selected to be the test reference sediment should be collected from an area documented to be free from chemical contamination and should represent the range of important natural, physical, and chemical characteristics of the test sediments, specifically, sediment grain size and TOC. Sediments to be used as reference sediment for the three bioassays will be collected from Carr Inlet (PSEP 1995).

Bioassays require that proper water quality conditions be maintained to ensure the survival of the organisms and to ensure that undue stress unrelated to test sediments is not exerted on the organisms. Salinity, dissolved oxygen (DO), pH, ammonia, total

sulfides, and temperature will be regularly measured during testing. Temperature, salinity, DO, and pH will be measured daily for the amphipod mortality and larval development tests. Temperature will be measured daily for the polychaete growth test; whereas salinity, DO, and pH water quality variables will be measured every 3 days.

Interstitial porewater will be analyzed for ammonia and total sulfides at test initiation for both the amphipod and polychaete tests.[5] Ammonia and total sulfides will be measured in overlying water in all three tests at test initiation (after salinity adjustment) and test termination.

Toxicity test samples will be retested within the holding time if the negative control fails to meet the performance criteria. If a toxicity test fails and the holding time has expired, the decision to resample and retest sediments will be made in consultation with EPA. Similarly, if the independent data validator recommends retesting based on data quality concerns, the decision to retest will be made in consultation with EPA.

3.5.3 Chemical analyses QC criteria

Before analyzing the samples, the laboratory must provide written protocols for the analytical methods to be used, calculate MDLs for each analyte in each matrix type, and establish an initial calibration curve for all analytes. The laboratory must demonstrate their continued proficiency through participation in inter-laboratory comparison studies and through repeated analyses of SRMs, calibration checks, method blanks, and spiked samples.

3.5.3.1 Sample delivery group

Project- and/or method-specific QC measures such as MS/MSD or laboratory replicate samples will be analyzed per SDG, preparatory batch, or analytical batch, as specified in Table 3-9. An SDG is defined as no more than 20 samples or a group of samples received at the laboratory within a 2-week period. Although an SDG may span 2 weeks, all holding times specific to each analytical method will be met for each sample in the SDG.

[5] This analysis is not applicable to the bivalve larvae test because of the small amount of sediment used in the test.

Table 3-9. Quality control sample analysis summary

Analysis Type	Initial Calibration	Second Source Initial Calibration Verification	Continuing Calibration Verification	Laboratory Control Sample	Laboratory Replicate Sample	Matrix Spike	Matrix Spike Duplicate	Method Blank	Standard Reference Material	Surrogate Spike
PCB Aroclors	prior to analysis	after initial calibration	every 10 to 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 batch or SDG	each sample
PCB congeners and dioxins/furans	prior to analysis	after initial calibration	prior to 12-hour analytical batch	1 per prep batch	na	na	na	1 per prep batch	na	each sample
Organochlorine pesticides[a]	prior to analysis	after initial calibration	every 10 to 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 batch or SDG	each sample
Metals including mercury	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	each batch or SDG	na
SVOCs, including PAHs and low-level SVOCs by SIM	prior to analysis	after initial calibration	every 10 to 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 batch or SDG	each sample
Butyltins	prior to analysis	after initial calibration	every 10 samples	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each batch or SDG	each sample
Grain size	na	na	na	na	2 per batch or SDG	na	na	na	na	na
TOC	daily	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	na
Percent solids	na	na	na	na	1 per batch or SDG	na	na	1 per prep batch	na	na
Total sulfides and ammonia	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	each batch or SDG	na

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

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

na – not applicable
PCB – polychlorinated biphenyl
PAH – polycyclic aromatic hydrocarbon
SDG – sample delivery group
SIM – selected ion monitoring
SVOC – semivolatile organic compound
TOC – total organic carbon

3.5.3.2 Laboratory QC criteria

The laboratory analysts will review the results of QC analyses of each analytical batch (described below) immediately after the samples have been analyzed. The QC sample results will be evaluated to determine whether control limits have been exceeded. If control limits are exceeded, then appropriate corrective action must be initiated before a subsequent group of samples can be processed (e.g., recalibration followed by reprocessing of the affected samples). 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, Environmental Resource Associates, National Research Council of Canada, or other documented, reliable commercial sources. The accuracy of the standards should be verified through comparison with an independent standard. Laboratory QC standards are verified a multitude of ways. Second-source calibration verification (i.e., same chemicals manufactured by two different vendors) are analyzed to verify initial calibrations. New working standard mixes (e.g., calibrations, spikes) should be verified against the results of the original solution before being put into use and be within 10% of the true value. Newly purchased standards should be verified against current data. Any impurities found in the standard must be documented. The following subsections summarize the procedures that will be used to assess data quality throughout sample analysis.

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 a separate sample, assuming sufficient sample matrix is available. A minimum of one 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. Through the performance of MSD analyses, information on the precision of the method is also provided for organic analyses. For organic analyses, a minimum of one MS/MSD pair will be analyzed for each SDG, when sufficient sample volume is available. For inorganic analyses (i.e., metals), a minimum of one MS sample will be analyzed for each SDG, when sufficient sample volume is

available. MS/MSD samples are not performed for PCB congeners and dioxin/furan analyses.

Method Blanks

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

Standard Reference Material

SRMs are samples of similar matrix and of known analyte concentration that are processed through the entire analytical procedure and used as an indicator of method accuracy. A minimum of one SRM will be analyzed for each SDG or for every 20 samples, whichever is more frequent.

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, with the exception of the isotope dilution corrections that are required elements of the dioxin analysis (EPA 1613) and PCB congener analysis (EPA 1668A).

Laboratory Control Samples

LCSs are prepared from a clean matrix similar to the project samples and 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. LCS recoveries will be reported by the laboratories; however, no sample results will be corrected for recovery using these values.

Internal Standard Spikes

Internal standard spikes may be used for calibrating and quantifying organic compounds and metals by means of inductively coupled plasma-mass spectrometry (ICP-MS). If internal standards are used, 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/or laboratory criteria.

Interference Check Samples

In order to identify specific organochlorine pesticides that may coelute with PCB congeners, single point mid-concentration PCB standards (Aroclors 1248, 1254, and 1260) should be run regularly with single-component pesticides in the initial calibration. Additional Aroclors should be analyzed if they are detected in project

samples. The resulting data will be reviewed by data validators in order to assess potential interference issues that could affect the reported pesticide results.

3.6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

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

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

3.7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Multipoint initial calibrations will be performed on each instrument prior to sample analysis, after each major interruption to the analytical instrument, and when more than one continuing calibration verification sample does not meet the specified criteria. The number of points used in the initial calibration is defined in each analytical method. Continuing calibration verifications will be performed daily for organic analyses, once every 10 samples for the inorganic analyses and with every sample batch for conventional parameters to ensure proper instrument performance.

In addition, if an Aroclor is detected in a sample, then the standard for that Aroclor must be analyzed in the continuing calibration within 72 hours of the original detection of the Aroclor.

Gel permeation chromatography calibration verifications will be performed at least once every 7 days, and corresponding raw data will be submitted by the laboratory with the data package. In addition, florisil performance checks will be performed for every florisil lot, and the resulting raw data will be submitted with the data package, when applicable.

Calibration of analytical equipment used for chemical analyses includes instrument blanks or continuing calibration blanks, which provide information on the stability of the baseline established. Continuing calibration blanks will be analyzed immediately after the continuing calibration verification at a frequency of one blank for every 10 samples analyzed for inorganic analyses and one blank for every 12 hours or 10 to 20 samples 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. None of the field equipment requires calibration.

3.8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The field team leaders for each sampling event will have a checklist of supplies required for each day in the field (see Section 3.2.5). The FC will gather and check these supplies daily for satisfactory conditions before each field event. Batteries used in the GPS unit and digital camera will be checked daily and recharged as necessary. Supplies and consumables for field sampling will be inspected upon delivery and accepted if the condition of the supplies is satisfactory. For example, jars will be inspected to ensure that they are the correct size and quantity and have not been damaged in shipment.

3.9 DATA MANAGEMENT

All field data will be recorded on field forms (see Appendix B), which will be checked for missing information by the FC at the end of each field day and amended as necessary. After sampling has been completed, all data from field forms will be entered into a Microsoft Excel® spreadsheet for import into the project database. A secondary QC check will be done to ensure that 100% of the data were properly transferred from the field forms to the spreadsheet. This spreadsheet will be kept on the Windward network server, which is backed up daily. Field forms will be archived in the Windward library. All photographs will be transferred to the secure network or a CD at the end of the sampling effort.

Field sampling and analytical information will be submitted to EPA's Analytical Services Tracking System (ANSETS) no later than the 15th of the month after sampling activities have occurred and the sampling compositing and analysis scheme have been approved. The project QA/QC coordinator will be responsible for the submitting the required information to ANSETS.

Analytical laboratories are expected to submit data in an electronic format as described in Section 2.6.2. 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 ensures that all data are consistently converted into the desired data structures and that operator time is kept to a minimum. In addition, routines and methods for quality checks will be used to ensure 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. Data management files will be stored on a secure computer

4 Assessment and Oversight

4.1 Compliance Assessments and Response Actions

EPA or their designees may observe field activities during each sampling event, as needed. If situations arise in which there is an inability to follow QAPP methods precisely, the Windward PM will determine the appropriate actions or consult EPA if the issue is significant.

4.1.1 Compliance assessments

Laboratory and field performance assessments consist of onsite EPA reviews 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 and toxicity laboratories are required to have written procedures to address internal QA/QC; these procedures will be submitted to the project QA/QC coordinator for review to ensure compliance with the QAPP. All laboratories and QA/QC coordinators are required to ensure that all personnel engaged in sampling and analysis tasks have appropriate training.

4.1.2 Response actions for field sampling

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

4.1.3 Corrective action for laboratory analyses

Analytical and toxicity laboratories are required to comply with their current written standard operating procedures (SOPs), laboratory QA plan, and analytical methods. Laboratory personnel will identify and correct any anomalies before continuing with sample analysis and will be responsible for reporting problems that may compromise the quality of the data. 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 parameter exceeds the project DQIs outlined in this QAPP (Table 3-7) and 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 and described in the case narrative or corrective action form.

4.2 REPORTS TO MANAGEMENT

Progress reports will be prepared by the FC for the EWG following each sampling event. The project QA/QC coordinator will also prepare progress reports after the sampling is completed and samples have been submitted for analyses, when information is received from the laboratory, and when analyses are complete. The status of the samples and analyses will be indicated with emphasis on any deviations from the QAPP. Data reports will be written after validated data are available for each sampling round, as described in Section 2.6.4.

5 Data Validation and Usability

5.1 DATA VALIDATION

5.1.1 Chemical data

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

Data are not considered final until validated. Data validation will be conducted following EPA guidance (1995, 1996, 1999, 2004, 2005). Independent third-party data review and summary validation of the analytical chemistry data will be conducted by EcoChem. A minimum of 20% of sample results or a single SDG will undergo full data validation. In addition, all dioxin/furan and PCB congener data will undergo full validation following EPA Region 10 guidance for validation of dioxin/furan data (EPA 1996) and Method 1668 (EPA 1995). Full data validation parameters include:

- Quality control analysis frequencies
- Analysis holding times
- Laboratory blank contamination
- Instrument calibration
- Surrogate recoveries

- LCS recoveries
- MS recoveries
- MS/MSD RPDs
- Compound identifications
- Compound quantitations
- Instrument performance checks (i.e., tune ion abundances)
- Internal standard areas and retention time shifts

If no discrepancies between reported results and raw data in the set that undergoes full data validation are identified, validation can proceed as a summary-level data validation on the rest of the data using all the QC forms submitted in the laboratory data package. QA review of the sediment chemistry data will be performed in accordance with the QA requirements of the project; the technical specifications of the analytical methods indentified in Table 3-6; and EPA guidance for organic and inorganic data review (EPA 1995, 1996, 1999, 2004, 2005). The EPA PM may have EPA peer review the third-party validation or perform data assessment/validation on a percentage of the data.

All discrepancies and requests for additional, corrected data will be discussed with the laboratories prior to issuing the formal data validation report. The project QA/QC coordinator should 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. Only validated data with appropriate qualifiers will be released for use in the EW SRI/FS. Rejected data will not be used for any purpose.

5.1.2 Toxicity testing data

Independent third-party data review and summary validation of the toxicity test data will be conducted by Paul Dinnel of Dinnel Marine Resources. The validation of the toxicity test data will include:

- Prior to test initiation, ensuring that all laboratory test protocols are in accordance with PSEP protocols, up to date, and include any modifications to the protocol of current SMS-approved toxicity tests that have recently been published based on the Sediment Management Annual Review Meetings
- Possibly conducting test audits during sediment testing, which may involve several audit visits if tests are run in multiple batches
- Identifying any problems or deviations from established protocols or SOPs

- Reviewing all toxicity and QA data from the testing laboratory for each batch of tests, noting any data gaps or items that were out of compliance with protocols, noting time period for out-of-compliance events and corrective actions taken, and providing guidance regarding the severity of any out-of-compliance items
- Recommending retesting if necessary
- Preparing QA reports for the testing laboratory for each test and a final QA report covering all laboratory and data audits.

All discrepancies and requests for additional, corrected data will be discussed with the laboratories prior to issuing the formal data validation report. All contacts with the laboratories will be documented in a communication report. Review procedures used and findings made during data validation will be documented on worksheets. The data validator will prepare a data validation report that summarizes QC results, qualifiers, and possible data limitations. Only validated data with appropriate qualifiers will be released for general use.

5.2 RECONCILIATION WITH DATA QUALITY OBJECTIVES

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

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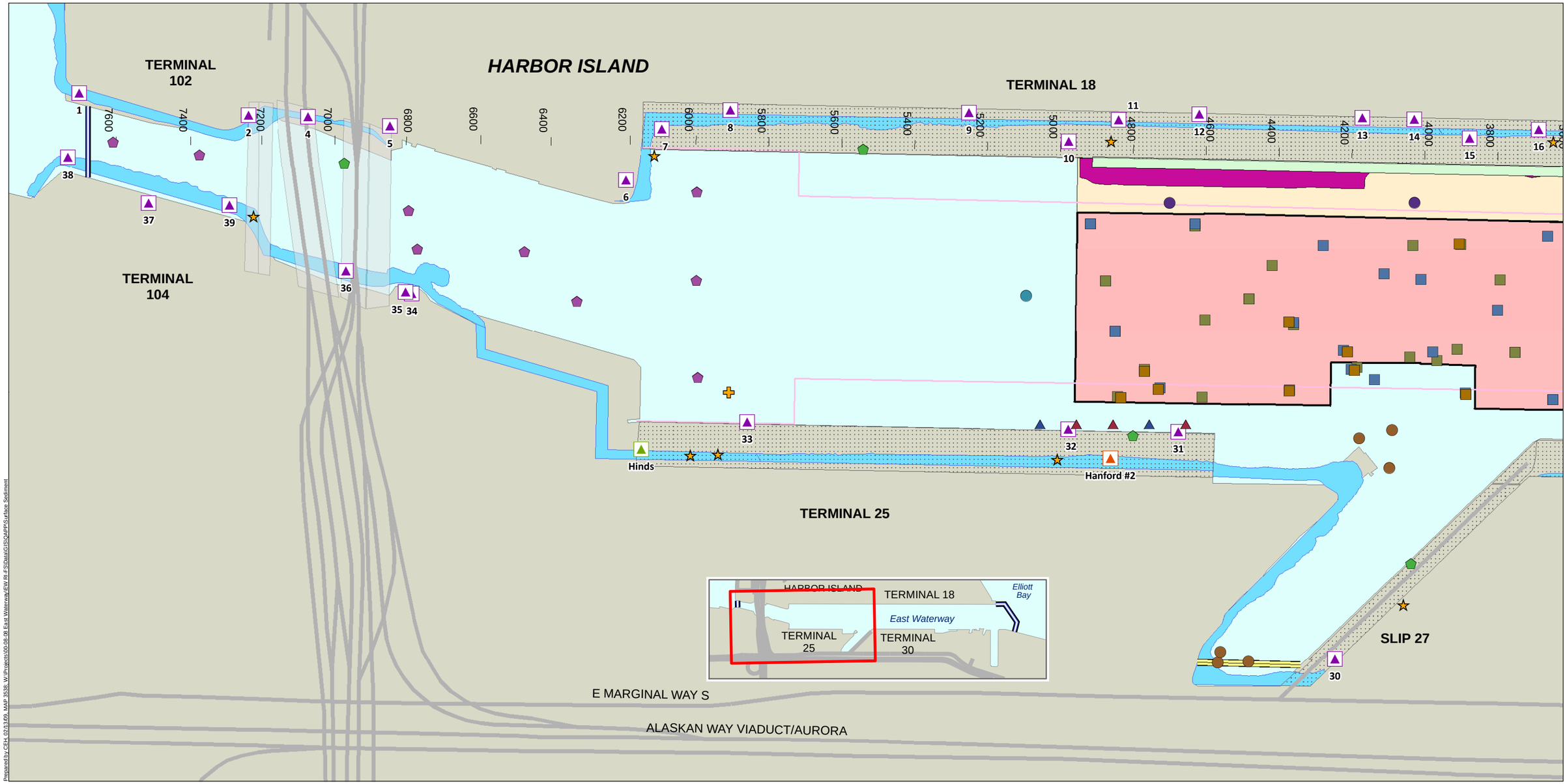
Maps



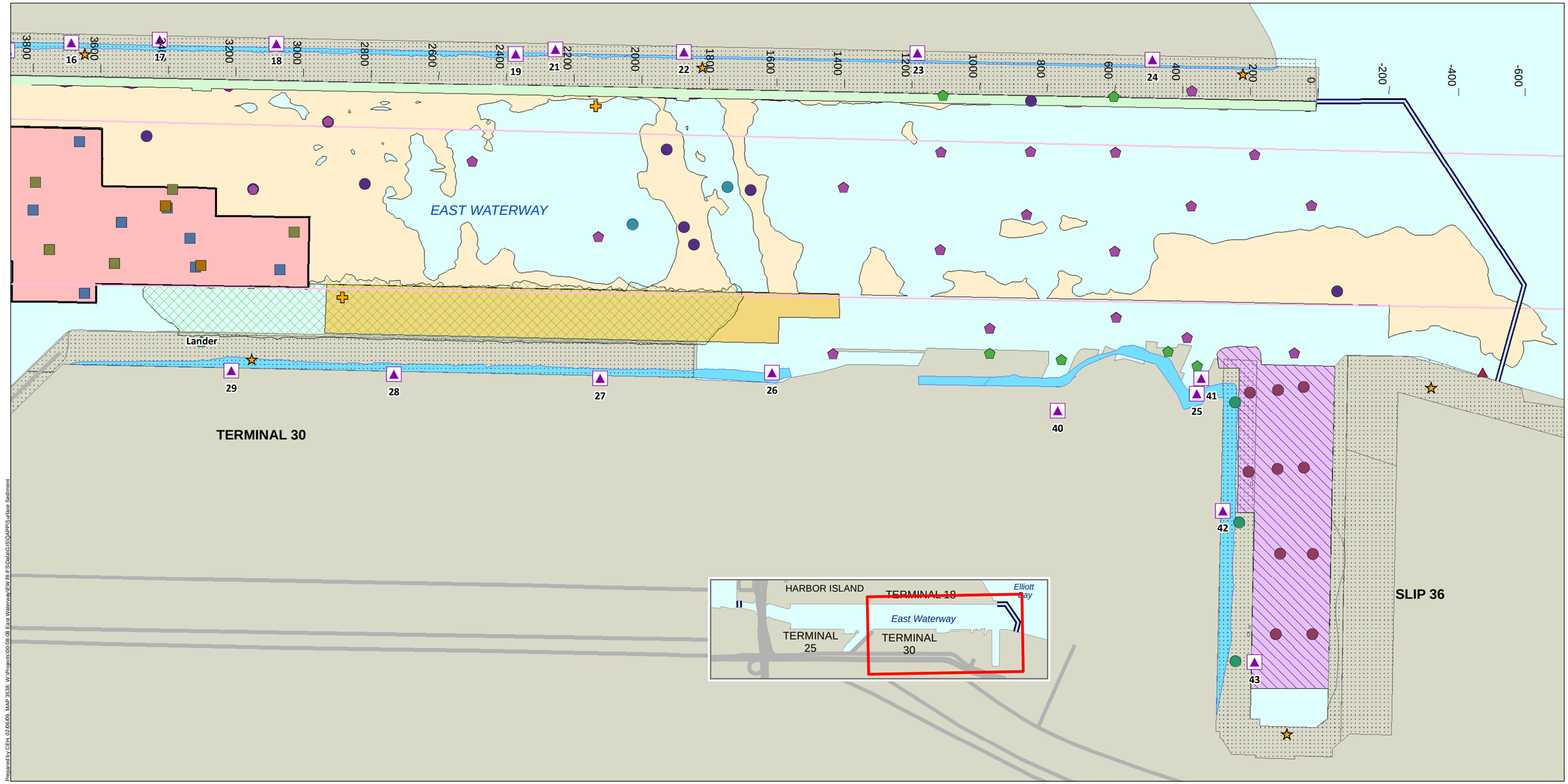
Surface sediment sampling location by event

