# EAST WATERWAY OPERATIONAL UNIT SUPPLEMENTAL REMEDIAL INVESTIGATION/ FEASIBILITY STUDY DATA REPORT: SUBSURFACE SEDIMENT SAMPLING FOR CHEMICAL ANALYSES

## FINAL

**For submittal to:**

**The US Environmental Protection Agency**
**Region 10**
**Seattle, WA**

**November 2010**

**Prepared by:** Windward environmental LLC

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

# Table of Contents

## Tables

## Maps

## Acronyms

| Acronym | Definition |
|---|---|
| AES | atomic emission spectrometry |
| AET | apparent effects threshold |
| ARI | Analytical Resources, Inc. |
| ASTM | American Society for Testing and Materials |
| BEHP | bis(2-ethylhexyl) phthalate |
| BHC | benzene hexachloride |
| CAS | Columbia Analytical Services, Inc. |
| CCV | continuing calibration verification |
| CSL | cleanup screening level |
| CVAA | cold vapor atomic absorption |
| DDD | dichlorodiphenyldichloroethane |
| DDE | dichlorodiphenyldichloroethylene |
| DMMP | Dredged Material Management Program |
| DDT | dichlorodiphenyltrichloroethane |
| dw | dry weight |
| ECD | electron capture detection |
| EPA | US Environmental Protection Agency |
| EW | East Waterway |
| FPD | flame photometric detection |
| FS | feasibility study |
| GC | gas chromatography |
| GPS | global positioning system |
| HPAH | high-molecular-weight polycyclic aromatic hydrocarbon |
| HRGC | high-resolution gas chromatography |
| HRMS | high-resolution mass spectrometry |
| ICP | inductively coupled plasma |
| ID | identification |
| J-qualifier | estimated concentration |
| LAET | lowest apparent effects threshold |
| 2LAET | second lowest apparent effects threshold |
| LCS | laboratory control sample |
| LCSD | laboratory control sample duplicate |
| LDW | Lower Duwamish Waterway |
| LPAH | low-molecular-weight polycyclic aromatic hydrocarbon |
| ML | maximum level |
| MLLW | mean lower low water |

| Acronym | Definition |
|---|---|
| **MS** | mass spectrometry |
| **MS/MSD** | matrix spike/matrix spike duplicate |
| **NAD83** | North American Datum of 1983 |
| **OC** | organic carbon |
| **PAH** | polycyclic aromatic hydrocarbon |
| **PCB** | polychlorinated biphenyl |
| **pcf** | pounds per cubic foot |
| **PID** | photoionization detector |
| **PSEP** | Puget Sound Estuary Program |
| **PST** | Pacific Standard Time |
| **QAPP** | quality assurance project plan |
| **RL** | reporting limit |
| **RPD** | relative percent difference |
| **SDG** | sample delivery group |
| **SIM** | selected ion monitoring |
| **SL** | screening level |
| **SMS** | Washington State Sediment Management Standards |
| **SPT** | standard penetration test |
| **SQS** | sediment quality standards |
| **SRI** | supplemental remedial investigation |
| **SRM** | standard reference material |
| **SU** | standard unit |
| **SVOC** | semivolatile organic compound |
| **TOC** | total organic carbon |
| **VOC** | volatile organic compound |
| **U-qualifier** | not detected at given concentration |
| **Windward** | Windward Environmental LLC |

# 1 Introduction

This data report presents the results of chemical analyses conducted on subsurface sediment samples collected from the East Waterway (EW) as part of the supplemental remedial investigation and feasibility study (SRI/FS). The subsurface sediment quality assurance project plan (QAPP) (Windward 2010) presented the design for the sampling and analysis of subsurface sediment, including details on project organization, field data collection, laboratory analyses, and data management.

Subsurface sediment cores were collected at 65 locations in the EW during the subsurface sediment sampling event in February and March of 2010. In addition as part of a geotechnical investigation of the mound area[1] near Slip 27, two subsurface sediment borings were sampled for sediment chemistry and geotechnical analyses as described in Appendix E of the QAPP (Windward 2010). Sediment core locations are shown on Map 2-1. Cores from each location were evaluated for stratigraphy and lithology and then divided into 0.5-, 1-, or 2-ft depth intervals according to the QAPP (Windward 2010). Chemical analyses were conducted on a total of 194 subsurface sediment samples. Geotechnical analyses were conducted on a subset of these samples. Geotechnical data will be used in the FS to evaluate sediment bed properties and remedial alternatives.

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

- Section 2 – Subsurface Sediment Collection Methods
- Section 3 – Laboratory Methods
- Section 4 – Results
- Section 5 – References

The text of this report is supported by the following appendices:

- Appendix A – Data Tables
- Appendix B – Sediment Core Logs
- Appendix C – Data Management
- Appendix D – Data Validation Reports
- Appendix E – Analytical Laboratory Data
- Appendix F – Field Forms
- Appendix G – Chain-of-Custody Forms
- Appendix H – Photographs of Sediment Cores
- Appendix I Geotechnical Results for Sediment Borings

[1] The mound area is a shallow area on the southern side of Slip 27.

# 2 Subsurface Sediment Core Collection Methods

This section describes the methods used for the collection of subsurface sediment samples, including the sample identification (ID) scheme, sampling locations, sediment core collection and processing methods, and field deviations from the QAPP (Windward 2010). Copies of field notebooks and forms completed during the subsurface sediment core sampling effort (i.e., sediment core collection logs and sediment core processing logs) are presented in Appendix F. Copies of completed chain-of-custody forms used to track sample custody are presented in Appendix G.

## 2.1 SAMPLE IDENTIFICATION SCHEME

Each subsurface sediment core sampling location was assigned a unique alphanumeric location ID number. The first four characters of the location ID were "EW" to identify the EW project area, followed by "10" to identify the year in which the sample was collected (i.e., EW10). The next four characters were "SC" for sediment core or "SB" for sediment boring to indicate the type of samples collected, followed by a consecutive number identifying the specific location within the EW (e.g., SC01).

The sample ID consisted of the location ID followed by a numerical suffix that indicated the depth horizon from which the sediment sample came. For example, the sample from the upper 2-ft (60-cm) section of the core collected at location EW10-SC01 was identified as EW10-SC01-0-2; the 2-to-4-ft (60-to-120-cm) section of sediment from the same core was identified as EW10-SC01-2-4. Samples collected at 0.5-ft intervals were similarly identified. For example, the sample collected from the upper 0.5-ft section of the core collected at location EW10-SC01 was identified as EW10-SC01-0-0.5. Field duplicate samples were identified using location numbers starting with 201. For example, the upper 2-ft section of the first field duplicate sample was identified as EW10-SC201-0-2. A rinsate blank sample was assigned the first four characters of the location ID, followed by "SC" and "RB" (i.e., EW10-SC-RB).

## 2.2 SAMPLING LOCATIONS

Subsurface sediment cores were collected from 65 sampling locations between February 22 and March 9, 2010, as presented in Table 2-1 and on Map 2-1. Table 2-1 also presents the mudline elevation at which each core was collected relative to mean lower low water (MLLW), the depth below mudline to which the core penetrated, and the volume of sediment recovered in the core sample. The target sampling locations from the QAPP (Windward 2010), as well as the actual sampling locations, are shown on Map 2-2. In general, the actual sampling locations differed slightly from the target sampling locations because of difficulties associated with positioning the sample vessel as a result of weather conditions (specifically wind and currents) and, to a small extent, the accuracy of the global positioning system (GPS) unit (depending on signal strength).