- Harbor Island SRI (Mar. 1995)
- King County CSO 95 (June 1995)
- King County CSO 96 (Sept. 1996)
- T-18 Post Dredge (Mar. 2000)
- EW/HI Nature and Extent - Phase 1 (Sept. 2001)
- EW/HI Nature and Extent - Phase 2 (Sept. 2001)
- EW - Recontamination Monitoring 2006 (Jan. 2006)
- EW - Slip 27 (Jan. 2007)
- EW - Recontamination Monitoring 2007 (Feb. 2007)
- EW - Recontamination Monitoring 2008 (Jan. 2008)
- Dioxin summary location
- Rockfish sample location
- T-18 (proposed 2009)
- Stage 1a (completed 2006, -51 MLLW)
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)
- Intertidal zone
- CSO
- Storm drain
- CSO/storm drain
- Proposed East Waterway Operable Unit Boundary
- Dock/Pier
- Slip 27 Bridge
- Road
- Navigation channel

0 600
Scale in feet

Map 2-1a
Existing surface sediment sampling locations by event - South
Surface Sediment QAPP
East Waterway Operable Unit

Prepared by CEH, 02/13/09, MAP 3538; W:\Projects\00-08-06 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment



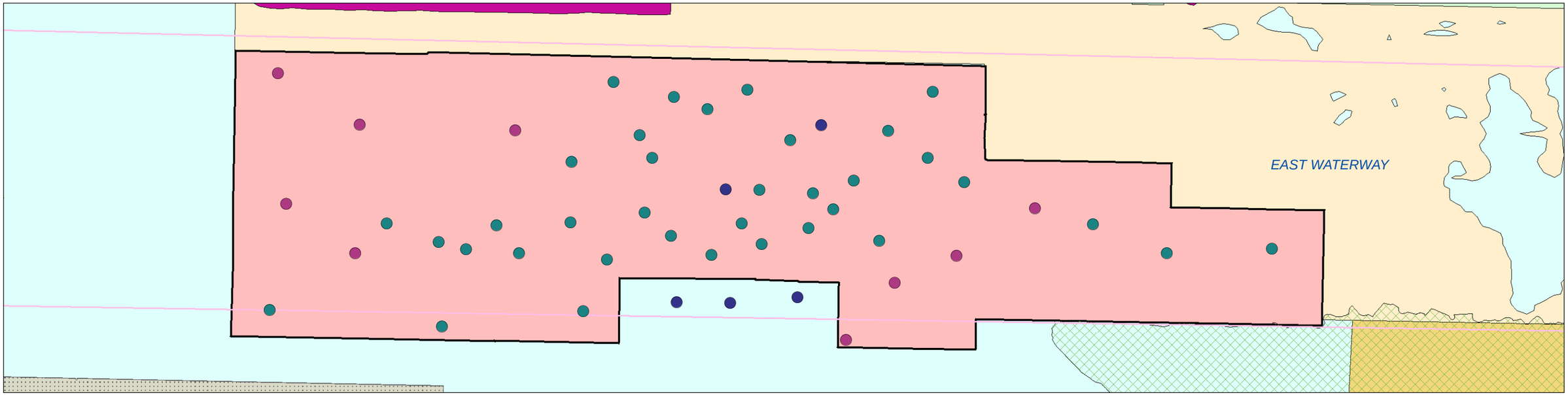
Surface sediment sampling location by event

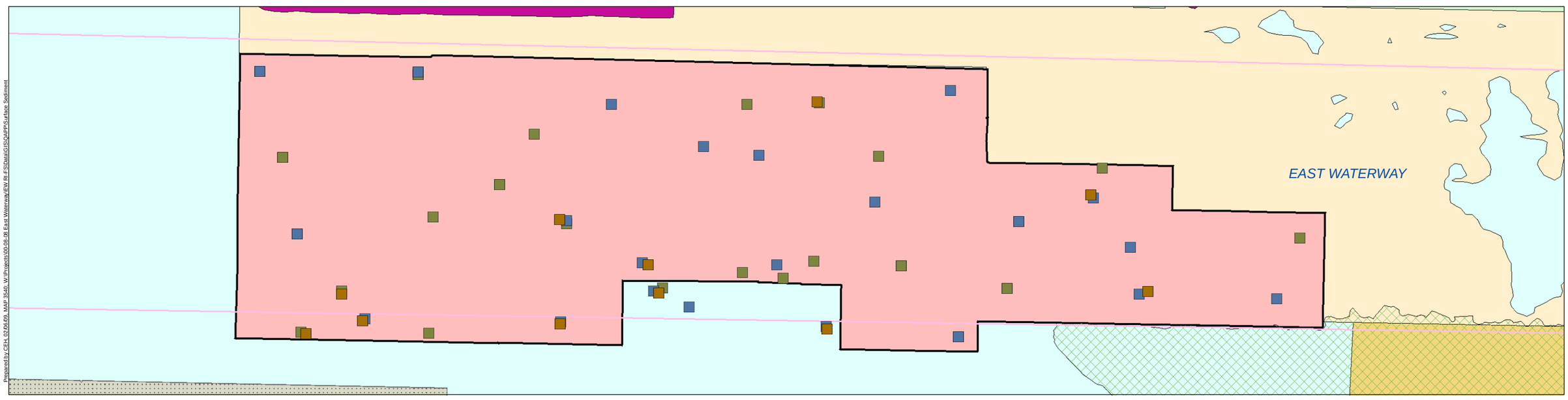
- Harbor Island SRI (Mar. 1995)
- King County CSO 95 (June 1995)
- King County CSO 96 (Sept. 1996)
- Pier 36 Underpier (Oct. 1996)
- T-18 Post Dredge (Mar. 2000)
- EW/HI Nature and Extent - Phase 1 (Sept. 2001)
- EW/HI Nature and Extent - Phase 2 (Sept. 2001)
- USCG Pier 36 Post Dredge (May 2005)
- EW - Recontamination Monitoring 2006 (Jan. 2006)
- EW - Recontamination Monitoring 2007 (Feb. 2007)
- EW - Recontamination Monitoring 2008 (Jan. 2008)
- Dioxin summary location
- Rockfish sample location
- T-18 (proposed 2009)
- T-30 interim dredge (proposed 2008, -51 MLLW)
- Stage 1a (completed 2006, -51 MLLW)
- Coast Guard dredge, completed 2005
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- T-30 boundary (completed 2002, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)
- CSO
- Storm drain
- Proposed East Waterway Operable Unit Boundary
- Intertidal zone
- Dock/Pier
- Road
- Navigation channel

0 600
Scale in feet

Map 2-1b
Existing surface sediment sampling locations by event - North
Surface Sediment QAPP
East Waterway Operable Unit

Prepared by CEH, 02/06/09, MAP 3538; W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment





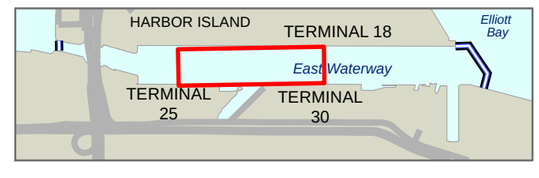
Prepared by CEH, 02/06/09, MAP 3540; W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment

Surface sediment sampling location by event

- Post Dredge Monitoring-2005 (Jan. 2005)
- Post Dredge Monitoring-2005 Phase 2 (Feb. 2005)
- EW Pre-Sand Placement Monitoring (Feb. 2005)
- EW - Recontamination Monitoring 2006 (Jan. 2006)
- EW - Recontamination Monitoring 2007 (Feb. 2007)
- EW - Recontamination Monitoring 2008 (Jan. 2008)

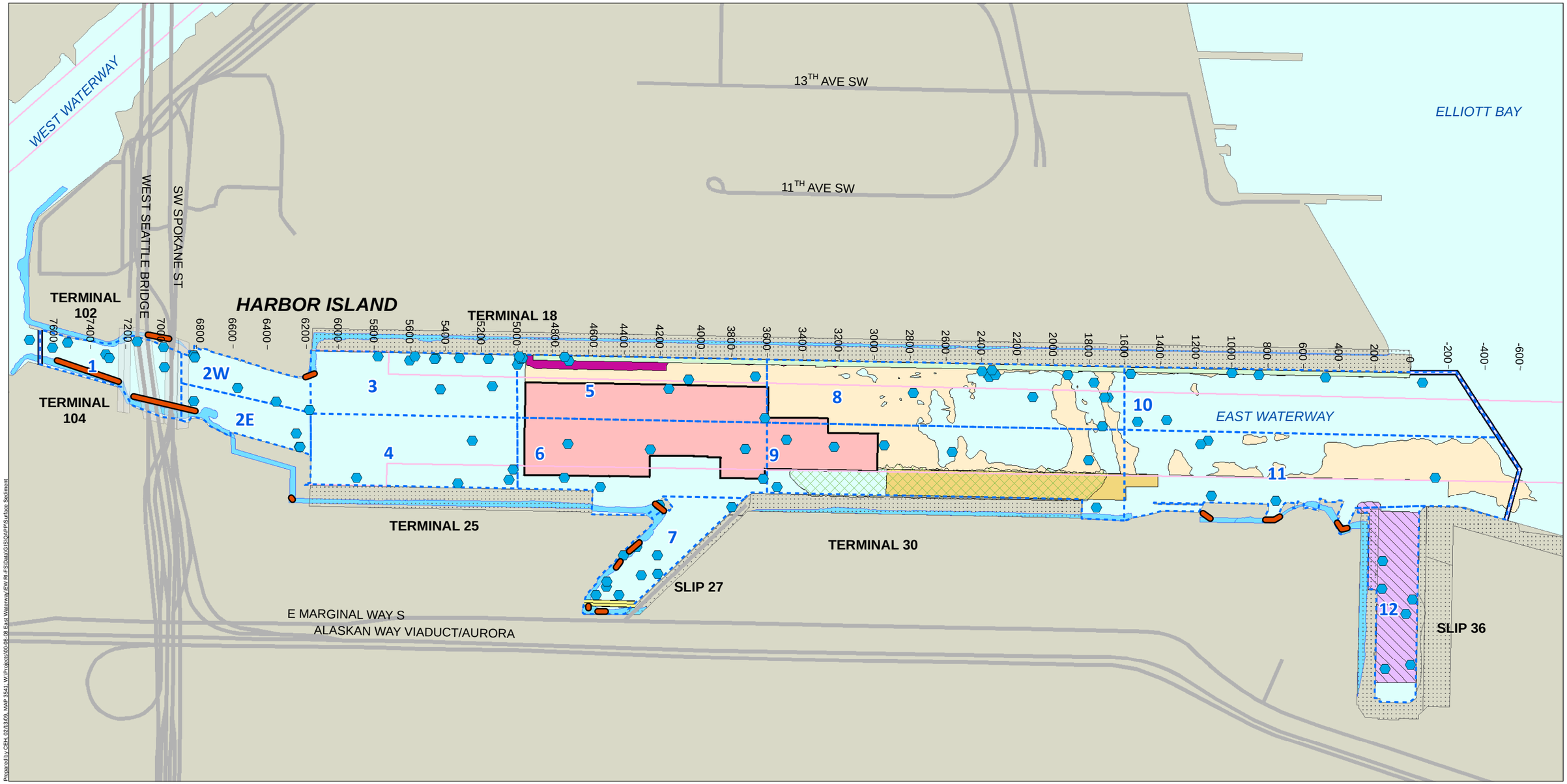
- T-30 interim dredge (proposed 2008, -51 MLLW)
- Stage 1a (completed 2006, -51 MLLW)
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- T-30 boundary (completed 2002, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)

- Proposed East Waterway Operable Unit Boundary
- Dock/Pier
- Navigation channel



0 300
Scale in feet

Map 2-2
Post-dredge monitoring and recontamination monitoring locations for the Phase 1 removal area
Surface Sediment QAPP
East Waterway Operable Unit



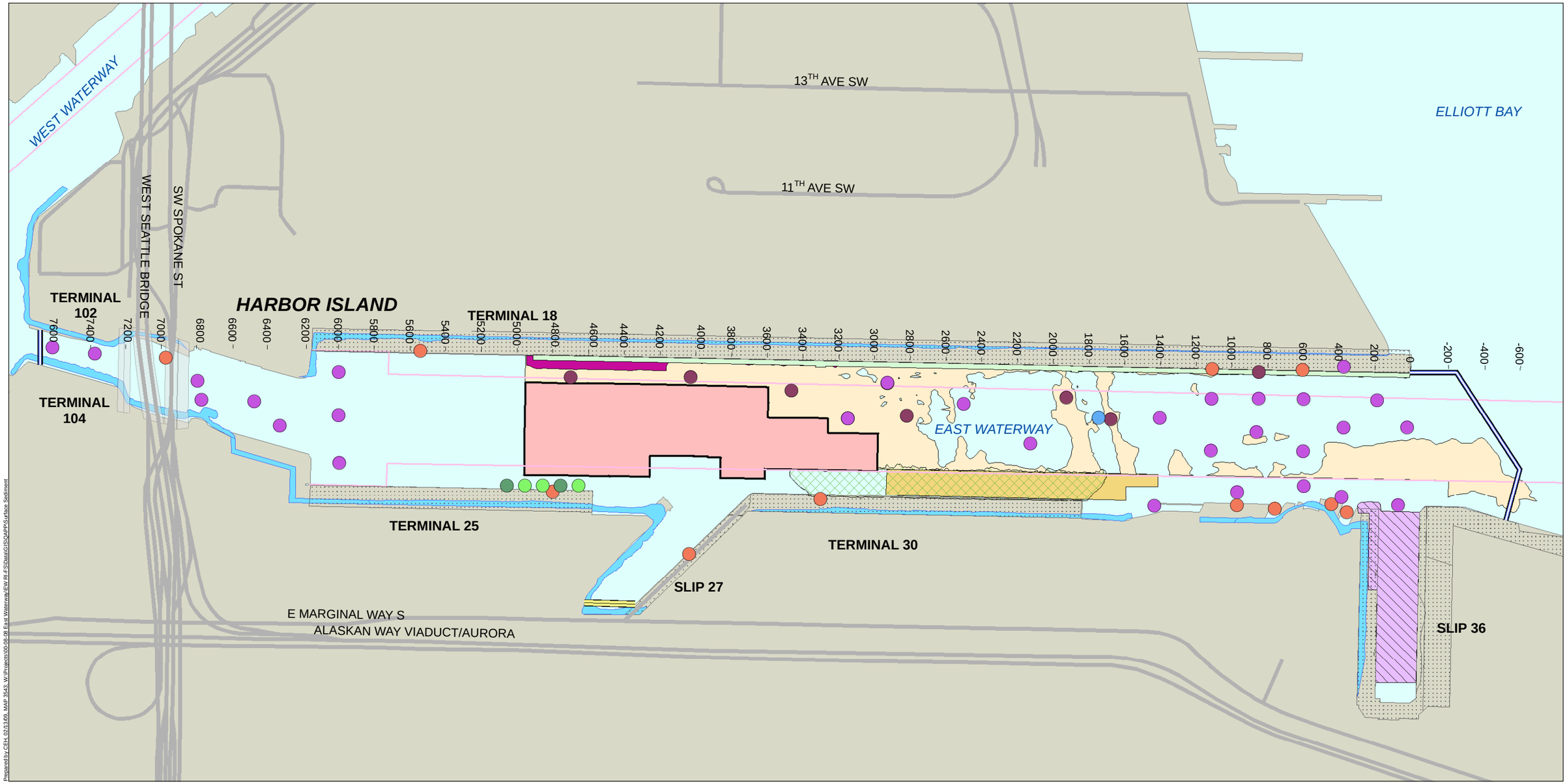
Prepared by CEH, 02/13/09, MAP 3541; W:\Projects\00-08-09 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment

- Benthic tissue collection area boundary
- Benthic tissue sampling location
- Clam collection beach
- T-18 (proposed 2009)
- Stage 1a (completed 2006, -51 MLLW)
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)
- Intertidal zone
- Proposed East Waterway Operable Unit Boundary
- Dock/Pier
- Slip 27 Bridge
- Road
- Navigation channel

Note: Benthic invertebrate sediment and tissue were analyzed as composite samples for each sampling area. Clam tissue and associated sediment were composited by beach area.