## Table 2-1. EW subsurface sediment sampling locations

| Location ID | Collection Date | Collection Time (PST) | Collection Method | Processing Date | Target Location[a] | | Actual Location[a] | | Distance from Target (m) | Mudline Elevation (above [+] or below [-] MLLW [ft]) | Penetration Depth (ft) | Recovery (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | X | Y | X | Y | | | | |
| EW10-SB-01A[b] | 3/17/10 | 0715 | sediment boring | 3/19/10<br>3/22/10<br>3/23/10 | 1267829.5 | 214926.5 | 1267834 | 214908 | 5.8 | 11.2 | 3.5 | na |
| EW10-SB-01B[b] | 3/17/10 | 1145 | sediment boring | 3/19/10<br>3/22/10<br>3/23/10 | 1267829.5 | 214926.5 | 1267830 | 214912 | 4.4 | 9.8 | 60.5 | na |
| EW10-SB-02A[b] | 3/16/10 | 0945 | sediment boring | 3/22/10<br>3/23/10 | 1267745 | 215001 | 1267735 | 215007 | 3.6 | 24.7 | 20 | na |
| EW10-SB-02B[b] | 3/18/10 | 1000 | sediment boring | 3/22/10<br>3/23/10 | 1267745 | 215001 | 1267716 | 215024 | 11.3 | 26.1 | 61.5 | na |
| EW10-SC03 | 2/22/2010 | 1348 | MudMole™ | 2/23/2010 | 1267044 | 212025 | 1267032 | 212018 | 4.3 | -6.25 | 7.65 | 75 |
| EW10-SC04 | 2/22/2010 | 1447 | MudMole™ | 2/23/2010 | 1267343 | 212070 | 1267325 | 212072 | 5.4 | 0.93 | 12.45 | 59 |
| EW10-SC05[c] | 2/23/2010 | 1155 | MudMole™ | 2/23/2010 | 1267231 | 212246 | 1267235 | 212245 | 1.3 | -11.14 | 7.35 | 82 |
| EW10-SC06 | 2/22/2010 | 1147 | MudMole™ | 2/22/2010 | 1267396 | 212537 | 1267401 | 212536 | 1.6 | -29.36 | 14.35 | 81 |
| EW10-SC07B[d] | 2/26/2010 | 1215 | vibracorer | 3/1/2010 | 1267191 | 212587 | 1267211 | 212605 | 8.2 | -18.37 | 13.5 | 96.3 |
| EW10-SC08 | 2/22/2010 | 1002 | MudMole™ | 2/22/2010 | 1267533 | 212850 | 1267533 | 212848 | 0.7 | -36.13 | 14.35 | 88 |
| EW10-SC09 | 3/8/2010 | 1135 | vibracorer | 3/9/2010 | 1267756 | 212976 | 1267763 | 212916 | 18.3 | -40.36 | 14 | 96 |
| EW10-SC10 | 2/26/2010 | 0855 | vibracorer | 3/1/2010 | 1267114 | 213011 | 1267112 | 213011 | 0.6 | -37.18 | 14 | 93.6 |
| EW10-SC11[c] | 2/23/2010 | 1015 | MudMole™ | 2/23/2010 | 1267404 | 213062 | 1267401 | 213056 | 2.0 | -36.89 | 13.85 | 74 |
| EW10-SC12 | 2/26/2010 | 0945 | vibracorer | 3/1/2010 | 1267225 | 213429 | 1267226 | 213425 | 1.3 | -39.05 | 14 | 90 |
| EW10-SC13 | 3/3/2010 | 1003 | vibracorer | 3/4/2010 | 1267786 | 213481 | 1267785 | 213479 | 0.7 | -48.92 | 14 | 84 |
| EW10-SC14[c] | 3/8/2010 | 0945 | vibracorer | 3/9/2010 | 1267761 | 213730 | 1267763 | 213722 | 2.4 | -49.18 | 14 | 95.8 |
| EW10-SC15 | 2/26/2010 | 1200 | vibracorer | 3/1/2010 | 1267156 | 213760 | 1267152 | 213757 | 1.5 | -42.19 | 14 | > 100 |
| EW10-SC16 | 3/8/2010 | 0945 | vibracorer | 3/8/2010 | 1267593 | 213782 | 1267589 | 213785 | 1.5 | -43.95 | 13.2 | 76 |
| EW10-SC17 | 3/8/2010 | 1030 | vibracorer | 3/9/2010 | 1267365 | 213811 | 1267364 | 213815 | 1.3 | -44.42 | 14 | 97 |
| EW10-SC18 | 2/26/2010 | 0850 | vibracorer | 3/1/2010 | 1267121 | 214044 | 1267122 | 214044 | 0.2 | -42.93 | 14 | 97.1 |
| EW10-SC19 | 2/24/2010 | 1030 | vibracorer | 2/25/2010 | 1267759 | 214130 | 1267764 | 214129 | 1.4 | -50.19 | 14 | 97.1 |
| EW10-SC20[c] | 2/24/2010 | 1250 | vibracorer | 2/26/2010 | 1267678 | 214189 | 1267684 | 214192 | 1.9 | -53.10 | 14 | 91.4 |
| EW10-SC21 | 2/24/2010 | 1428 | vibracorer | 2/25/2010 | 1267769 | 214348 | 1267768 | 214352 | 1.2 | -50.63 | 14 | 95.7 |