0 1,200
Scale in feet

Map 2-3
Composite sediment sampling locations associated with clam and benthic invertebrate tissue sampling events
Surface Sediment QAPP
East Waterway Operable Unit



Prepared by CEH, 02/13/09, MAP 3543; W:\Projects\00-08-09 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment

Bioassay sampling location, 0–15 cm, by event

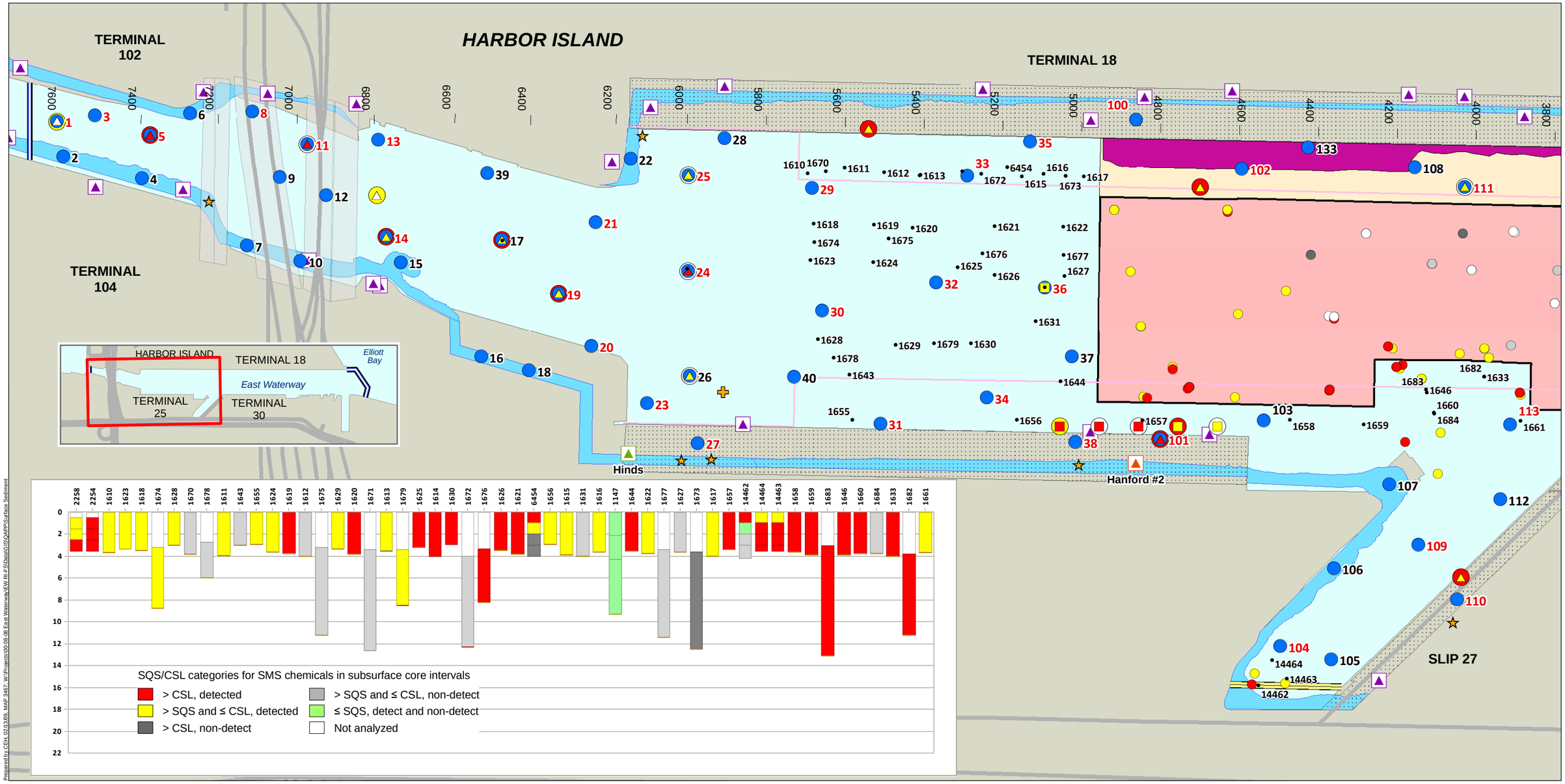
- Harbor Island SRI (Mar. 1995)
- King County CSO 95 (June 1995)
- King County CSO 96 (Sept. 1996)
- T-18 Post Dredge (Mar. 2000)
- EW/HI Nature and Extent Phase 1 (Sept. 2001)
- EW/HI Nature and Extent Phase 2 (Sept. 2001)

- T-18 (proposed 2009)
- Stage 1a (completed 2006, -51 MLLW)
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)
- Intertidal zone

- Proposed East Waterway Operable Unit Boundary
- Dock/Pier
- Slip 27 Bridge
- Road
- Navigation channel

0 1,200
Scale in feet

Map 2-4
Existing sediment bioassay sample locations
Surface Sediment QAPP
East Waterway Operable Unit



Prepared by CEH, 02/13/09, MAP 3467; W:\Projects\90-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment

- Proposed 2009 sampling location[a]
- Subsurface sampling location

Bioassay sampling location, 0–15 cm

- > CSL
- > SQS and ≤ CSL
- ≤ SQS

SQS/CSL categories for all chemicals in surface sediment by year category

Years collected: > 2005

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

Years collected: 2000 - 2005

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

Years collected: < 2000

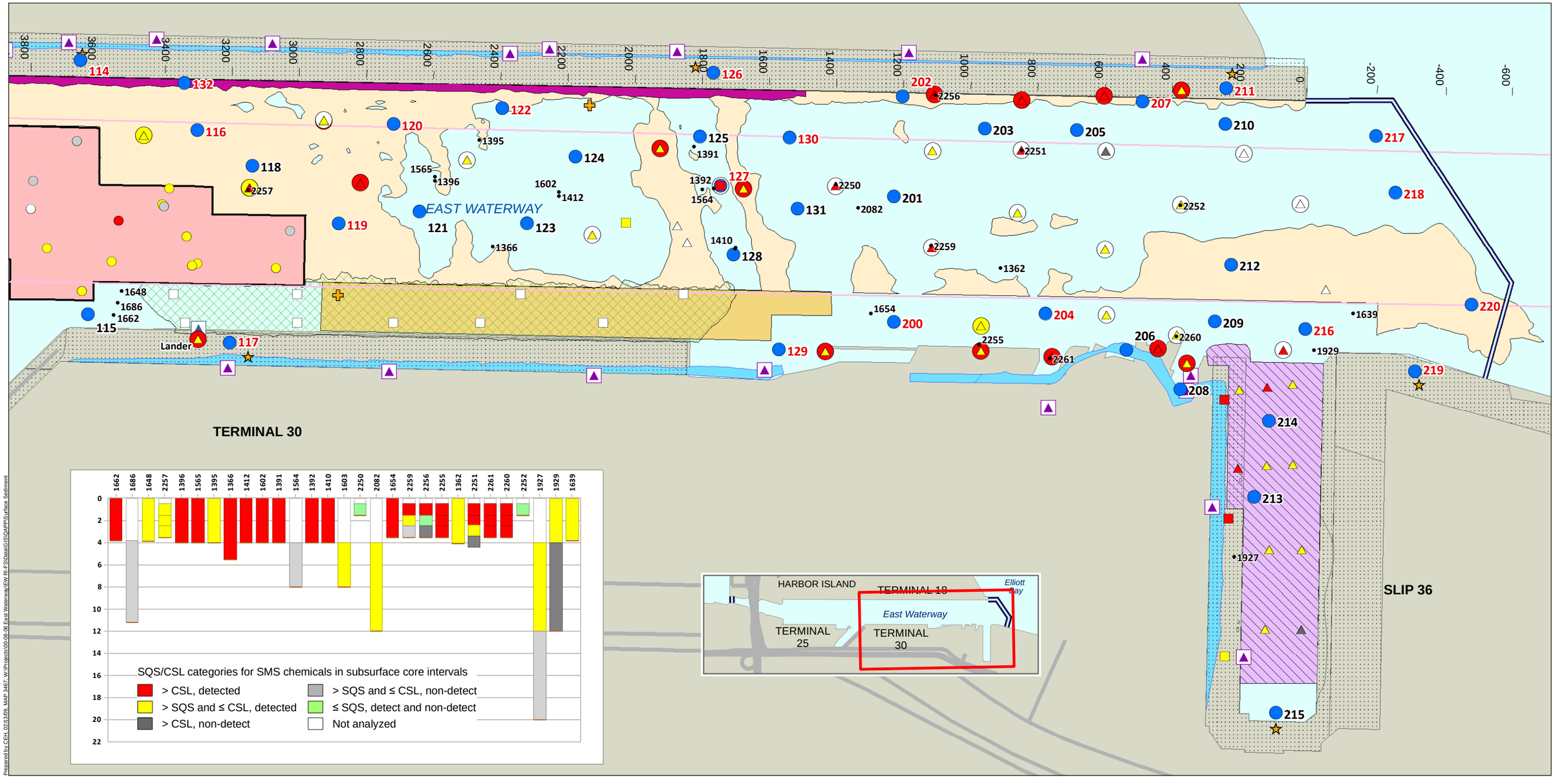
- > CSL, detect
- > SQS and ≤ CSL, detect

- Dioxin summary location
- Rockfish sample location
- Stage 1a (completed 2006, -51 MLLW)
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)
- Intertidal zone
- CSO
- Storm drain
- CSO/storm drain
- Proposed East Waterway Operable Unit Boundary
- Dock/Pier
- Slip 27 Bridge
- Road
- Navigation channel

[a] For proposed locations: red label = Round 1 sample; black label = Round 2 sample.

0 600
Scale in feet

Map 3-1a
Proposed sampling locations with exceedances of SMS criteria for existing surface sediment locations, bioassay results, and subsurface SMS results - South Surface Sediment QAPP
East Waterway Operable Unit



Proposed 2009 sampling location[a]

Proposed post-dredge analytical sampling location[b]

Subsurface sampling location

Bioassay sampling location, 0–15 cm

> CSL

> SQS and ≤ CSL

≤ SQS

SQS/CSL categories for all chemicals in surface sediment by year category

Years collected: > 2005

> CSL, detect

> SQS and ≤ CSL, detect

≤ SQS, detect

> CSL, non-detect

> SQS and ≤ CSL, non-detect

Years collected: 2000 - 2005

> CSL, detect

> SQS and ≤ CSL, detect

≤ SQS, detect

> CSL, non-detect

Years collected: < 2000

> CSL, detect

> SQS and ≤ CSL, detect

Dioxin summary location

Rockfish sample location

T-30 interim dredge (proposed 2008, -51 MLLW)

Stage 1a (completed 2006, -51 MLLW)

Coast Guard dredge, completed 2005

Phase 1 removal action boundary (completed 2005, -51 MLLW)

T-30 boundary (completed 2002, -51 MLLW)

Stage 1 (completed 2000, -51 MLLW)

Storm drain

CSO/storm drain

Intertidal zone

Proposed East Waterway Operable Unit Boundary

Dock/Pier

Road

Navigation channel

[a] For proposed locations: red label = Round 1 sample; black label = Round 2 sample. [b] Additional post-dredge samples will be collected and archived. Samples represent analytical samples only.

0 600

Scale in feet

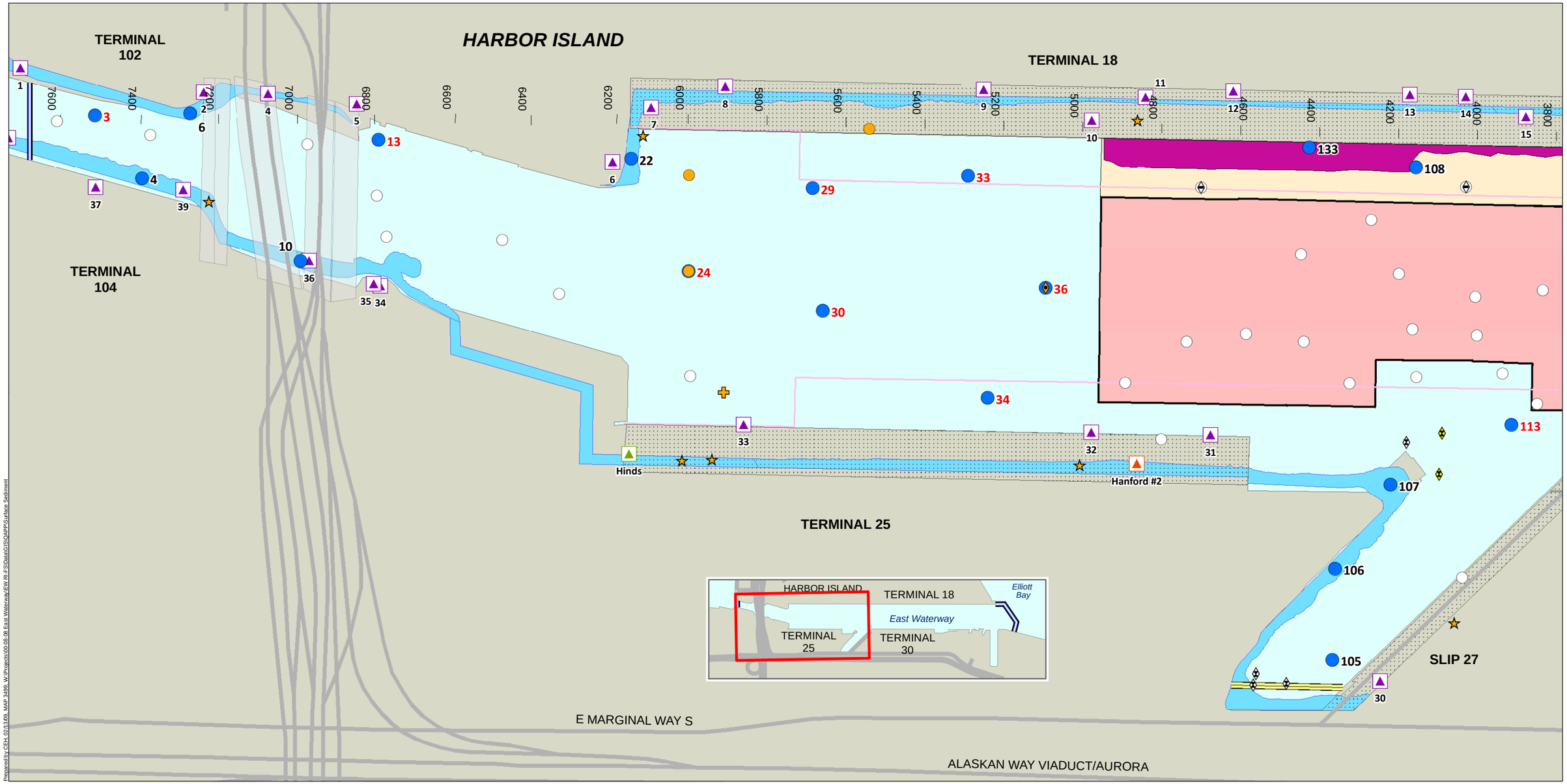
Map 3-1b

Proposed sampling locations with exceedances of SMS criteria for existing surface sediment locations, bioassay results, and subsurface SMS results - North

Surface Sediment QAPP

East Waterway Operable Unit

Prepared by CEH, 02/13/09, MAP 3467; W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment



Proposed 2009 sampling location analyzed for TBT[a]

Tributyltin as ion
Porewater
SL = 0.15 µg/L
Years collected: 2000 - 2005

- > SL and no ML, detect
- ≤ SL and no ML
- Dioxin summary location
- Rockfish sample location

Bulk sediment detected values (µg/kg dw)

- > 1,000
- > 500 and ≤ 1,000
- > 200 and ≤ 500
- > 100 and ≤ 200
- ≤ 100

Years collected:

- < 2000
- 2000 - 2005
- > 2005

- Stage 1a (completed 2006, -51 MLLW)
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)
- Intertidal zone

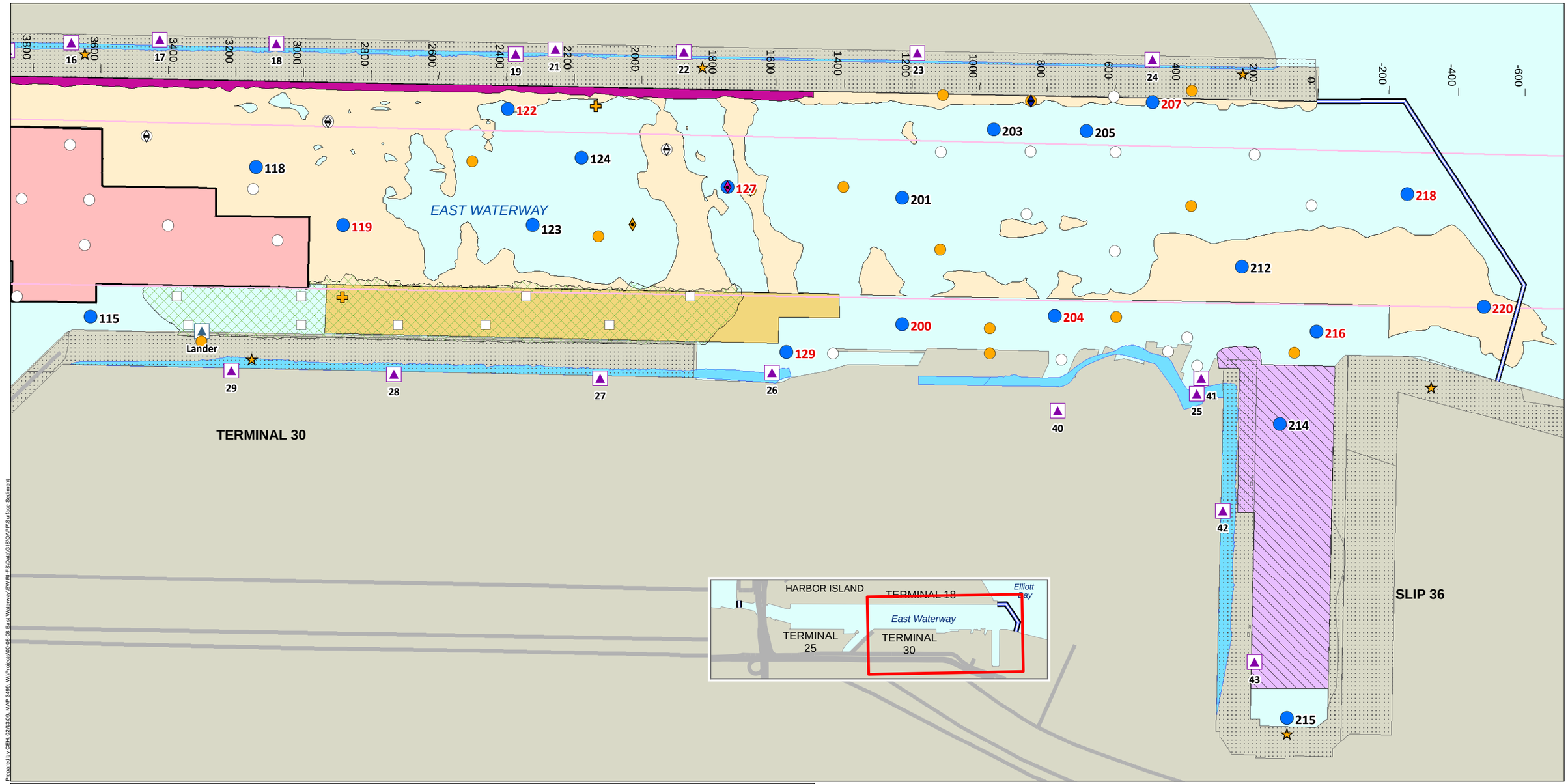
- CSO
- Storm drain
- CSO/storm drain
- Proposed East Waterway Operable Unit Boundary
- Dock/Pier
- Slip 27 Bridge
- Road
- Navigation channel

0 600
Scale in feet

[a] For proposed locations: red label = Round 1 sample; black label = Round 2 sample.

Map 3-2a
Proposed sampling locations for the analysis of TBT with TBT results for existing sediment and porewater samples - South Surface Sediment QAPP
East Waterway Operable Unit

Prepared by CEH, 02/13/09, MAP 3499; W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment



Prepared by CEH, 02/13/09, MAP 3499; W:\Projects\00-08-09 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment

- Proposed 2009 sampling location analyzed for TBT[a]
- Proposed post-dredge analytical sampling location[b]

Tributyltin as ion

Porewater
SL = 0.15 µg/L
Years collected: 2000 - 2005

- > SL and no ML, detect
- ≤ SL and no ML

Bulk sediment detected values (µg/kg dw)

- > 1,000
- > 500 and ≤ 1,000
- > 200 and ≤ 500
- > 100 and ≤ 200
- ≤ 100

Years collected:

- < 2000
- 2000 - 2005
- > 2005

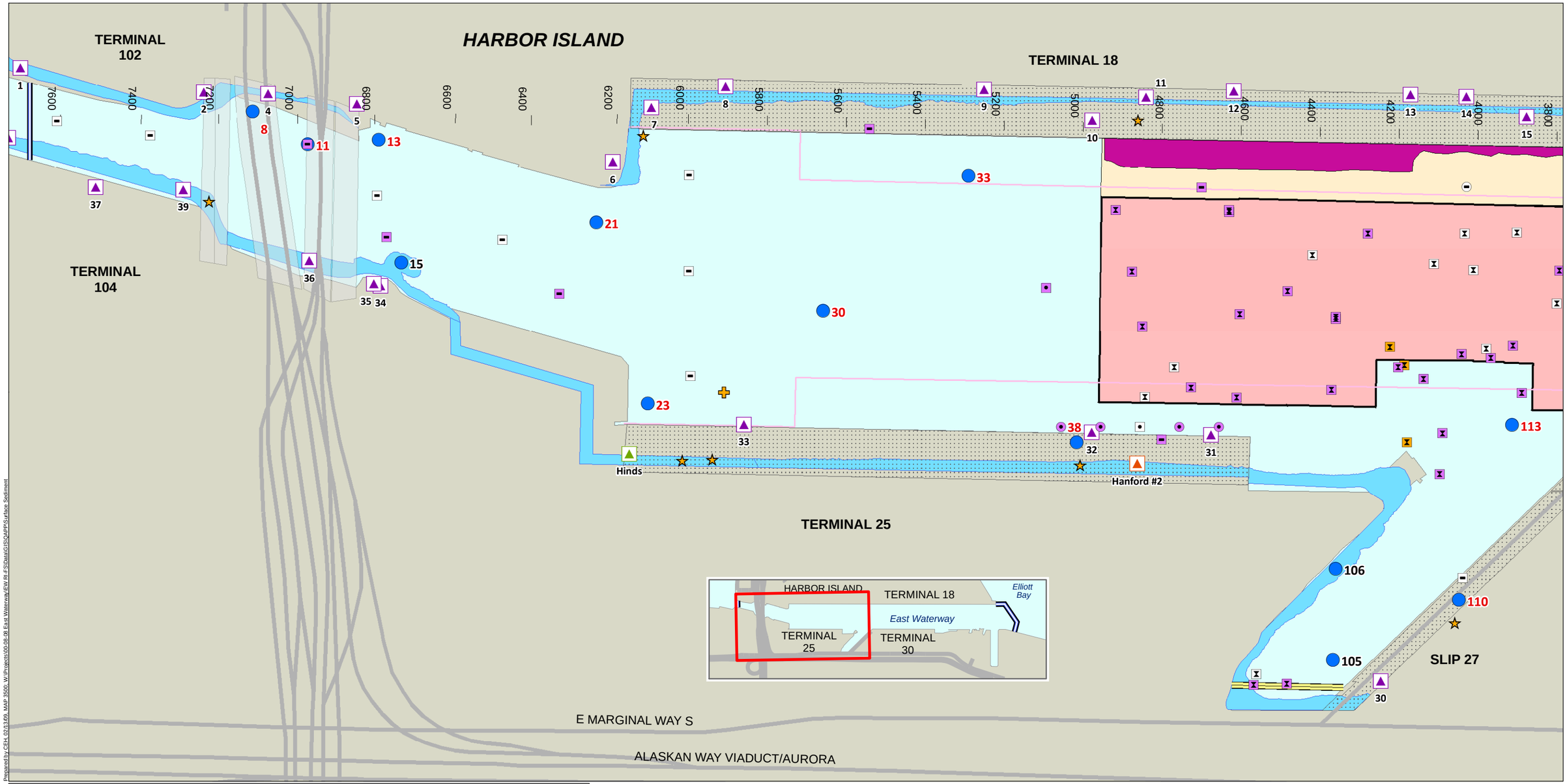
- Dioxin summary location
- Rockfish sample location
- T-30 interim dredge (proposed 2008, -51 MLLW)
- Stage 1a (completed 2006, -51 MLLW)
- Coast Guard dredge, completed 2005
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- T-30 boundary (completed 2002, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)

- Storm drain
- CSO/storm drain
- Intertidal zone
- Proposed East Waterway Operable Unit Boundary
- Dock/Pier
- Road
- Navigation channel

[a] For proposed locations: red label = Round 1 sample; black label = Round 2 sample.
[b] Additional post-dredge samples will be collected and archived. Samples represent analytical samples only.

0 600
Scale in feet

Map 3-2b
Proposed sampling locations for the analysis of TBT with TBT results for existing sediment and porewater samples - North
Surface Sediment QAPP
East Waterway Operable Unit



Prepared by CEH, 02/13/09, MAP 3500; W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment

Proposed 2009 sampling location analyzed for pesticides[a]

Total DDTs
- > SL and ≤ ML, detect
- ≤ SL, detect
- > ML, non-detect
- > SL and ≤ ML, non-detect
- ≤ SL, non-detect

Years collected:
- < 2000
- 2000 - 2005
- > 2005

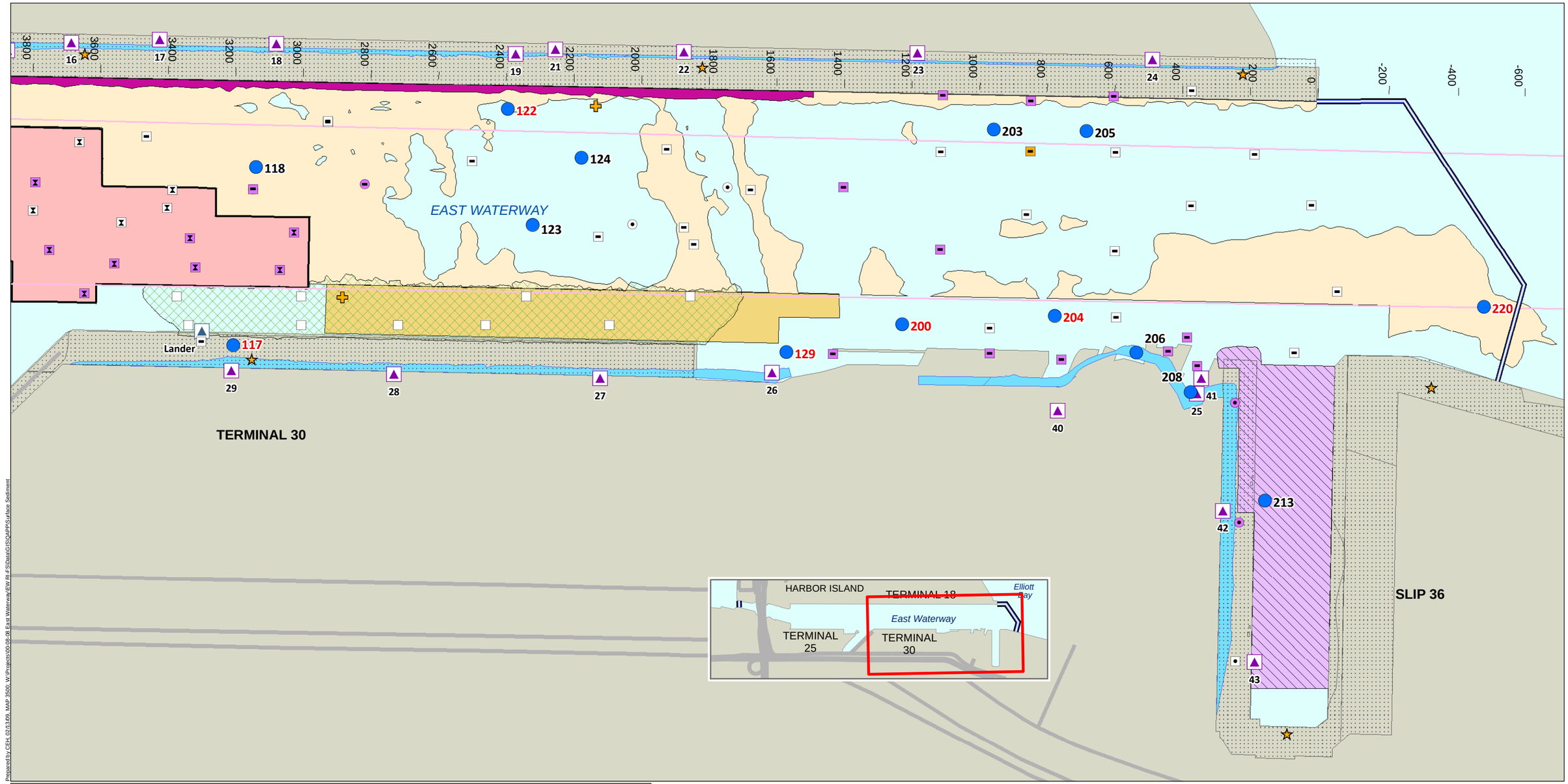
Rockfish sample location
Dioxin summary location
Stage 1a (completed 2006, -51 MLLW)
Phase 1 removal action boundary (completed 2005, -51 MLLW)
Stage 1 (completed 2000, -51 MLLW)
Intertidal zone

CSO
Storm drain
CSO/storm drain
Proposed East Waterway Operable Unit Boundary
Dock/Pier
Slip 27 Bridge
Road
Navigation channel

0 600
Scale in feet

[a] For proposed locations: red label = Round 1 sample; black label = Round 2 sample.

Map 3-3a
Proposed sampling locations for the analysis of pesticides with total DDTs results for existing sediment samples - South Surface Sediment QAPP
East Waterway Operable Unit



Prepared by CEH, 02/13/09, MAP 3500; W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment

- Proposed 2009 sampling location analyzed for pesticides[a]

Total DDTs

- > SL and ≤ ML, detect
- ≤ SL, detect
- > ML, non-detect
- > SL and ≤ ML, non-detect
- ≤ SL, non-detect

Years collected:

- < 2000
- 2000 - 2005
- > 2005

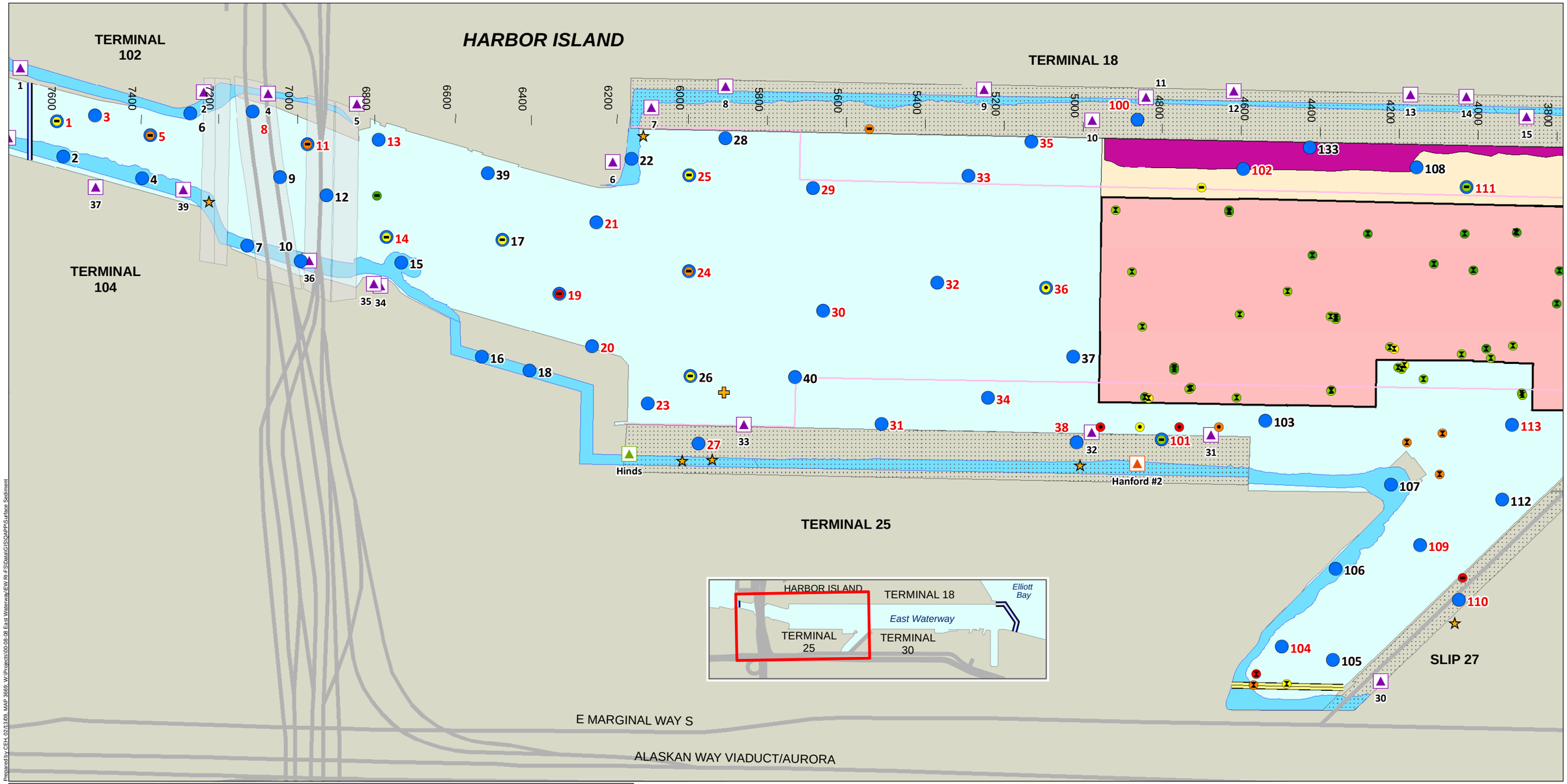
- Proposed post-dredge analytical sampling location[b]
- Dioxin summary location
- Rockfish sample location
- T-30 interim dredge (proposed 2008, -51 MLLW)
- Stage 1a (completed 2006, -51 MLLW)
- Coast Guard dredge, completed 2005
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- T-30 boundary (completed 2002, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)

- Storm drain
- CSO/storm drain
- Intertidal zone
- Proposed East Waterway Operable Unit Boundary
- Dock/Pier
- Road
- Navigation channel

0 600
Scale in feet

[a] For proposed locations: red label = Round 1 sample; black label = Round 2 sample.
[b] Additional post-dredge samples will be collected and archived. Samples represent analytical samples only.

Map 3-3b
Proposed sampling locations for the analysis of pesticides with total DDTs results for existing sediment samples - North
Surface Sediment QAPP
East Waterway Operable Unit



Proposed 2009 sampling location analyzed for cPAHs[a]

cPAHs (µg/kg dw)[b]

- > 930 and ≤ 3,800 (80th to 100th percentile)
- > 580 and ≤ 930 (60th to 80th percentile)
- > 350 and ≤ 580 (40th to 60th percentile)
- > 110 and ≤ 350 (20th to 40th percentile)
- ≤ 110 (20th percentile)

Years collected:

- < 2000
- 2000 - 2005
- > 2005

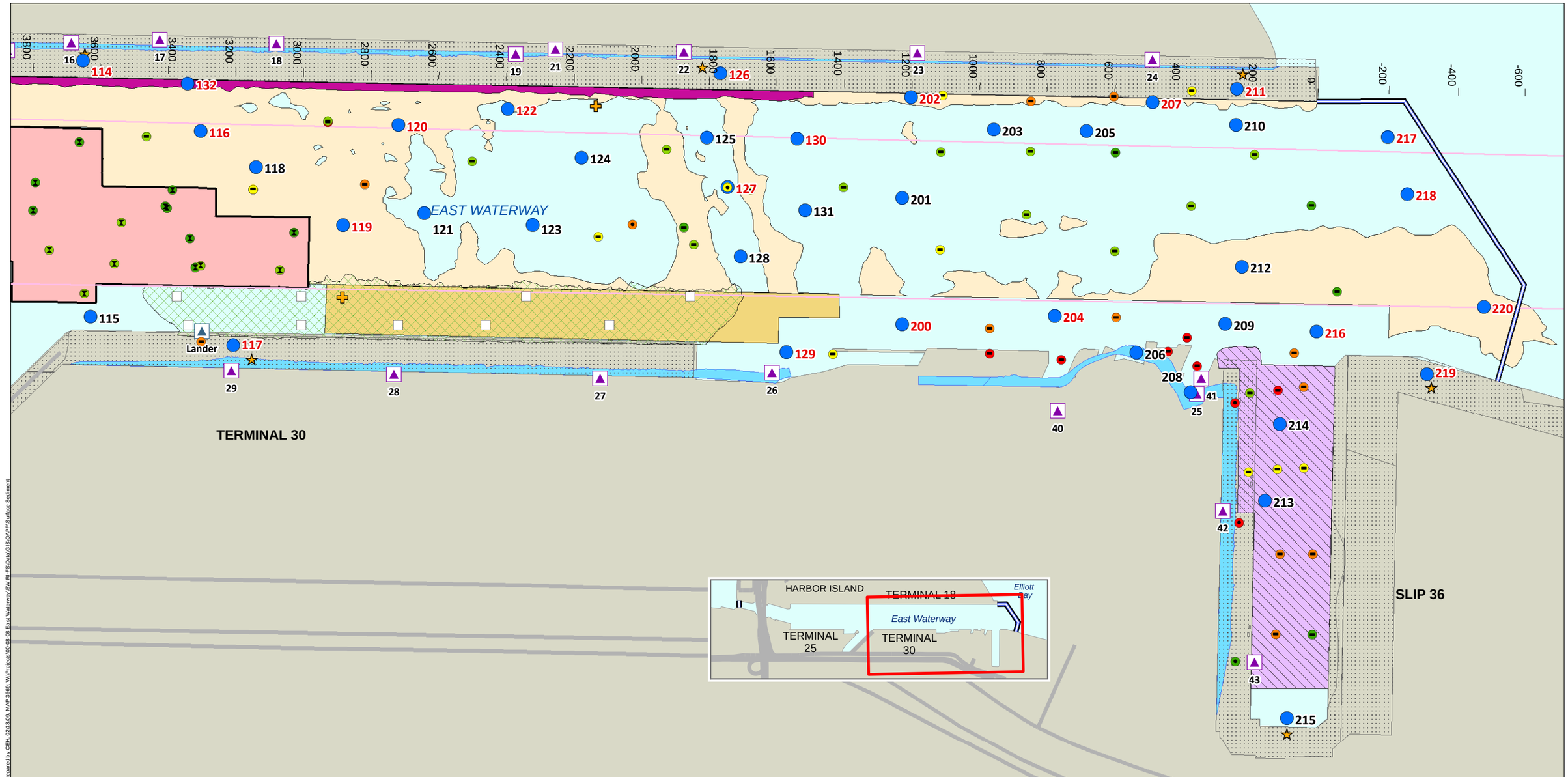
- Rockfish sample location
- Dioxin summary location
- Stage 1a (completed 2006, -51 MLLW)
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)
- Intertidal zone
- CSO
- Storm drain
- CSO/storm drain
- Proposed East Waterway Operable Unit Boundary
- Dock/Pier
- Slip 27 Bridge
- Road
- Navigation channel

0 600
Scale in feet

Note: Chemistry data for all samples is provided for every averaged location with an exceedance.
[a] For proposed locations: red label = Round 1 sample; black label = Round 2 sample.
[b] cPAH concentrations were calculated as benzo(a)pyrene equivalents using PEF values from CalEPA 1994.
[c] Averaged locations are symbolized using an outline around the location symbol.