## Table 2-1. EW subsurface sediment sampling locations (cont.)

| Location ID | Collection Date | Collection Time (PST) | Collection Method | Processing Date | Target Location[a] | | Actual Location[a] | | Distance from Target (m) | Mudline Elevation (above [+] or below [-] MLLW [ft]) | Penetration Depth (ft) | Recovery (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | X | Y | X | Y | | | | |
| EW10-SC22[c] | 3/5/2010 | 1539 | vibracorer | 3/8/2010 | 1267333 | 214426 | 1267337 | 214429 | 1.6 | -53.23 | 14 | 97 |
| EW10-SC23 | 3/2/2010 | 1516 | vibracorer | 3/3/2010 | 1268428 | 214536 | 1268429 | 214533 | 0.8 | -15.21 | 14 | 96 |
| EW10-SC24 | 3/5/2010 | 1015 | vibracorer | 3/8/2010 | 1267778 | 214561 | 1267772 | 214564 | 2.1 | -47.43 | 14 | 96 |
| EW10-SC25 | 3/5/2010 | 0840 | vibracorer | 3/8/2010 | 1267556 | 214621 | 1267554 | 214617 | 1.3 | -52.22 | 14 | 93 |
| EW10-SC26 | 3/3/2010 | 0900 | vibracorer | 3/4/2010 | 1267148 | 214666 | 1267152 | 214665 | 1.2 | -51.45 | 14 | 94 |
| EW10-SC27 | 3/2/2010 | 0936 | vibracorer | 3/3/2010 | 1268221 | 214738 | 1268225 | 214738 | 1.3 | -27.64 | 14 | 94 |
| EW10-SC28 | 3/5/2010 | 1052 | vibracorer | 3/8/2010 | 1267507 | 214901 | 1267504 | 214898 | 1.1 | -53.06 | 14 | 85 |
| EW10-SC29 | 3/2/2010 | 0935 | vibracorer | 3/3/2010 | 1267830 | 214927 | 1267829 | 214940 | 4.0 | -10.67 | 14 | 89 |
| EW10-SC30[c] | 3/2/2010 | 1055 | vibracorer | 3/3/2010 | 1268098 | 215026 | 1268100 | 215022 | 1.4 | -43.83 | 14 | 98 |
| EW10-SC31 | 3/5/2010 | 1220 | vibracorer | 3/8/2010 | 1267287 | 215034 | 1267289 | 215035 | 0.6 | -54.72 | 14 | 94 |
| EW10-SC32 | 3/2/2010 | 1025 | vibracorer | 3/3/2010 | 1267676 | 215084 | 1267683 | 215089 | 2.6 | -37.53 | 14 | 99 |
| EW10-SC33 | 3/2/2010 | 1136 | vibracorer | 3/4/2010 | 1267871 | 215110 | 1267860 | 215111 | 3.4 | -30.87 | 14 | 96 |
| EW10-SC34 | 3/8/2010 | 1315 | vibracorer | 3/9/2010 | 1267416 | 215363 | 1267414 | 215362 | 0.7 | -53.32 | 14 | 94 |
| EW10-SC35 | 2/24/2010 | 1110 | vibracorer | 2/24/2010 | 1267806 | 215510 | 1267804 | 215517 | 2.2 | -43.71 | 14 | 94.2 |
| EW10-SC36[c] | 3/8/2010 | 1250 | vibracorer | 3/9/2010 | 1267602 | 215781 | 1267599 | 215782 | 0.9 | -52.71 | 14 | 90 |
| EW10-SC37 | 2/25/2010 | 0940 | vibracorer | 2/26/2010 | 1267215 | 215783 | 1267214 | 215787 | 1.3 | -53.24 | 14 | 97.1 |
| EW10-SC38 | 2/24/2010 | 1330 | vibracorer | 2/25/2010 | 1267779 | 215793 | 1267775 | 215797 | 1.8 | -52.04 | 14 | 97.1 |
| EW10-SC39 | 3/8/2010 | 0855 | vibracorer | 3/10/2000 | 1267371 | 216089 | 1267370 | 216084 | 1.5 | -53.98 | 14 | 95 |
| EW10-SC40 | 3/9/2010 | 1035 | vibracorer | 3/10/2010 | 1267408 | 216466 | 1267401 | 216467 | 2.2 | -53.56 | 14 | 95 |
| EW10-SC41 | 2/24/2010 | 1350 | vibracorer | 2/25/2010 | 1267792 | 216611 | 1267794 | 216611 | 0.7 | -52.62 | 14 | 98.6 |
| EW10-SC42 | 3/9/2010 | 0845 | vibracorer | 3/10/2010 | 1267504 | 216787 | 1267484 | 216794 | 6.5 | -54.93 | 14 | 98.6 |
| EW10-SC43[c] | 2/25/2010 | 1153 | vibracorer | 2/26/2010 | 1267235 | 216832 | 1267226 | 216826 | 3.2 | -53.16 | 14 | 86.4 |
| EW10-SC44 | 3/9/2010 | 0925 | vibracorer | 3/10/2010 | 1267472 | 217192 | 1267469 | 217194 | 0.9 | -53.91 | 14 | >100 |
| EW10-SC45 | 2/24/2010 | 0945 | vibracorer | 2/25/2010 | 1267777 | 217252 | 1267783 | 217250 | 1.8 | -51.58 | 14 | >100 |
| EW10-SC46 | 2/25/2010 | 1035 | vibracorer | 2/26/2010 | 1267210 | 217355 | 1267209 | 217340 | 4.7 | -53.46 | 14 | 92.8 |
| EW10-SC47 | 3/9/2010 | 1308 | vibracorer | 3/10/2010 | 1267422 | 217660 | 1267543 | 217654 | 36.9 | -55.33 | 14 | 84 |
| EW10-SC48[c] | 3/4/2010 | 1055 | vibracorer | 3/5/2010 | 1267855 | 217669 | 1267853 | 217674 | 1.7 | -33.55 | 14 | 96 |
| EW10-SC49 | 3/9/2010 | 1115 | vibracorer | 3/10/2010 | 1267527 | 217974 | 1267527 | 217979 | 1.6 | -54.05 | 14 | 99 |
| EW10-SC50 | 3/4/2010 | 1126 | vibracorer | 3/5/2010 | 1267839 | 218092 | 1267841 | 218095 | 1.1 | -37.55 | 14 | 84 |