Map 3-4a
Proposed sampling locations for the analysis of PAHs with cPAH results for existing sediment samples - South
Surface Sediment QAPP
East Waterway Operable Unit

Prepared by CEH, 02/13/09, MAP 3669: W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment



Prepared by CEH, 02/13/09, MAP 3669; W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment

- Proposed 2009 sampling location analyzed for cPAHs[a]

cPAHs (µg/kg dw)[b]

- > 930 and ≤ 3,800 (80th to 100th percentile)
- > 580 and ≤ 930 (60th to 80th percentile)
- > 350 and ≤ 580 (40th to 60th percentile)
- > 110 and ≤ 350 (20th to 40th percentile)
- ≤ 110 (20th percentile)

Years collected:

- < 2000
- 2000 - 2005
- > 2005

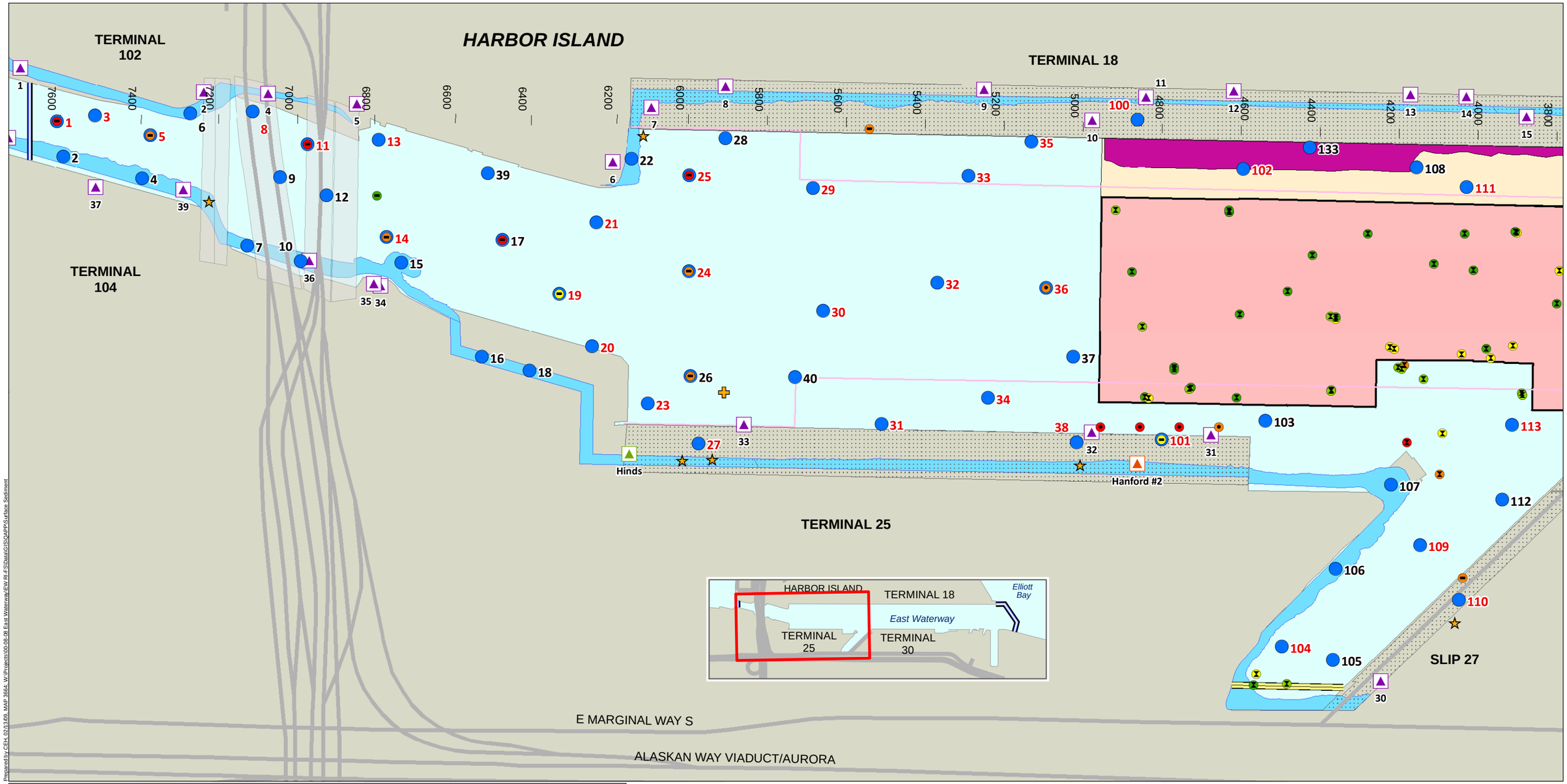
- Proposed post-dredge analytical sampling location[d]
- Dioxin summary location
- Rockfish sample location
- T-30 interim dredge (proposed 2008, -51 MLLW)
- Stage 1a (completed 2006, -51 MLLW)
- Coast Guard dredge, completed 2005
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- T-30 boundary (completed 2002, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)

- Storm drain
- CSO/storm drain
- Intertidal zone
- Proposed East Waterway Operable Unit Boundary
- Dock/Pier
- Road
- Navigation channel

0 600
Scale in feet

Note: Chemistry data for all samples is provided for every averaged location with an exceedance.
[a] For proposed locations: red label = Round 1 sample; black label = Round 2 sample.
[b] cPAH concentrations were calculated as benzo(a)pyrene equivalents using PEF values from CalEPA 1994.
[c] Averaged locations are symbolized using an outline around the location symbol.
[d] Additional post-dredge samples will be collected and archived. Samples represent analytical samples only.

Map 3-4b
Proposed sampling locations for the analysis of PAHs with cPAH results for existing sediment samples - North
Surface Sediment QAPP
East Waterway Operable Unit



Prepared by CEH, 02/13/09, MAP 3664, W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment

- Proposed 2009 sampling location analyzed for arsenic[a]

Arsenic (mg/kg dw)

- > 13.1 and ≤ 241 (80th to 100th percentile)
- > 9 and ≤ 13.1 (60th to 80th percentile)
- > 4.5 and ≤ 9 (40th to 60th percentile)
- > 3.5 and ≤ 4.5 (20th to 40th percentile)
- ≤ 3.5 (20th percentile)

Years collected:

- < 2000
- 2000 - 2005
- > 2005

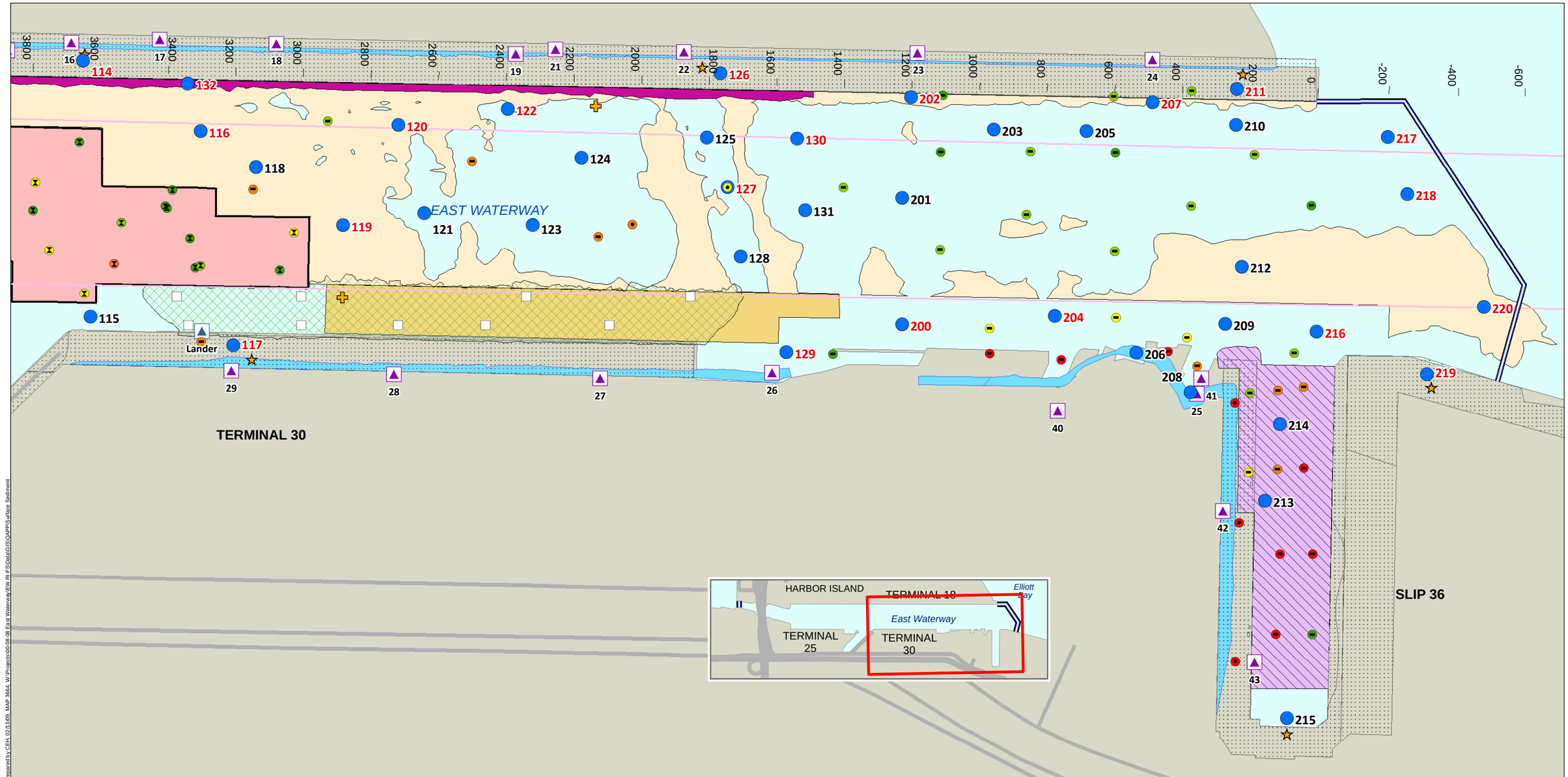
- Rockfish sample location
- Dioxin summary location
- Stage 1a (completed 2006, -51 MLLW)
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)
- Intertidal zone

- CSO
- Storm drain
- CSO/storm drain
- Proposed East Waterway Operable Unit Boundary
- Dock/Pier
- Slip 27 Bridge
- Road
- Navigation channel

0 600
Scale in feet

Note: Chemistry data for all samples is provided for every averaged location with an exceedance.
[a] For proposed locations: red label = Round 1 sample; black label = Round 2 sample.

Map 3-5a
Proposed sampling locations for the analysis of arsenic with arsenic results for existing sediment samples - South
Surface Sediment QAPP
East Waterway Operable Unit



Prepared by CEH, 02/13/09, MAP 3664; W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment

- Proposed 2009 sampling location analyzed for arsenic[a]

Arsenic (mg/kg dw)

- > 13.1 and ≤ 241 (80th to 100th percentile)
- > 9 and ≤ 13.1 (60th to 80th percentile)
- > 4.5 and ≤ 9 (40th to 60th percentile)
- > 3.5 and ≤ 4.5 (20th to 40th percentile)
- ≤ 3.5 (20th percentile)

Years collected:

- < 2000
- 2000 - 2005
- > 2005

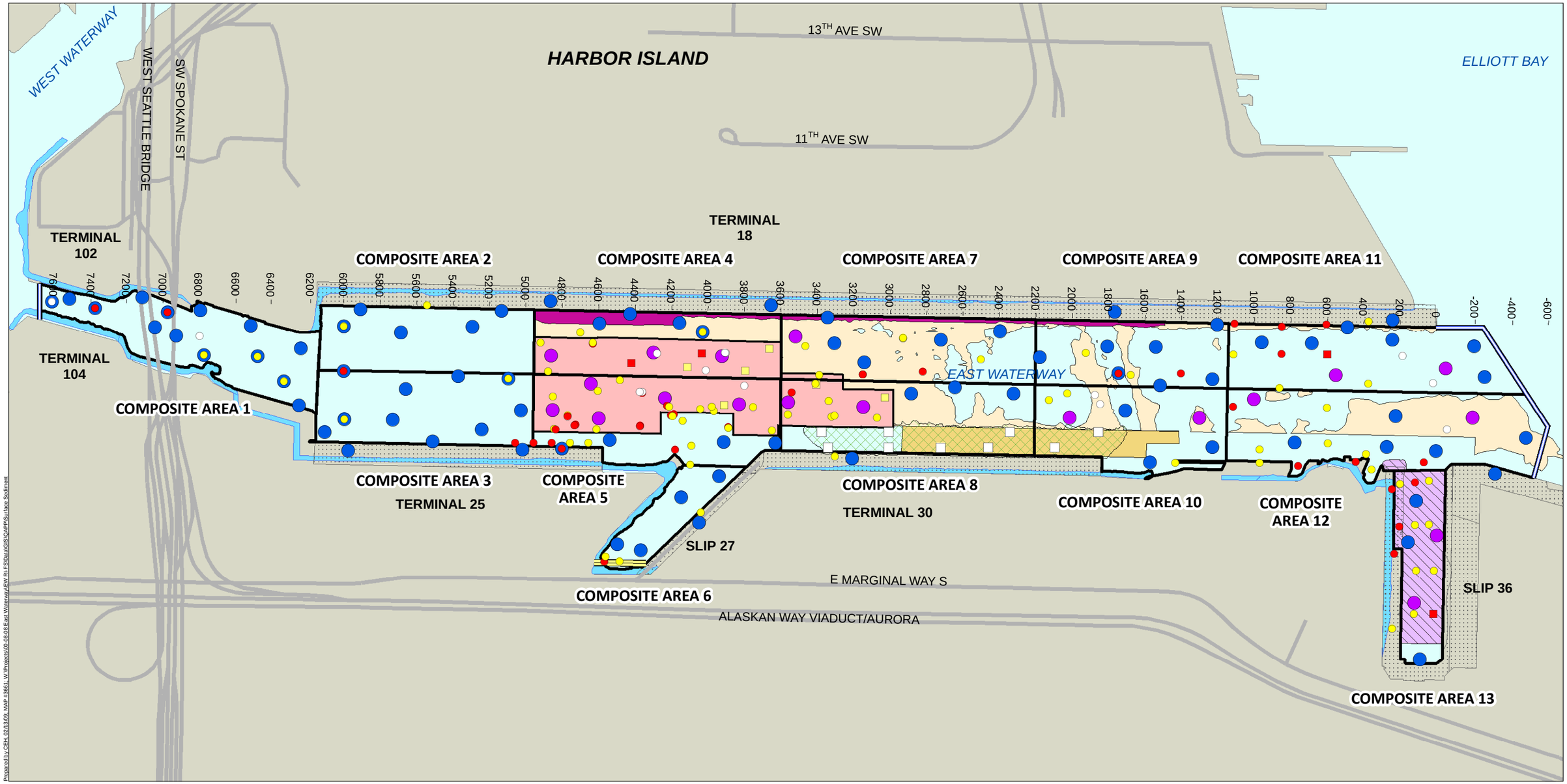
- Proposed post-dredge analytical sampling location[d]
- Dioxin summary location
- Rockfish sample location
- T-30 interim dredge (proposed 2008, -51 MLLW)
- Stage 1a (completed 2006, -51 MLLW)
- Coast Guard dredge, completed 2005
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- T-30 boundary (completed 2002, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)

- Storm drain
- CSO/storm drain
- Intertidal zone
- Proposed East Waterway Operable Unit Boundary
- Dock/Pier
- Road
- Navigation channel

0 600
Scale in feet

Note: Chemistry data for all samples is provided for every averaged location with an exceedance.
[a] For proposed locations: red label = Round 1 sample; black label = Round 2 sample.

Map 3-5b
Proposed sampling locations for the analysis of arsenic with arsenic results for existing sediment samples - North
Surface Sediment QAPP
East Waterway Operable Unit



Prepared by CEH, 02/13/09; MAP #3661; W:\Projects\00-08-08 East Waterway\EW RI-FS\Data\GIS\QAPP\Surface Sediment

- Proposed 2009 sampling location
- Proposed subtidal composite sampling location

SQS/CSL categories for all chemicals

- > CSL, detect
- > SQS and ≤ CSL, detect
- > CSL, non-detect
- > SQS and ≤ CSL, non-detect
- ≤ SQS, detect
- Proposed post-dredge analytical sampling location

- Subtidal composite area
- Dock/Pier
- Slip 27 Bridge
- Proposed East Waterway Operable Unit Boundary
- T-30 interim dredge (proposed 2008, -51 MLLW)
- Stage 1a (completed 2006, -51 MLLW)
- Coast Guard dredge, completed 2005
- Phase 1 removal action boundary (completed 2005, -51 MLLW)
- Stage 1 (completed 2000, -51 MLLW)
- T-30 boundary (completed 2002, -51 MLLW)

0 600
Scale in feet

Map 3-6
Proposed sediment locations for the creation of subtidal composite sediment samples
Surface Sediment QAPP
East Waterway Operable Unit

APPENDIX A

Health and Safety Plan

EAST WATERWAY OPERABLE UNIT
SUPPLEMENTAL REMEDIAL INVESTIGATION/ FEASIBILITY STUDY
HEALTH AND SAFETY PLAN
SURFACE SEDIMENT SAMPLING FOR CHEMICAL ANALYSES AND TOXICITY TESTING OF THE EAST WATERWAY

For submittal to:

The US Environmental Protection Agency
Region 10
Seattle, WA

February 22, 2009

Prepared by:

Windward environmental LLC
200 West Mercer Street, Suite 401
Seattle, Washington • 98119

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.

February 22, 2009

Susan McGroddy — Date

Project Manager

February 22, 2009

Tad Deshler — Date

Corporate Health and Safety Manager

February 22, 2009

Thai Do — Date

Field Coordinator/Health and Safety Officer

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Acronyms

CFR	Code of Federal Regulations
CPR	cardiopulmonary resuscitation
EW	East Waterway
FC	field coordinator
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSM	health and safety manager
HSO	health and safety officer
HSP	health and safety plan
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PCBs	polychlorinated biphenyls
PEC	project emergency coordinator
PFD	personal flotation device
PM	project manager
PPE	personal protective equipment
QAPP	quality assurance project plan
TCDD	tetrachlorodibenzo-*p*-dioxin
USCG	US Coast Guard

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 the elements specified in 29 CFR 1910§120. The goal of the HSP is to establish procedures for safe working practices for all field personnel.

This HSP addresses all activities associated with collection and handling of surface sediment in the East Waterway (EW). During site work, this HSP will be implemented by the field coordinator (FC), who is also the designated site health and safety officer (HSO), in cooperation with the corporate health and safety manager (HSM) and the project manager (PM).

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

2 Site Description and Project Scope

2.1 Site Description

The sampling area is in the EW (see Maps 3-1a and 3-1b in the quality assurance project plan [QAPP] to which this HSP is attached). The area is affected by tidal fluctuations. The QAPP provides complete details of the sampling program.

2.2 Scope and Duration of Work

This section summarizes the types of work that will be performed during field activities. Specific tasks to be performed are as follows:

- Collection of sediment samples by: van Veen grab sampler from a boat, hand using a stainless steel spoon in intertidal areas, or hand-corer using a diver in underpier areas
- Sample handling, processing, and shipping

The collection sediment samples is anticipated to occur in two rounds beginning in March 2009, as described in 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.

Project Manager: The PM has 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. The PM, in consultation with the HSM, makes final decisions concerning implementation of the HSP.

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

Corporate Health and Safety Manager: The HSM has overall responsibility for the preparation, approval, and revision 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 a members must be familiar and comply with the information in this HSP. They also have the responsibility to immediately report any potentially unsafe or hazardous conditions to the FC/HSO.

4 Hazard Evaluation and Control Measures

This section discusses 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 4.4) 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 present a greater risk of injury than do chemical hazards. Physical hazards are identified and discussed below.

4.1.1 Slips, trips, and falls

As with all fieldwork sites, caution should be exercised to prevent slips on slick surfaces. In particular, sampling from a boat or other floating platform requires careful attention to minimize the risk of falling down or falling overboard. The same care should be used in rainy conditions or on the shoreline where slick rocks are found. Slips can be minimized through the use of boots with good treads, made of material that does not become overly slippery when wet.

Trips are always a hazard on the uneven deck of a boat, in a cluttered work area, or in the intertidal zone where uneven substrate is common. Personnel will keep work areas as free as possible from items that interfere with walking.

Falls can also be a hazard. Personnel can avoid falls by working as far from exposed edges as possible, erecting railings, and using fall protection when working on elevated platforms. For this project, no work that would present a fall hazard is anticipated.

4.1.2 Sampling equipment

A van Veen grab sampler will be used to collect most of the sediment samples, as described in Section 3.2 of the QAPP. Before sampling activities begin, all personnel will attend a training session to discuss the equipment that will be onboard the sampling vessel.

Other sediment samples will be collected by hand (e.g., stainless steel spoon) in the intertidal areas, or by divers using a hand corer at underpier locations, as described in the QAPP.

4.1.3 Falling overboard

Most of the sampling activities will be performed on a boat. As with any work from a floating platform, there is a chance of falling overboard. Personal flotation devices (PFDs) will be worn by all personnel while working from the 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, hypothermia, or frostbite

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

4.1.6 Weather

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

4.1.7 Sharp objects

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

4.1.8 Scuba diving

Scuba diving presents an array of risks not common to a normal worksite. Therefore, tasks that involve diving will be performed by a professional diver who has been properly trained and certified and is aware of the myriad inherent risks involved with scuba diving in hazardous environments. With proper training, the risk of these potential hazards can be minimized. Commercial divers provided by Research Support Services will adhere to their dive plan (Attachment 1).

The diver will dive line-tended, with wireless communication to the surface. A safety diver will tend the line and wear a headset to talk with the diver in the water. The safety diver will also be suited up and ready to enter the water if necessary. In the unlikely event that the in-water diver would require assistance, the diver could be retrieved using the tending line or assisted by the safety diver. Emergency oxygen and first aid will be on the boat, as well as a dive plan that will list local hospitals and dive-related emergency contact information (Attachment 1).

Equipment failure is always a concern. Divers should be familiar with their specific type of equipment and check the tank, regulator, buoyancy control device, gauges, and any other equipment to make sure everything is in proper working order prior to use. The compressed air supply is filled by a local dive store so an air check is not necessary. The diver is also equipped with a pony bottle, which is a small emergency (bailout) air tank.

Divers must be careful to avoid pilings and other obstacles that might snag gear or entrap the diver. Having a clear sense of the layout of the area before getting into the water and taking extra caution during times of low visibility will minimize the risk from these hazards.

Hypothermia sets in much more quickly in water than in air. Wearing proper insulation and knowing the symptoms can help prevent this hazard. Warm clothes should be available on board the support boat.

Nitrogen narcosis is a risk associated with spending too much time at depth. This project will not require diving below approximately 50 ft, so the risk of narcosis is minimal. However, it is still necessary to consult dive tables to create a dive profile for each dive. Strict adherence to the diver safety manual should prevent nitrogen narcosis.

If boat traffic is a possibility, a dive flag must be deployed in the vicinity of the divers. Divers should surface as close as possible to the flag and/or support boat. Diving will not be done in the channel, where shipping activity takes place. The dive tender will continuously monitor Channels 13, 14, and 16 for boat traffic near the dive area, advise other vessels of diving operations, and, if possible, warn off boat traffic that may pose a hazard to divers.

4.2 VESSEL HAZARDS

Because of the high volumes of vessel and barge traffic on the EW, precautions and safe boating practices will be implemented to ensure that the field boat does not interrupt vessel traffic. Additional potential vessel emergency hazards and responses are listed in Table 1.

Table 1. Potential vessel emergency hazards and responses

POTENTIAL EMERGENCY OR HAZARD	RESPONSE
Fire or explosion	If manageable, personnel should attempt to put out a small fire with a fire extinguisher. Otherwise, personnel should call the USCG or 911 and evacuate the area (by rescue boat or swimming) and meet at a designated area. The FC/HSO will take roll call to make sure everyone evacuated safely. Emergency meeting places will be determined in the field during the daily safety briefing.
Medical emergency or injury	At least one person with current first aid and CPR training will be aboard the vessel at all times. This person will attempt to assess the nature and severity of the injury, immediately call 911, and perform CPR if necessary. Personnel should stop work and wait for medical personnel to arrive. Once the emergency has passed, the FC/HSO should fill out a site accident report.
Person overboard	All personnel aboard the sampling vessel will wear PFDs at all times. One person should keep an eye on the individual who fell overboard and shout the distance (boat lengths) and direction (o'clock) of the individual from the vessel. Personnel should stop work and use the vessel to retrieve the individual in the water.
Sinking vessel	Personnel should call the USCG immediately. If possible, personnel should wait for a rescue boat to arrive to evacuate vessel personnel. See fire or explosion (above) for emergency evacuation procedures. The FC/HSO will take a roll call to make sure everyone is present.
Lack of visibility	If navigation visibility or personal safety is compromised because of smoke, fog, or other unanticipated hazards, personnel should stop work immediately. The vessel operator and FC/HSO will assess the hazard and, if necessary, send out periodic horn blasts to mark vessel location to other vessels potentially in the area, move to a secure location (i.e., berth), and wait for the visibility to clear.
Loss of power	Personnel should stop work and call the USCG for assistance. Personnel should use oars to move vessel towards the shoreline. Other vessel personnel should watch for potential collision hazards and notify the vessel operator if hazards exist. Personnel should secure the vessel to a berth, dock, or mooring as soon as possible.

Potential Emergency or Hazard	Response
Collision	Personnel should stop work and call the USCG for assistance. The FC/HSO and vessel operator will assess damage and potential hazards. If necessary, the vessel will be evacuated and secured until repairs can be made.

CPR – cardiopulmonary resuscitation
FC – field coordinator
HSO – health and safety officer
PFD – personal flotation device
USCG – US Coast Guard

4.3 Chemical Hazards

Previous investigations have shown that some chemical substances are present at higher-than-background concentrations in the sampling area. For the purpose of discussing potential exposure to substances in sediments, the chemicals of concern are metals, tributyltin, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and dioxins and furans.

4.3.1 Exposure routes

Potential routes of chemical exposure include inhalation, dermal contact, and ingestion. Exposure will be minimized by using safe work practices and by wearing the appropriate personal protective equipment (PPE). Further discussion of PPE requirements is presented in Section 7.

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

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

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

4.3.2 Description of chemical hazards

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

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

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

Dioxins/furans — Prolonged skin contact with dioxins/furans may cause acne-like symptoms known as chloracne. Other effects to 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, result in an increase in the risk of diabetes and abnormal glucose tolerance, and may 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 sediment 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 sediments from exposed skin.

4.4 ACTIVITY HAZARD ANALYSIS

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

Table 2 presents the activity hazard analysis for sampling from a boat, sampling from intertidal beaches, and scuba diving.

Table 2. Activity hazard analysis

ACTIVITY	HAZARD	CONTROL
Sampling from a boat	falling overboard	Use care in boarding and departing from vessel. Wear a PFD.
	skin contact with contaminated sediments or liquids	Wear modified Level D PPE.
	back strain	Use appropriate lifting technique when transporting equipment and supplies to/from the boat, or seek help.
Sampling from intertidal beaches	skin contact with contaminated sediments or liquids	Wear modified Level D PPE.
	slips, trips, and falls	Wear boots with good treads and use caution when walking on slippery surfaces and riprap.
	back strain	Use appropriate lifting techniques when digging in sediment with shovel.
Scuba diving	loss of communication	Terminate the dive.
	equipment failure	Conduct a pre-dive check; have dive tender and/or safety diver present during dive.
	scrapes and bruises; entrapment by pilings and other obstacles	Be familiar with the area before entering the water. Exercise caution when visibility is low.
	hypothermia	Wear appropriate insulation. Be aware of the symptoms and have warm clothes available.
	nitrogen narcosis	Consult dive tables prior to each dive.
	boat traffic	Deploy the dive flag in the vicinity of the divers. Ascend carefully and as close as possible to the support boat. Have dive tender continuously monitor Channels 13, 14, and 16 for boat traffic near dive area. Ensure that dive tender advises other vessels of diving operations and warns off boat traffic that may pose a hazard to the divers.
	loss of communication	Terminate the dive.

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

5.1 WORK ZONE

The work zone will encompass the area where sample collection and handling activities are performed. The FC/HSO will delineate the work zone as a particular area on-board the collection vessels. 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 will be set up, and personnel will clean soiled boots or PPE prior to leaving the work zone. The station will have the buckets, brushes, soapy water, rinse water, or wipes necessary to clean boots, PPE, or other equipment leaving the work zones. Plastic bags will be provided for expendable and disposable materials. If the location does not allow for the establishment of a decontamination station, the FC/HSO will provide alternatives to prevent the spread of contamination.

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

5.3 ACCESS CONTROL

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

6 Safe Work Practices

Following common sense rules will minimize the risk of exposure or accidents at the work site. These general safety rules will be followed onsite:

- Do not climb over or under obstacles of questionable stability.
- Do not eat, drink, smoke, or perform other hand-to-mouth transfers in the work zone.
- Work only in well-lighted spaces.
- Never enter a confined space without the proper training, permits, and equipment.
- Make eye contact with equipment operators when moving within the range of their equipment.
- Be aware of the movements of shipboard equipment when not in the operator's range of vision.
- Get immediate first aid for all cuts, scratches, abrasions, or other minor injuries.
- Use the established sampling and decontamination procedures.
- Always use the buddy system.
- Be alert to your own and other workers' physical condition.

- Report all accidents, no matter how minor, to the FC/HSO.
- Do not do anything dangerous or unwise even if ordered by a supervisor.

7 Personal Protective Equipment and Safety Equipment

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

Fieldwork will be conducted in Level D or modified Level D PPE, as discussed in Sections 7.1 and 7.2. Situations that would require 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 PPE selected.

7.1 Level D Personal Protective Equipment

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

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

7.2 Modified Level D Personal Protective Equipment

Individuals performing activities in which skin contact with contaminated materials is possible but inhalation risks are not expected will be required to wear an impermeable outer suit. The type of outerwear will be chosen according to the types of chemical contaminants that might be encountered. Modified Level D PPE includes the following:

- Impermeable outer garb, such as rain gear
- Chemical-resistant steel-toed boots
- Chemical-resistant outer gloves

7.3 Safety Equipment

In addition to the above-identified PPE, basic emergency and first aid equipment will also be provided. Equipment for the field team will include:

- A copy of this HSP
- First aid kit adequate for the number of personnel in the field crew

- Emergency eyewash

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 implemented. 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 emits high-amplitude (i.e., > 85 dBA) noise. For this project, the monitoring program will consist of all individuals monitoring themselves and their co-workers for signs of potential 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 conditions during the performance of all field activities. Examples of such changes are as follows:

- Headaches
- Dizziness
- Nausea
- Symptoms of heat stress
- Blurred vision
- Cramps
- Irritation of eyes, skin, or respiratory system
- Changes in complexion or skin color
- Changes in apparent motor coordination
- Increased frequency of minor mistakes
- Excessive salivation or changes in papillary response
- Changes in speech ability or speech pattern
- Shivering
- Blue lips or fingernails

If any of these conditions develop, work 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
- Long-handled 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 personal decontamination procedures. Personnel will perform decontamination procedures, as appropriate, before eating lunch, taking a break, or leaving the work location. Decontamination procedures for field personnel include:

1. Rinse off the outer suit if it is heavily soiled.
2. Wash and rinse outer gloves and boots with water.
3. Remove and inspect outer gloves and discard them if damaged.
4. Wash hands if taking a break.
5. Don necessary PPE before returning to work.
6. Dispose of soiled, disposable PPE before leaving for the day.

In addition to the decontamination procedures listed above, divers will:

1. Thoroughly rinse dive suit and gear after each dive.
2. Inspect gear for mud or stains, and re-rinse or scrub with Alconox®, if necessary.
3. Discard any damaged or heavily soiled gear after the project, if necessary.
4. Launder dry suit underwear after the project.

9.3 SAMPLING EQUIPMENT DECONTAMINATION

Sampling equipment will be decontaminated to minimize sample contamination. The practices listed below will be followed:

- Ice chests will be scrubbed with Alconox® detergent and rinsed with deionized water prior to any sampling activities.
- Samples will be placed in clean, laboratory certified sample jars, or resealable, waterproof plastic bags to avoid contamination from melting ice.
- Sampling equipment will be free from contaminants such as oils, grease, and fuels.
- All utensils or equipment used directly in handling sediment samples will be scrubbed with Alconox® detergent and rinsed with deionized water, and stored in aluminum foil until use.

9.4 VESSEL DECONTAMINATION

Some sampling will be conducted from a boat. Care will be taken to minimize the amount of sediment spilled on the vessel. The vessel deck will be hosed off regularly to remove sediment from the cockpit and crew areas to minimize slipping hazards and sediment transport on boots through work zones.

10 Disposal of Contaminated Materials

Contaminated materials that may be generated during field activities include PPE, decontamination fluids, 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, all excess sediment will be returned to the 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 the 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 Hazardous Waste Operations and Emergency Response (HAZWOPER) training, as described in Section 2.5 of the QAPP, field personnel will undergo training specifically for this project. All personnel must read this HSP and be familiar with its contents before beginning work. Personnel will acknowledge reading the HSP by signing the Field Team Health and Safety Plan Review Form (Attachment 2). The completed form will be kept in the project files.

Boat operators will also be required to have the US Coast Guard (USCG) auxiliary boating safely certification. The boat captain and FC/HSO 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 chemical exposure
- Activities that pose physical hazards and actions to control the hazard

- Ship access control and procedure
- Use and limitations of PPE
- Decontamination procedures
- Emergency procedures
- Use and hazards of sampling equipment
- Location of emergency equipment
- Vessel safety practices
- Emergency 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 safety briefings in the logbook.

11.3 First Aid and CPR

At least one member of the field team must have first-aid and cardiopulmonary resuscitation (CPR) training. The diver and dive tender will also be trained in first-aid and CPR as required by the Research Support Services' diver safety manual. 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) will not be necessary for field team members because the field team members do not meet any of the four criteria outlined in the regulations for the 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 due to 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 of any deleterious changes in their physical or mental condition during the performance of all field activities.

13 Reporting and Record Keeping

Each member of the field crew will sign the Field Team Health and Safety Plan Review (see Attachment 2). 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 that records health- and safety-related details of the project. Alternatively, entries may be made in the field logbook, in which case a separate health and safety logbook will not be required. The logbook must be bound, and the pages must be numbered consecutively. Entries will be made with indelible blue ink. At a minimum, each day's entries must include the following information:

- Project name or location
- Names of all personnel
- Weather conditions
- Type of fieldwork being performed

The individual 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 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 the release of toxic or non-toxic substances (i.e., spills). OSHA regulations require that an emergency response plan be available to guide actions in emergency situations.

Onshore organizations will be relied upon to provide response in emergency situations. The local fire department and ambulance service can provide timely response. Field personnel will be responsible for identifying emergency situations, providing first aid if applicable, notifying the appropriate personnel or agency, and evacuating any hazardous area. Shipboard personnel will attempt to control only very minor hazards that could present an emergency situation, such as a small fire, and will otherwise rely on outside emergency response resources.

The following sections identify the 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 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. This preparation includes the following:

- Meeting with the FC/HSO and equipment handlers concerning the emergency procedures to be followed in the event of an injury
- Conducting a training session informing all field personnel of emergency procedures, locations of emergency equipment and their use, and proper evacuation procedures
- Conducting a training session (led by senior staff responsible for operating field equipment) to apprise field personnel of operating procedures and specific risks associated with field 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 (PEC) in the event of an emergency. He will designate a replacement for times when he is not available or is not serving as the PEC. The designation will be noted in the logbook. The PEC will be notified immediately when an emergency is recognized. The PEC will be responsible for evaluating the emergency situation, notifying the appropriate emergency response units, coordinating access with those units, and directing onboard interim actions before the arrival of emergency response units. The PEC will notify the HSM and the PM as soon as possible after initiating an emergency response action. The PM will have responsibility for notifying the client.

14.3 EMERGENCY RESPONSE CONTACTS

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

Table 3. Emergency response contacts

CONTACT	TELEPHONE NUMBER
Emergency Numbers	
Ambulance	911
Police	911
Fire	911
Harborview Medical Center	(206) 323-3074
US Coast Guard Office Emergency General information	 (206) 286-5400 (206) 442-5295 UHF Channel 16
National Response Center	(800) 424-8802
US Environmental Protection Agency	(908) 321-6660
Washington State Department of Ecology – Northwest Region Spill Response (24-hour emergency line)	(206) 649-7000
Emergency Contacts	
Susan McGroddy, Project Manager	(206) 812-5421
Tad Deshler, Corporate Health and Safety Manager	(206) 812-5406
Thai Do, Field Coordinator/ Health and Safety Officer	(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 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. 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:

- Administer first aid, if qualified.
- If not qualified, seek out an individual who is qualified to administer first aid, if time and conditions permit.
- Notify the PEC of the incident, the name of the individual, the location, and the nature of the injury.

The PEC will immediately do the following:

- Notify the boat captain and the appropriate emergency response organization.
- Assist the injured individual(s).
- Follow the emergency procedures for retrieving or disposing of equipment and leave the site and proceed to the predetermined land-based emergency pick-up.
- Designate someone to accompany the injured individual to the hospital.
- If a life-threatening emergency occurs (i.e., injury in which death is imminent without immediate treatment), the PEC or boat captain will call 911 and arrange to meet the emergency responder at the nearest accessible location or dock. For injuries or emergencies that are not life-threatening (i.e., broken bones, minor lacerations), the PEC will follow the procedures outlined above and proceed to the Harbor Island Marina or to an alternative location if that would be more expedient.
- Notify the HSM and the PM.

If the PEC determines that emergency response is not necessary, he may direct someone to decontaminate and transport the individual by vehicle to the nearest hospital. Directions describing the route to the hospital are in Section 14.10.

If a worker leaves the to seek medical attention, another worker should accompany that person to the hospital. When in doubt about the severity of an injury or exposure, always seek medical attention as a conservative approach and notify the PEC.

The PEC will 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, eyes should be rinsed 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 Emergency Route to the Hospital

The name, address, and telephone number of the hospital that will be used to provide medical care is as follows:

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

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

- Dock the vessel at the First Avenue S boat launch.
- Drive east on S River Street.

- Turn left on Occidental Avenue S.
- Turn left on E Marginal Way S.
- Turn right on S Michigan Street.
- Look for entrance ramps to I-5 northbound.
- Head north on I-5.
- Take the James Street exit.
- Head east on James Street to Ninth Avenue.
- Turn right on Ninth Avenue.
- Emergency entrance will be two blocks south on the right.

15 References

PSEP. 1997. Recommended guidelines for sampling marine sediment, water column, and tissue in Puget Sound. Final Report. Prepared for the U.S. Environmental Protection Agency, Seattle, Washington, and the Puget Sound Water Quality Action Team, Olympia, WA.

Attachment 1. Dive Plan

RSS RESEARCH SUPPORT SERVICES, INC. 206-550-5202
8010 NE Lovgren Road, Bainbridge Island, WA 98110 eparker@rssincorporated.com

DIVE SAFETY AND WORK PLAN
EAST WATERWAY SURFACE SEDIMENT SAMPLING
FOR
WINDWARD ENVIRONMENTAL

EMERGENCY RESPONSE INFORMATION

NOTE: Call local 911 first in case of any medical emergency prior to traveling to the emergency medical facility. Call DAN with questions regarding treatment of diving emergencies.