**Table 2-1. EW subsurface sediment sampling locations (cont.)**

| Location ID | Collection Date | Collection Time (PST) | Collection Method | Processing Date | Target Location[a] X | Target Location[a] Y | Actual Location[a] X | Actual Location[a] Y | Distance from Target (m) | Mudline Elevation (above [+] or below [-] MLLW [ft]) | Penetration Depth (ft) | Recovery (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EW10-SC51[c] | 3/3/2010 | 1230 | vibracorer | 3/4/2010 | 1267316 | 218213 | 1267313 | 218208 | 1.8 | -61.72 | 14 | 88 |
| EW10-SC52 | 3/4/2010 | 1006 | vibracorer | 3/5/2010 | 1267874 | 218317 | 1267865 | 218318 | 2.8 | -33.04 | 14 | 91 |
| EW10-SC53 | 3/4/2010 | 0850 | vibracorer | 3/5/2010 | 1267694 | 218506 | 1267693 | 218510 | 1.3 | -54.51 | 14 | 88 |
| EW10-SC54 | 3/4/2010 | 0926 | vibracorer | 3/5/2010 | 1267907 | 218620 | 1267907 | 218619 | 0.3 | -8.70 | 14 | 71 |
| EW10-SC55 | 2/25/2010 | 1043 | vibracorer | 2/26/2010 | 1267245 | 218670 | 1267238 | 218670 | 2.1 | -54.69 | 14 | 78.6 |
| EW10-SC56[c] | 3/9/2010 | 0845 | vibracorer | 3/11/2010 | 1267478 | 218688 | 1267476 | 218694 | 1.9 | -56.10 | 14 | 92 |
| EW10-SC57 | 3/1/2010 | 1220 | vibracorer | 3/2/2010 | 1268204 | 218890 | 1268202 | 218918 | 8.6 | -40.82 | 14 | 99 |
| EW10-SC58 | 3/1/2010 | 1310 | vibracorer | 3/2/2010 | 1268991 | 218983 | 1268982 | 218978 | 3.2 | -34.72 | 14 | 90 |
| EW10-SC59[c] | 3/1/2010 | 1035 | vibracorer | 3/2/2010 | 1268509 | 218984 | 1268513 | 218984 | 1.3 | -41.03 | 14 | 99 |
| EW10-SC60 | 3/1/2010 | 0855 | vibracorer | 3/2/2010 | 1268052 | 218994 | 1268047 | 218992 | 1.5 | -42.30 | 14 | 99 |
| EW10-SC61 | 3/1/2010 | 0955 | vibracorer | 3/2/2010 | 1267826 | 219053 | 1267827 | 219047 | 1.7 | -42.72 | 14 | 91 |
| EW10-SC62 | 3/9/2010 | 1115 | vibracorer | 3/11/2010 | 1267287 | 219275 | 1267290 | 219278 | 1.3 | -54.55 | 14 | 93 |
| EW10-SC63[c] | 3/1/2010 | 1215 | vibracorer | 3/2/2010 | 1267775 | 219508 | 1267778 | 219507 | 1.1 | -53.65 | 14 | 94 |
| EW10-SC100 | 3/3/2010 | 1015 | vibracorer | 3/4/2010 | 1267169 | 215359 | 1267169 | 215363 | 1.2 | -52.79 | 14 | 97 |
| EW10-SC101 | 3/3/2010 | 0945 | vibracorer | 3/4/2010 | 1267236 | 217926 | 1267229 | 217923 | 2.2 | -54.20 | 14 | 95 |

[a] Sampling location coordinates are Washington State Plane North, US survey ft, NAD83.