Telephone emergency: **911 and Divers Alert Network 1-919-684-8111**

Coast Guard emergency: **1-206-217-6000 (*CG from any cell phone)**

Dive Emergency Gear**:** **First aid kit, emergency oxygen kit, VHF radio, and cellular phones**

Field Cellular Phone: (b) (6)

Nearest Dive Emergency Medical Facilities:

Harborview Medical Center, 325 9th Ave., Seattle (206) 731-3074 emergency room

Virginia Mason Hospital, Hyperbaric Medicine Dept., 1202 Terry Ave., Seattle

(206) 583-6543 hyperbaric; (206) 583-6433 emergency room and after hours hyperbaric

U.S. Naval Torpedo Station, Keyport (360) 396-2111 or (360) 396-8111

Nearest Non-dive Emergency Medical Facilities:

Virginia Mason Hospital, Hyperbaric Medicine Dept., 925 Seneca Street, Seattle

(206) 583-6433 emergency room

DIVE PLAN

Project: Collect surface sediment samples using a diver-deployed sampler.

Work window: **Start 0900, end 1700**

Project Managers: Eric Parker, RSS; Susan McGroddy, Windward Environmental

Dates of operation: **March 2-3, 2009**

Location of Dives: **East Waterway, Seattle**

Primary Divers: Eric Parker

Don Peterson

Tender: Andrew Muth

Purpose of Work: Sediment sampling

Number of Dives Anticipated: TBD

Maximum depth Anticipated: 65 ft.

Depth for Majority of Work: 50 ft. and shallower

Breathing Gas: Air

Pre-Dive Procedures:

- The U.S. Coast Guard in Seattle will be provided with an emailed copy of this Dive Plan prior to the dive operations (email sectorseattlewwm@.uscg.mil).
- The Coast Guard VTS will be notified on VHF channel 14 or by phone at (206) 217-6152 on the day of work prior to commencing diving operations and again when work is finished for the day.
- A pre-dive briefing will be conducted to familiarize divers and surface personnel of site-specific hazards and to ensure readiness to work.

General Work Plan:

- **Operations will be conducted from the *Carolyn Dow*,** a 36' aluminum landing craft anchored adjacent to the dive location.
- A single, line-tended diver will conduct the sampling.
- A safety diver will stand ready on the vessel ready to assist.
- Divers and tender will communicate via single side band wireless equipment.

Safety Procedures:

- Diving operations will be conducted in accordance with federal and state health and safety regulations and according to procedures outlined in the RSS Dive Safety Manual. The Windward Site Specific Health and Safety Plan will apply to non-diving components of this operation and will be reviewed by all participants.
- The vessel will notify Seattle VTS of the operation and will monitor VHF channels 14 and 13. **No special vessel consideration (such as a no wake zone) is requested.**
- A blue-and-white alpha flag will be flown conspicuously when divers are in the water.
- Emergency oxygen will be available on site in case of a pressure-related injury. In addition to administration of oxygen to an injured diver, basic first aid and activation of EMS will apply.

Area of operations:

Attachment 2. Field Team Health and Safety Plan Review

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

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 Collection Forms

SURFACE SEDIMENT COLLECTION FORM

Project Name: _____ **Project no.** _____

Date: _____ **Station:** _____

Start/Stop time: _____ _____

Sampling Method: _____ _____

Weather: _____

Crew: _____

SampleID: _____ **Bottom depth:** _____ **Penetration depth** _____ **Time:** _____

Analyses needed before homogenization (circle): **VOC** **sulfides** **AVS/SEM** **Acceptable grab (circle)** **yes** **no**

Sediment type:	**Sediment color:**	**Sediment odor:**		**Comments:**
cobble	drab olive	none	H_2S	
gravel	gray	slight	petroleum	
sand C M F	black	moderate	other:	
silt clay	brown	strong		
organic matter	brown surface			

SampleID: _____ **Bottom depth:** _____ **Penetration depth** _____ **Time:** _____

Analyses needed before homogenization (circle): **VOC** **sulfides** **AVS/SEM** **Acceptable grab (circle)** **yes** **no**

Sediment type:	**Sediment color:**	**Sediment odor:**		**Comments:**
cobble	drab olive	none	H_2S	
gravel	gray	slight	petroleum	
sand C M F	black	moderate	other:	
silt clay	brown	strong		
organic matter	brown surface			

SampleID: _____ **Bottom depth:** _____ **Penetration depth** _____ **Time:** _____

Analyses needed before homogenization (circle): **VOC** **sulfides** **AVS/SEM** **Acceptable grab (circle)** **yes** **no**

Sediment type:	**Sediment color:**	**Sediment odor:**		**Comments:**
cobble	drab olive	none	H_2S	
gravel	gray	slight	petroleum	
sand C M F	black	moderate	other:	
silt clay	brown	strong		
organic matter	brown surface			

SampleID: _____ **Bottom depth:** _____ **Penetration depth** _____ **Time:** _____

Analyses needed before homogenization (circle): **VOC** **sulfides** **AVS/SEM** **Acceptable grab (circle)** **yes** **no**

Sediment type:	**Sediment color:**	**Sediment odor:**		**Comments:**
cobble	drab olive	none	H_2S	
gravel	gray	slight	petroleum	
sand C M F	black	moderate	other:	
silt clay	brown	strong		
organic matter	brown surface			

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

Risk-based Analytical Concentration Goals for Sediment

Appendix C Risk-based Analytical Concentration Goals for Sediment

C.1 INTRODUCTION

This appendix addresses the following question:

> Are standard analytical methods proposed for the chemical analysis of sediment samples sufficiently sensitive to meet the needs of the East Waterway ecological and human health risk assessments?

To answer this question, standard laboratory reporting limits (RLs) and method detection limits (MDLs) were compared to analytical concentration goals (ACGs) for sediment. To determine ACGs for this quality assurance project plan (QAPP), sediment risk-based concentrations (RBCs) were identified or derived for the protection of benthic invertebrates and humans. RBCs in sediment are not relevant for other ecological receptors because sediment is generally a very small dietary component for the fish and other wildlife receptor species that will be evaluated in the ecological risk assessment (ERA). The risk-based ACGs for sediment are equal to the lowest RBC for each chemical. For example, if RBCs are identified or calculated for humans and benthic invertebrates for cadmium, the risk-based ACG for cadmium in sediment is set by the RBC for the receptor most sensitive to cadmium (the lowest of the two RBCs).

For the protection of benthic invertebrates, RBCs are defined as the concentration of a chemical in sediment corresponding to numerical criteria found in the Washington State Sediment Management Standards (SMS). The SMS include numerical criteria for 47 chemicals or groups of chemicals. The lowest numerical criterion for each chemical is called the Sediment Quality Standard (SQS). The Dredged Material Management Program (DMMP) also includes criteria for chemicals in sediment. The lowest guideline in that program is called the Screening Level (SL). RBCs are set equal to the SQS or to the SLs if no SQS is available for a given chemical.

Sediment RBCs are defined for the protection of wildlife receptors as the concentration of a chemical in sediment incidentally ingested by that receptor that is associated with no adverse effects on growth, reproduction, or survival.[1] For the protection of human health, RBCs are defined by two methods. In one method, which was applied to all chemicals, RBCs are defined as the concentration of a chemical in sediment incidentally ingested or directly contacted that has been identified as having an acceptable risk level (e.g., excess cancer risk of 10^{-6} or HQ less than 0.1 for non-cancer risk). In the other method, which was applied for chemicals likely to bioaccumulate in fish and shellfish

[1] The lowest concentration associated with adverse effects was used if data were not available for a concentration associated with no effects.

consumed by humans, sediment RBCs were based on a back-calculation[2] from clam tissue RBCs.

Sediment RBCs have not been developed by EPA Region 10 or Ecology for the protection of humans. Therefore human RBCs were calculated by reviewing human health guidance documents. Although information from the toxicological literature is used in this document, the objective of this memo is not to establish the toxicity reference values (TRVs) to be used for the ecological and human health risk assessments. The TRVs to be used in those assessments will be determined during in consultation with EPA.

The remainder of this appendix is organized as follows:

- Section C.2.0 – RBC derivation methods for benthic invertebrates and humans
- Section C.3.0 – Comparison of ACGs to RLs
- Tables C-1 through C-5 (located at the end of this appendix) summarize RBCs for all receptors for each chemical, provide background information for RBC selection, and compare ACGs and RLs.

C.2 RISK-BASED CONCENTRATIONS

For this QAPP, RBCs are sediment concentrations associated with an acceptable risk level as derived from state standards, the toxicity literature, or human health guidance documents. In this appendix, sediment RBCs are derived for the protection of the following receptors through several exposure pathways:

- Benthic invertebrates exposed to chemicals via direct contact with sediment
- Humans exposed to chemicals via direct contact or incidental ingestion of sediment
- Humans exposed to chemicals via seafood consumption

Sediment RBCs were calculated from clam tissue RBCs using a biota-sediment accumulation factor, as described in Windward (2004a). The clam tissue RBCs were calculated using the total seafood consumption rate rather than the consumption rate of clams. The following sections describe how RBCs were derived for each receptor. The specific chemicals for which RBCs were derived are discussed in the sections below for each receptor, and are summarized in Table C-1.

[2] Sediment RBCs were calculated from clam tissue RBCs using a biota-sediment accumulation factor, as described in Windward (2004a). The clam tissue RBCs were calculated using the total seafood consumption rate rather than the consumption rate of clams.

Table C-1. Receptor-specific RBCs for sediment

Analyte	Receptor-Specific RBC (mg/kg dw)		
	Human Health[a]		Benthic Invertebrates[b]
	Indirect Exposure	Direct Exposure	
Metals			
Antimony	na	**3.1**	150
Arsenic	**0.006**	0.39	57
Cadmium	**0.003**	7	5.1
Chromium	100	**23**	260
Cobalt	na	na	na
Copper	**1.3**	310	390
Lead	na[c]	**40**	450
Mercury	**0.016**	0.78	0.41
Molybdenum	na	**39**	na
Nickel	na[c]	160	**140**
Selenium	na[c]	**39**	na
Silver	na[c]	39	**6.1**
Thallium	na	**0.51**	na
Vanadium	na	**39**	na
Zinc	**16**	2,300	410
Organometals			
Tri-n-butyltin ion	**0.00028**	1.8	0.0085
PAHs			
2-Methylnaphthalene	1.7	31	**0.19**
Acenaphthylene	na	na	**0.33**
Acenaphthene	540	340	**0.080**
Anthracene	900	1,700	**1.1**
Benzo(a)anthracene	**0.0052**	0.15	0.55
Benzo(a)pyrene	**0.00076**	0.015	0.50
Benzo(b)fluoranthene	**0.0047**	0.15	na
Benzo(g,h,i)perylene	na	na	**0.16**
Benzo(k)fluoranthene	**0.047**	1.5	na
Total benzofluoranthenes	na	na	**1.2**
Chrysene	**0.48**	15	0.50
Dibenzo(a,h)anthracene	na[c]	**0.015**	0.06
Dibenzofuran	0.56	na	**0.075**
Fluoranthene	2.1	230	**0.80**
Fluorene	na[c]	230	**0.12**
Indeno(1,2,3-cd)pyrene	**0.0029**	0.15	0.17
Naphthalene	4.5	3.9	**0.50**
Phenanthrene	na	na	**0.50**
Pyrene	8.9	170	**5.0**
Total LPAHs	na	na	**1.9**
Total HPAHs	na	na	**4.8**
PCBs			
Aroclor 1016	**0.0061**	0.39	na
Aroclor 1221	**0.00021**	0.17	na
Aroclor 1232	**0.00021**	0.17	na

Analyte	Receptor-Specific RBC (mg/kg dw)		
	Human Health[a]		Benthic Invertebrates[b]
	Indirect Exposure	Direct Exposure	
Aroclor 1242	**0.00021**	0.22	na
Aroclor 1248	**0.00021**	0.22	na
Aroclor 1254	**0.00021**	0.22	na
Aroclor 1260	**0.00021**	0.22	na
Total PCBs	**0.00021**	na	0.06

NOTE: Values in **BOLD** were used as ACGs in Table C-5.

na – toxicity data not available or not applicable

[a] The RBC for a given chemical may be derived from either carcinogenic or non-carcinogenic endpoints. For chemicals with both endpoints, the lower RBC is shown.

[b] RBCs for benthic invertebrates are equivalent to the SQS/SL for chemicals with standards expressed on a dry weight basis. For chemicals with standards expressed on an organic-carbon normalized basis, an organic carbon content of 0.5% was assumed to convert the standards to dry weight.

[c] This chemical was identified as an important bioaccumulative chemical by EPA (2000), but no BSAF is available from the sources listed in Section D.2.2.2, so no RBC for indirect exposure was calculated.

[d] Dioxin-like PCB and dioxin/furan congeners will be evaluated as toxic equivalents (TEQs) in the risk assessments, rather than as individual congeners. However, because TEQs are calculated, rather than measured by the laboratory, RBCs for individual congeners are presented to facilitate comparison with RLs for those congeners. In reality, risks will be assessed based on sums of these congeners (normalized per their relative toxicity to TCDD), and thus comparison to RLs on a congener-specific basis is somewhat uncertain.

[e] RBCs for chlordane for human health are based on toxicity of mixtures of chlordane-related compounds (e.g., alpha- and gamma-chlordane, cis- and trans-nonachlor).

C.2.1 RBC derivation for the protection of benthic invertebrates

RBCs for the protection of benthic invertebrates are expressed as chemical concentrations in sediment, to which benthic invertebrates are directly exposed. The benthic invertebrate RBCs are derived from the SQS or from DMMP SLs when SQS are not available. There are 14 chemicals that have SLs but do not have an SQS value. The SQS and SL values are presented in Table C-2. The RBCs in Table C-1 for benthic invertebrates are equivalent to the SQS/SL for chemicals where the SQS is expressed on a dry weight basis. For chemicals with standards expressed on an organic-carbon (OC) normalized basis, a lower-than-average OC content of 0.5% was assumed to convert the SQS to its dry weight equivalent.

No sediment-based SQS or SL is available for TBT. The benthic invertebrate sediment RBC for TBT is calculated for the purposes of this appendix using a tissue effect value along with a modified bioaccumulation factor (BAF), as described below.

The tissue effect value was obtained from a review of effects data associated with TBT in benthic invertebrate tissues. The lowest LOEC (lowest-observed-effect concentration; the lowest concentration at which an adverse effect was observed) was 2.4 mg/kg dry weight (dw) associated with reduced growth of the polychaete *Armandia brevis* (Meador and Rice 2001). The highest NOEC (no-observed-effect concentration; the highest concentration at which no adverse effect was observed) found in a laboratory study was 0.85 mg/kg dw (reduced condition index in Pacific oysters, assuming a moisture content of 80% (Davies et al. 1988)). The LOEC and NOEC are 0.48 and 0.17 mg/kg ww,

respectively. The NOEC of 0.17 mg/kg ww was used as the tissue effect concentration for calculating the RBC only for the purposes of this appendix (the NOECs and LOEC to be used in the EW remedial investigation will be developed as part of the Phase 2 ERA).

The modified bioaccumulation factor was derived as described in the using a wet weight tissue concentration and a sediment concentration expressed on an organic carbon-normalized basis, as follows:

$$\text{Modified BAF for TBT} = \frac{\text{Biota (mg/kg ww)}}{\text{Sediment (mg/kg OC)}} \qquad \textbf{Equation 1}$$

The modified BAF used in this appendix is 0.10 (Windward, 2003). The sediment RBC was then calculated using Equation 2:

$$\text{Sediment (mg/kg dw)} = \frac{\text{Tissue effect concentration (mg/kg ww)}}{\text{Modified BAF for TBT}} \times 0.5\%\text{OC in sediment} \times 0.01$$

Equation 2

Using this approach, the sediment RBC for benthic invertebrates for TBT is 0.0085 mg/kg dw (Table C-1).

Table C-2. Chemical criteria used to derive sediment RBCs for benthic invertebrates

CHEMICAL	UNIT	SQS	SL
Metals			
Antimony	mg/kg dw	ns	150
Arsenic	mg/kg dw	57	sa
Cadmium	mg/kg dw	5.1	sa
Chromium	mg/kg dw	260	sa
Copper	mg/kg dw	390	sa
Lead	mg/kg dw	450	sa
Mercury	mg/kg dw	0.41	sa
Nickel	mg/kg dw	ns	140
Silver	mg/kg dw	6.1	sa
Zinc	mg/kg dw	410	sa
PAHs			
2-Methylnaphthalene	mg/kg OC	38	sa
Acenaphthene	mg/kg OC	16	sa
Acenaphthylene	mg/kg OC	66	sa
Anthracene	mg/kg OC	220	sa
Benzo(a)anthracene	mg/kg OC	110	sa
Benzo(a)pyrene	mg/kg OC	99	sa
Benzo(g,h,i)perylene	mg/kg OC	31	sa
Total benzofluoranthenes	mg/kg OC	230	sa
Chrysene	mg/kg OC	110	sa
Dibenzo(a,h)anthracene	mg/kg OC	12	sa
Dibenzofuran	mg/kg OC	15	sa
Fluoranthene	mg/kg OC	160	sa

CHEMICAL	UNIT	SQS	SL
Fluorene	mg/kg OC	23	sa
Indeno(1,2,3-cd)pyrene	mg/kg OC	34	sa
Naphthalene	mg/kg OC	99	sa
Phenanthrene	mg/kg OC	100	sa
Pyrene	mg/kg OC	1,000	sa
Total HPAHs	mg/kg OC	960	sa
Total LPAHs	mg/kg OC	370	sa
Polychlorinated biphenyls			
Total PCB Aroclors	mg/kg OC	12	sa

OC – organic carbon
dw – dry weight
ns – SQS not available
sa – SQS available and used as the preferred criterion

C.2.2 RBC derivation for the protection of humans

RBCs for the protection of human health were derived for both direct and indirect (i.e., seafood consumption) exposure pathways and are presented in Table D-1. For non-bioaccumulative chemicals, RBCs were calculated for direct exposure pathways, as described in Section D.2.2.1. For bioaccumulative chemicals, RBCs were calculated for the seafood consumption pathway, as described in Section D.2.2.2. Bioaccumulative compounds were identified by EPA (2000).

C.2.2.1 Direct sediment exposure pathway

RBCs for the protection of humans that may directly contact or incidentally ingest sediment are expressed as chemical concentrations in sediment. Human health guidance documents were reviewed for RBCs for human health. Oak Ridge National Laboratory (ORNL) presents RBCs for the protection of human health from exposures to soil that have been agreed upon by EPA Regions 3, 6, and 9 (ORNL 2008). The Model Toxics Control Act (MTCA, a Washington State statute) also includes RBCs for soil, but they are generally higher than the ORNL RBCs because of different exposure parameters. Consequently, ORNL RBCs were used instead of MTCA RBCs because they are more health protective and because they represent the best available science agreed upon by three EPA regional offices. The soil RBCs represent very conservative ACGs for East Waterway (EW) sediments because they are based on residential soil exposure scenarios at a target HQ of 0.1.

ORNL (2008) contains soil RBCs for both industrial and residential scenarios. Residential RBCs were used in this appendix because they are more health protective than the industrial RBCs. ORNL RBCs for chemicals with noncarcinogenic effects were decreased by a factor of 10 to account for the target hazard quotients of 0.1 used in screening by EPA Region 10.[3] ACGs can be calculated for chemicals with either

[3] EPA Region 10 recommends a target hazard quotient of 0.1; therefore, the EPA Region 9 RBCs (which are based on a target hazard quotient of 1) have been adjusted by dividing by 10 for the ACG.

carcinogenic or non-carcinogenic endpoints; some chemicals have both types of endpoints. For chemicals with both endpoints, the lower ACG is shown in Table D-5.