[b] Two borings to collect subsurface sediment samples for geotechnical analysis were planned in the QAPP (Windward 2010). However, field conditions prevented the two borings from being completed to their desired depth. The drilling and sampling of boring EW10-SB01 down to 60 ft was prevented by a layer of wood at 3.5 ft that prevented the augers from drilling vertically. The boring was terminated, renamed EW10-SB01A, and another boring was resumed a short distance away, named EW10-SB01B, and continued down to 60.5 ft. The drilling of boring EW10-SB02 down to 60 ft was prevented by high winds that threatened to break the drilling rods and augers in the ground while sampling at 20 ft below the mudline. Winds pushed the barge off the center of the hole and stretched anchor lines, which could have resulted in the potential loss of equipment. The drilling rods and equipment were removed, the boring was terminated and renamed EW10-SB02A, and drilling was resumed the next day. When drilling resumed near this location, augers were sent down to 17 ft, where sampling continued. The new boring was named EW10-SB02B and was continued down to a depth of 61.5 ft below the mudline.

[c] Subsurface sediment samples for geotechnical analysis were also collected.

[d] Subsurface sediment core EW10-SC07A was rejected in favor of EW10-SC07B.

EW – East Waterway
ID – identification
MLLW – mean lower low water
PST – Pacific Standard Time
NAD83 – North American Datum of 1983
QAPP – quality assurance project plan

GPS signal strength was insufficient near and beneath the bridges so locations in that area were determined by laser telemetry using locations with known coordinates. Two actual locations, EW10-SC09 and EW10-SC47, were more than 10 m from their target sampling locations (Section 2.5). The rationale for the selection of subsurface sediment sampling locations was presented in Section 3.1.1 of the QAPP.

## 2.3 Sample Collection Methods

Subsurface sediment cores were collected from February 22 to March 9, 2010, at a target depth of 14 ft (4.3 m) below mudline or until refusal, whichever was reached first. Sediment cores were collected using two methods, depending on location: 1) in the southern-most portion of the EW, a diver-assisted air-powered linear hammer core sampler called the MudMole™ was used, and 2) for the rest of the EW, a vibratory core sampler (i.e., vibracorer) was used. For MudMole™ and vibracorer sediment cores, a chain-of-custody form was compiled daily by Windward Environmental LLC (Windward) and Anchor QEA field staff. Deviations from the QAPP (Windward 2010) are presented in Section 2.5. Sediment borings were also collected for geotechnical analysis. Each collection method is described in detail in the following subsections.

### 2.3.1 MudMole™ sampling method

The MudMole™ was operated by AMEC and deployed from a 30-ft pontoon research vessel at eight sampling locations in the southern-most portion of the EW (EW10-SC01 to EW10-SC06, EW10-SC08, and EW10-SC11). The targeted penetration was achieved at all sampling locations except EW10-SC01, EW10-SC02, and EW10-SC07A, at which the MudMole™ encountered refusal from sand and gravel layers. EW10-SC07A was revisited with the vibracorer (EW10-SC07B). Despite repeated attempts using the vibracorer, cores were not collected from locations EW10-SC01 and EW10-SC02 due to the presence of hard substrate. The penetration at these locations was less than 1ft for all attempts. Sampling results are summarized in Section 4.

At each sampling location, the MudMole™ was lowered to the sediment surface using a winch. An air-powered linear hammer was then used to drive a pre-cleaned and decontaminated core tube into the sediment. At approximately 2-ft intervals, the operator suspended the driving operation, and a diver measured the penetration depth of the core tube and internal recovery of the core (total core length minus the empty space within the core). These measurements were recorded on sediment core logs, which are included in Appendix B. After the core had been driven to 14 ft or refusal, final penetration and recovery measurements were made, the actual sampling position was recorded and the core was extracted. The bottom of each core tube was fitted with a hinged core catcher to minimize the loss of sediment during extraction. Once the sediment core was on board the sampling vessel, the core catcher end was inspected for signs of sediment loss during retrieval. In addition, an on-deck measurement from the top of the core tube to the surface of the sediment within the core tube was made to account for any movement or loss of sediment in the core tube as the core catcher closed during extraction. Overlying water was siphoned out of the core tube on deck, and the cores were capped, taped, and labeled with the sampling location ID and the designations of "top" and "bottom." The core tubes were stored with the top higher than the bottom to prevent the loss of material and sealed to minimize moisture loss during transport. The sediment cores were transported to the processing laboratory at Analytical Resources, Inc. (ARI), in Tukwila, Washington, for processing.

The penetration and recovery data and the on-deck top-of-sediment measurements were entered into a spreadsheet in order to generate a bore log for each core. Each bore log included a graph that presented penetration versus distance from the top of the tube, which were used to identify the *in situ* depth of different sediment horizons. *In situ* depths are further described in Section 2.4.2 and presented on the core logs (Appendix B).

### 2.3.2 Vibracore sampling method

The vibracorer was operated by Marine Sampling Systems and deployed from the research vessel *Nancy Anne* and at 57 stations (EW10-SC07B, EW10-SC09 to EW10-SC63, EW10-SC100, and EW10-SC101). At all sampling locations, the vibracorer collected a continuous sample of subsurface sediment using a high-frequency vibrator that penetrated into the underlying sediment and caused minimal distortion. The bottom of each core tube was fitted with a hinged core catcher to minimize the loss of sediment during extraction. Penetration and recovery measurements were made once, at the end of driving, and averaged throughout the core. The vibracore method was also attempted at locations EW10-SC01 and EW10-SC02, but these attempts were not successful.

Once the core samples were deemed acceptable, the core catcher and cutterhead were removed, and a cap was placed over both ends of the core tube and firmly secured in place with duct tape. The core tube was labeled with permanent black pen and marked with the location ID and an arrow that pointed to the top of core. The cores were then cut into appropriate lengths, sealed, and labeled by section for vertical transport to the laboratory for processing. The cores were sealed tightly to prevent leakage or disturbance during transport and were cut to a maximum length of 5.7 ft in order to be stowed upright during transport. Cores were transported at the end of each collection day and stored overnight in a secure refrigerator at ARI.

### 2.3.3 Sediment boring method

Samples collected from the two borings at the mound area were collected at regular intervals from the mudline downward using two methods. Geotechnical index test samples were collected using a split-spoon sampler so that standard penetration test (SPT) blowcounts could be recorded. Geotechnical strength, consolidation, bulk density, and chemistry samples were obtained using stainless steel, thin-wall Shelby tubes because an undisturbed sample was required for these particular geotechnical tests, and a larger core was needed to obtain sample of sufficient size for chemical analyses.

The Shelby tube and split-spoon sampler were used in an alternating sequence for each boring. The drill rig was used to advance a casing (hollow steel pipe or hollow-stem auger) to the top of the sampling interval. For chemistry samples, the drill rig hydraulically pushed a decontaminated 3-in.-diameter Shelby tube below the casing to collect a 24-in. sample. Where split-spoon samplers were used, the SPT was initiated using a calibrated hammer system to advance the 1.5-in. (inner diameter) sampler to a total of 18 in. below the casing for sample collection.

## 2.4 Subsurface Sediment Core Processing

This section describes the processing and sectioning of core tubes at the field laboratory, the calculation of *in situ* depths from measured depths in the field, the evaluation of mudline elevations, and the generation of sediment core logs.

### 2.4.1 Core processing and sampling

Subsurface sediment cores were processed and sampled at the field processing laboratory at ARI. Core processing began on February 23, 2010, and was completed on March 11, 2010. Core tubes were stored in a vertical position in laboratory refrigerators and were processed within 72 hours of receipt. Core processing involved four main steps: 1) cutting, 2) logging, 3) sectioning, and 4) sampling.

#### *Cutting*

Each core was cut lengthwise with a circular saw to expose the sediment. Care was taken to not spill turbid water from the top of the tube. A thin film of sediment that had been in direct contact with the side of the core was removed from the exposed sediment surface prior to logging the core. After each core had been opened, a preliminary screening with a photoionization detector (PID) was used to measure volatile organic compounds (VOCs) in the air space immediately above the exposed sediment. This was performed for the health and safety of the core processing team. PID readings are provided in Appendix B.

#### *Logging*

The sediment profile was then photographed in 1-ft increments of recovered sediment. The core was visually logged for major and minor contacts (i.e., areas in the core where sediment characteristics noticeably changed). Cores were characterized according to the Unified Soil Classification System, consistent with current American Society for Testing and Materials (ASTM) methods (ASTM 2001a). Sediment classification was based on ASTM D-2488 (ASTM 2001b). A tape measure was affixed to the sidewalls of the tube or processing table to measure the length of the sediment core based on recovered depths. Finally, each core was sub-sectioned for sampling according to Methods A, B, or C, as described in the QAPP (Windward 2010) and summarized below.