C.2.2.2 Indirect sediment exposure pathway

RBCs for the indirect sediment exposure pathway (i.e., seafood consumption) require that a relationship be developed between chemical concentrations in tissue and sediment. One commonly used method for evaluating such a relationship for nonpolar organic chemicals that may bioaccumulate is the biota sediment accumulation factor (BSAF).

BSAFs can be derived using Equation 3:

$$BSAF = \frac{C_{WB} \div F_L}{C_{sed} \div F_{oc}} \qquad \textbf{Equation 3}$$

where:

C_{WB}	=	chemical concentration in whole-body tissue (mg/kg ww)
C_{sed}	=	chemical concentration in sediment (mg/kg dw)
F_L	=	fraction lipid in tissue (kg lipid/kg ww)
F_{oc}	=	fraction organic carbon in sediment (kg OC/kg dw)

A key variable in the BSAF equation is the sediment concentration (C_{sed}). The BSAF equation is based on the assumption that C_{sed} represents the average chemical concentration in sediment to which the organism is exposed. For animals with very small home ranges, such as clams, this assumption may be reasonable if sediment data are collected concurrently with tissue data at the tissue collection locations. For animals with larger home ranges, such as fish, there is greater uncertainty in this assumption because many fish are highly mobile and are not likely to inhabit all areas of their home range with equal frequency. Consequently, fish BSAFs for a given chemical may easily range over at least an order of magnitude (USACE 2003).

Equation 3 can be rearranged to solve for C_{sed}, as follows:

$$C_{sed} = \frac{(C_{WB} \div F_L) \times F_{oc}}{BSAF} \qquad \textbf{Equation 4}$$

For this appendix, the C_{WB} based on 98 g/day was used in Equation 5. More details on calculation of chemical concentrations in tissue, including for chemicals with toxic equivalency factors can be found in Appendix C. The BSAFs used to calculate ACGs for sediment (i.e., C_{sed} in Equation 5) were from four sources:

- US Army Corps of Engineers Environmental Residue-Effects Database (ERED) - http://www.wes.army.mil/el/ered/

- Tracey GA, Hansen DJ. 1996. Use of biota-sediment accumulation factors to assess similarity of nonionic organic chemical exposure to benthically-coupled organisms of differing trophic mode. Arch Environ Contam Toxicol 30:467-475.
- EPA. 1997. The incidence and severity of sediment contamination in surface waters of the United States. Volume 1: National Sediment Quality Survey. EPA 823-R-97-006. US Environmental Protection Agency, Office of Science and Technology, Washington, DC.
- Washington State Department of Health. 1995. Tier I report, development of sediment quality criteria for the protection of human health. Washington State Department of Health, Olympia, Washington.

The BSAFs cited in these four sources will not necessarily be used for any other purpose in the EW RI other than developing sediment ACGs in this appendix. BSAFs for bivalve mollusks are most appropriate for the ACG calculation, as described above. However, some fish BSAFs were used in this appendix when bivalve BSAFs were not available (i.e., some SVOCs and 2,3,7,8-TCDD).

C.3 COMPARISON OF ACGS TO RLS

ACGs were determined for sediment by selecting the lowest RBC for each chemical from Table C-1. These ACGs for sediment were compared with RLs, which represent the minimum analyte concentrations that can be reliably quantified, and with MDLs, which are lower than the RL and represent the minimum analyte concentration that can be detected with 99% confidence.

As shown in Table C-5, all ACGs are higher than the target RLs and MDLs, with the exception of five PAHs (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-c,d)pyrene), six PCB Aroclors, total PCBs, three metals (arsenic, cadmium, mercury), and tributyltin. When the ACGs for these analytes are compared with the target MDLs, ACGs for 13 of these chemicals are higher than the target MDL, indicating that the test methods should be sufficiently sensitive to detect these chemicals at concentrations above the ACGs. Fourteen chemicals have ACGs lower than both their target RL and MDL (six Aroclors, total PCBs, four PAHs, , tributyltin, arsenic, and cadmium).

Four PAHs listed above with target MDLs or RLs greater than the ACG, as well as cadmium, mercury, tributyltin, Aroclor 1260 and total PCBs were detected in over 80% of the historical surface sediment samples using standard test methods with comparable target RLs. Arsenic, dibenzo(a,h)anthracene, and Aroclor 1254 were detected in over 50% of the historical sediment samples (68%, 54%, and 68%, respectively). Based on these historical results, the PAHs, PCBs, and metals listed above are also likely to be detected in most or all the sediment samples described in this QAPP. Consequently, the fact that the ACGs are lower than both the MDL and RL should not compromise the quality of the data to be used in the risk assessments for these chemicals.

The MDLs and RLs for Aroclor 1242, and Aroclor 1248 are higher than the respective ACGs. These chemicals were detected in 2 to 28% of the historical sediment samples. For the undetected chemicals with RLs above the ACGs, the ramifications for the HHRA and ERA will be discussed in the uncertainty assessments.

The laboratories will make all reasonable efforts to achieve the target MDLs and RLs for all chemicals. Additional efforts may include modified extraction techniques (e.g., extracting a higher sample volume or adjusting the final extract volume), sample cleanup procedures (e.g., gel-permeation column chromatography), using a lower concentration for the lowest standard in the initial calibration, or adjusting the amount of extract injected into the instrument. If no PCB Aroclors are detected in a sample, a low-level extraction technique may be performed.

Table C-5. Comparison of sediment ACGs to target RLs and MDLs

Chemical	MDL[a]	RL[a]	Sediment ACG[b]
Metals (EPA 6020/7471A)			
Antimony	0.013	0.2	3.1
Arsenic	**0.17**	**0.5**	0.006
Cadmium	**0.016**	**0.2**	0.003
Chromium	0.136	0.5	23
Cobalt	0.008	0.2	na
Copper	0.043	0.5	1.3
Lead	0.078	1.0	40
Mercury	0.005	**0.05**	0.016
Molybdenum	0.008	0.2	39
Nickel	0.111	0.5	140
Selenium	0.671	2	39
Silver	0.006	0.2	6.1
Thallium	0.005	0.2	0.51
Vanadium	0.034	0.2	39
Zinc	0.443	4.0	16
Organometals (Krone 1989)			
Tri-n-butyltin ion	**0.0012**	**0.0040**	0.00028
PAHs (EPA 8270D)			
2-Methylnaphthalene	0.0082	0.020	0.19
Acenaphthylene	0.0087	0.020	0.33
Acenaphthene	0.0082	0.020	0.08
Anthracene	0.0077	0.020	1.1
Benzo(a)anthracene	**0.0059**	**0.020**	0.0052
Benzo(a)pyrene	**0.0082**	**0.020**	0.00076
Benzo(b)fluoranthene	**0.0095**	**0.020**	0.0047
Benzo(g,h,i)perylene	0.0068	0.020	0.16
Benzo(k)fluoranthene	0.0093	0.020	0.047
Total benzofluoranthenes[c]	0.0095	0.020	1.2
Chrysene	0.0066	0.020	0.48
Dibenzo(a,h)anthracene	0.0086	**0.020**	0.015
Dibenzofuran	0.0076	0.020	0.075

Chemical	MDL[a]	RL[a]	Sediment ACG[b]
Fluoranthene	0.0079	0.020	0.80
Fluorene	0.0090	0.020	0.12
Indeno(1,2,3-cd)pyrene	**0.0086**	**0.020**	0.0029
Naphthalene	0.0087	0.020	0.50
Phenanthrene	0.0084	0.020	0.50
Pyrene	0.0078	0.020	5.0
Total LPAHs[d]	0.0090	0.020	1.9
Total HPAHs[e]	0.0095	0.020	4.8
PCBs			
Aroclor 1016	0.0013	0.0040	0.0061
Aroclor 1221	**0.0013**	**0.0040**	0.00021
Aroclor 1232	**0.0013**	**0.0040**	0.00021
Aroclor 1242	**0.0028**	**0.0040**	0.00021
Aroclor 1248	**0.0028**	**0.0040**	0.00021
Aroclor 1254	**0.0028**	**0.0040**	0.00021
Aroclor 1260	**0.0028**	**0.0040**	0.00021
Total PCBs[f]	**0.0028**	**0.0040**	0.00021

RLs and MDLs in **BOLD** are greater than at least one of their respective ACGs.

na – not available

[a] Target RLs and MDLs are the most recent values provided by ARI and Analytical Perspectives. Actual RLs and MDLs will vary based on amount of sample analyzed, matrix interferences, analytical dilution, percent solids of the sample and/or updates to RLs and MDLs by the laboratory. The MDLs provided for PCB and dioxin congeners are the average MDLs of sample-specific detection limits, calculated from specific samples over 4-6 years

[b] ACG for sediment is the lowest of the RBCs for benthic invertebrates and humans.

[c] Total benzofluoranthenes is the sum of benzo(b)fluoranthene and benzo(k)fluoranthene. RL and MDL are the highest of the RLs and MDLs for benzo(b)fluoranthene or benzo(k)fluoranthene.

[d] Total LPAHs is the sum of naphthalene, 2-methyl naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. RL and MDL are the highest RL and MDL for the LPAHs.

[e] Total HPAHs is the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(k)fluoranthene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene. RL and MDL are the highest RL and MDL for the HPAHs.

[f] Total PCBs is the sum of the Aroclors. RL and MDL are the highest RL and MDL for the individual Aroclors.

C.4 REFERENCES

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APPENDIX D

Laboratory Method Detection Limits and Reporting Limits

Appendix D. Laboratory Method Detection Limits and Reporting Limits

Table D-1. Target MDLs and RLs (mg/kg)

Chemical	MDL[a]	RL[a]
Metals (EPA 6010B/200.8/7471A)		
Antimony	0.38	5
Arsenic	0.17	0.5
Cadmium	0.02	0.2
Chromium	0.28	0.5
Cobalt	0.09	0.3
Copper	0.043	0.5
Lead	0.2	2
Mercury	0.005	0.05
Molybdenum	0.15	0.5
Nickel	0.31	1
Selenium	0.671	2
Silver	0.11	0.3
Thallium	0.005	0.2
Vanadium	0.04	0.3
Zinc	0.443	4.0
Organometals (Krone 1989)		
Monobutyltin ion	0.0041	0.0040
Dibutyltin ion	0.0032	0.0060
Tributyltin ion	0.0012	0.0040
PAHs (EPA 8270D)		
1-Methylnaphthalene	0.0072	0.020
2-Methylnaphthalene	0.0082	0.020
Acenaphthylene	0.0087	0.020
Acenaphthene	0.0082	0.020
Anthracene	0.0077	0.020
Benzo(a)anthracene	0.0059	0.020
Benzo(a)pyrene	0.0082	0.020
Benzo(b)fluoranthene	0.0095	0.020
Benzo(g,h,i)perylene	0.0068	0.020
Benzo(k)fluoranthene	0.0093	0.020
Total benzofluoranthenes[b]	0.0095	0.020
Chrysene	0.0066	0.020
Dibenzo(a,h)anthracene	0.0086	0.020
Dibenzofuran	0.0076	0.020
Fluoranthene	0.0079	0.020
Fluorene	0.0090	0.020
Indeno(1,2,3-cd)pyrene	0.0086	0.020
Naphthalene	0.0087	0.020

Chemical	MDL[a]	RL[a]
Phenanthrene	0.0084	0.020
Pyrene	0.0078	0.020
Total LPAHs[c]	0.0090	0.020
Total HPAHs[d]	0.0095	0.020
Phthalates (EPA 8270D)		
Bis(2-ethylhexyl)phthalate	0.011	0.020
Butyl benzyl phthalate	0.011	0.020
Di-ethyl phthalate	0.016	0.020
Dimethyl phthalate	0.0078	0.020
Di-n-butyl phthalate	0.012	0.020
Di-n-octyl phthalate	0.0083	0.020
Other SVOCs (EPA 8270D)		
1,2,4-Trichlorobenzene	0.0091	0.020
1,2-Dichlorobenzene	0.0079	0.020
1,3-Dichlorobenzene	0.0075	0.020
1,4-Dichlorobenzene	0.0074	0.020
2,4,5-Trichlorophenol	0.045	0.10
2,4,6-Trichlorophenol	0.046	0.10
2,4-Dichlorophenol	0.041	0.10
2,4-Dimethylphenol	0.015	0.020
2,4-Dinitrophenol	0.11	0.20
2,4-Dinitrotoluene	0.039	0.10
2,6-Dinitrotoluene	0.054	0.10
2-Chloronaphthalene	0.0080	0.020
2-Chlorophenol	0.0075	0.020
2-Methylphenol	0.014	0.020
3,3'-Dichlorobenzidine	0.049	0.10
4-Chloroaniline	0.035	0.10
4-Methylphenol	0.013	0.020
Aniline	0.067	0.067
Benzoic acid	0.12	0.20
Benzyl alcohol	0.015	0.020
Bis(2-chloroethyl)ether	0.0075	0.020
Bis-chloroisopropyl ether	0.0080	0.020
Carbazole	0.0066	0.020
Hexachlorobenzene	0.0080	0.020
Hexachlorobutadiene	0.0081	0.020
Hexachloroethane	0.0072	0.020
Isophorone	0.0083	0.020
Nitrobenzene	0.0088	0.020
N-Nitrosodimethylamine	0.035	0.10
N-Nitrosodi-n-propylamine	0.036	0.10
N-Nitrosodiphenylamine	0.0087	0.020
Pentachlorophenol	0.048	0.10
Phenol	0.014	0.020

Chemical	MDL[a]	RL[a]
Selected SVOCs by EPA 8270D-SIM		
1,2,4-Trichlorobenzene	0.0016	0.0067
1,2-Dichlorobenzene	0.0013	0.0067
1,4-Dichlorobenzene	0.0022	0.0067
2,4-Dimethylphenol	0.0039	0.0067
2-Methylphenol	0.0034	0.0067
Benzyl alcohol	0.016	0.033
Butyl benzyl phthalate	0.0040	0.0067
Dibenzo(a,h)anthracene	0.00050	0.0063
Dimethyl phthalate	0.0017	0.0065
Hexachlorobenzene	0.0020	0.0067
Hexachlorobutadiene	0.0029	0.0067
N-Nitrosodiphenylamine	0.0031	0.0067
N-Nitrosodimethylamine	0.024	0.033
N-Nitrosodi-n-propylamine	0.0027	0.033
Pentachlorophenol	0.013	0.033
PCBs		
Aroclor 1016	0.0013	0.0040
Aroclor 1221	0.0013	0.0040
Aroclor 1232	0.0013	0.0040
Aroclor 1242	0.0028	0.0040
Aroclor 1248	0.0028	0.0040
Aroclor 1254	0.0028	0.0040
Aroclor 1260	0.0028	0.0040
Total PCBs[e]	0.0028	0.0040
PCB Congeners (EPA 1668)		
209 PCB Congeners	$3.13 \times 10^{-7} – 5.60 \times 10^{-5}$	$2.63 \times 10^{-6} – 1.66 \times 10^{-4}$
Dioxins/furans (EPA 1613B)		
2,3,7,8-TCDD	7.40E-08	5.0E-07
1,2,3,7,8-PeCDD	2.10E-07	2.5E-06
1,2,3,4,7,8-HxCDD	2.60E-07	2.5E-06
1,2,3,6,7,8-HxCDD	2.90E-07	2.5E-06
1,2,3,7,8,9-HxCDD	2.48E-07	2.5E-06
1,2,3,4,6,7,8-HpCDD	2.80E-07	2.5E-06
OCDD	3.88E-07	5.0E-06
2,3,7,8-TCDF	7.80E-08	5.0E-07
1,2,3,7,8-PeCDF	1.82E-07	2.5E-06
2,3,4,7,8-PeCDF	2.38E-07	2.5E-06
1,2,3,4,7,8-HxCDF	2.22E-07	2.5E-06
1,2,3,6,7,8-HxCDF	2.06E-07	2.5E-06
1,2,3,7,8,9-HxCDF	2.52E-07	2.5E-06
2,3,4,6,7,8-HxCDF	2.40E-07	2.5E-06
1,2,3,4,6,7,8-HpCDF	3.28E-07	2.5E-06
1,2,3,4,7,8,9-HpCDF	2.98E-07	2.5E-06

Chemical	MDL[a]	RL[a]
OCDF	6.22E-07	5.0E-06
Pesticides (EPA 8081A)		
2,4'-DDD	0.0012	0.0020
2,4'-DDE	0.00093	0.0020
2,4'-DDT	0.0010	0.0020
4,4'-DDD	0.0013	0.0020
4,4'-DDE	0.0012	0.0020
4,4'-DDT	0.00088	0.0020
Total DDTs[f]	0.0013	0.0020
Aldrin	0.00048	0.0010
alpha-BHC	0.00062	0.0010
beta-BHC	0.00039	0.0010
delta-BHC	0.00043	0.0010
alpha-Chlordane	0.00061	0.0010
Total chlordane[g]	0.0010	0.0020
Dieldrin	0.00084	0.0020
alpha-Endosulfan	0.00067	0.0010
beta-Endosulfan	0.0012	0.0020
Endosulfan sulfate	0.00088	0.0020
Endrin	0.0012	0.0020
Endrin aldehyde	0.00098	0.0020
Endrin ketone	0.0016	0.0020
gamma-BHC (Lindane)	0.00049	0.0010
Heptachlor	0.00040	0.0010
Heptachlor epoxide	0.00038	0.0010
Methoxychlor	0.0033	0.010
Mirex	0.0010	0.0020
Cis-nonachlor	0.00082	0.0020
Trans-nonachlor	0.0010	0.0020
Oxychlordane	0.00095	0.0020
Toxaphene	0.048	0.10
Conventionals (PSEP, 1986; Plumb 1981, EPA 376.2, EPA 350.1)		
Total Solids	na	0.01%
Grain Size	na	0.1%
Total Organic Carbon	0.01%	0.02%
Total Sulfides	1.0	1.0
Ammonia	0.1	0.1

na – not available
MDL – method detection limit
PCB – polychlorinated biphenyl
RL – reporting limit
SIM – selected ion monitoring
SVOCs – semi-volatile organic compounds
VOC – volatile organic compounds

[a] Target RLs and MDLs are the most recent values provided by ARI and Analytical Perspectives. Actual RLs and MDLs will vary based on amount of sample analyzed, matrix interferences, analytical dilution, percent solids of

the sample and/or updates to RLs and MDLs by the laboratory. The MDLs provided for dioxin congeners are the average MDLs of sample-specific detection limits, calculated from specific samples over 4-6 years

[b] Total benzofluoranthenes is the sum of benzo(b)fluoranthene and benzo(k)fluoranthene. RL and MDL are the highest of the RLs and MDLs for benzo(b)fluoranthene or benzo(k)fluoranthene.

[c] Total LPAHs is the sum of naphthalene, 2-methyl naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. RL and MDL are the highest RL and MDL for the LPAHs.

[d] Total HPAHs is the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(k)fluoranthene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene. RL and MDL are the highest RL and MDL for the HPAHs.

[e] Total PCBs is the sum of the Aroclors. RL and MDL are the highest RL and MDL for the individual Aroclors.

[f] Total DDT is the sum of 4,4'-DDD, 4,4-DDE, 4,4'-DDT, 2,4'-DDD, 2,4-DDE, and 2,4'-DDT. RL and MDL are the highest RL and MDL for the DDT isomers.

[g] Total chlordane is the sum of oxychlordane, alpha- and gamma-chlordane, and cis- and trans-nonachlor. RL and MDL are the highest RL and MDL for the chlordane-related compounds.