### *Sectioning*

Sediment was sampled in accordance with the QAPP (Windward 2010) based on location within the waterway. The sampling scheme consisted of Methods A, B, or C, unless stratigraphic boundaries were observed. If stratigraphic boundaries were observed, the samples were collected from intervals from within the same stratigraphic units rather than at the fixed intervals indicated by the sampling scheme. The sectioning decision for each core was made by the field geologist in consultation with US Environmental Protection Agency (EPA) oversight personnel, if present, at the time the core was sectioned.

Sediment sampled from Method A cores (i.e., EW10-SC09, EW10-SC10, EW10-SC12 to EW10-SC37, EW10-SC39, EW10-SC40, EW10-SC42-SC44, EW10-SC46 to EW10-SC63, EW10-SC100, and EW10-SC101) involved sub-sectioning sediment into 2-ft intervals. Sediment sampled from mudline to 4 ft of recovered depth was sent to the laboratory for analysis; samples from core depths greater than 4 ft to the bottom of the core were archived. The decision regarding the potential analysis of archived samples was made after preliminary unvalidated results of the chemical analyses of samples in the upper intervals had been inspected in consultation with EPA.

Method B cores (i.e., EW10-SC03 to EW10-SC08 and EW10-SC11) were sub-sectioned such that the uppermost 6 ft were split in half vertically. One half of this core was sub-sectioned into 2-ft sampling intervals, and the other half was sub-sectioned into 0.5-ft sampling intervals. Sediment sampled in the 0-to-2- and 2-to-4-ft intervals was sent to the laboratory for analysis; sediment in the 2-ft intervals beyond 4 ft and the 0.5-ft intervals was archived. As noted above for Method A cores, the decision regarding the potential analysis of archived samples was made after the preliminary unvalidated results of the chemical analyses of samples in the upper intervals had been inspected in consultation with EPA.

Method C cores (i.e., EW10-SC38, EW10-SC41, and EW10-SC45) were sub-sectioned into 1-ft intervals. Sediment sampled from depths of less than 2 ft was sent to the laboratory for analysis. Sediment from the remaining intervals from below 2 ft to the bottom of the core was archived. As noted above, the decision regarding the potential analysis of archived samples was made after the preliminary unvalidated results of chemical analyses in the upper intervals had been inspected in consultation with EPA.

Sampling intervals were adjusted as necessary to maintain consistency in stratigraphy within each sample or based on the presence of odor, sheen, or debris. Sediment descriptions were recorded on the sediment core processing logs. Draft logs were provided to EPA at the end of each sampling day, as requested, along with draft native sediment depth interpretations. Appendix B presents the final sediment core logs that include native sediment depth interpretations. Final sediment logs include collection details, percent recovery, sampling intervals and chemicals, and stratigraphic interpretations.

#### *Sampling*

After each core was sectioned, a scoop of sediment was removed to expose a fresh sample of sediment, and PID measurements were made in order to determine the concentrations of VOCs in the air space above the exposed sediment. After PID measurements had been recorded on the field forms, geotechnical samplers were placed in the sediment so that sediment of each major type was sampled. Geotechnical samples were collected from 13 cores distributed throughout the EW to collect undisturbed sediment samples (EW10-SC05, EW10-SC11, EW10-SC14, EW10-SC20, EW10-SC22, EW10-SC30, EW10-SC36, EW10-SC43, EW10-SC48, EW10-SC51, EW10-SC56, EW10-SC59, and EW10-SC63). The geotechnical core sampler consisted of a 2-in.-diameter by 6-in.-long Dames and Moore sampling tube. The sampler was pushed (or gently pounded with a mallet when necessary) into the sediment. A metal plate was placed across the bottom to lift the tube out of the core, and plastic caps were placed over both ends of the tube to secure sediment in place. The final sample consisted of an intact portion of sediment from each major sediment type.

After the placement of geotechnical samplers, but prior to removal, chemistry samples were collected. For chemistry samples, sediment was transferred from designated sampling intervals into decontaminated stainless steel bowls, homogenized until uniform in color and texture, and placed into pre-cleaned labeled glass jars for laboratory analysis. When material larger than approximately 1 in. in diameter (e.g., organisms, shell fragments, debris) was encountered, it was removed prior to the placement of sediment in sample containers. Removed materials were noted in the sediment core logs, and debris (e.g., asphalt agglomerate, rope) was retained. All sample containers were labeled on the outside (using indelible ink) with the sample ID number, time and date collected, and analyses to be performed.

### 2.4.2 Calculating *in situ* depths

The volume of sediment retained in the core tube during collection was typically less than 100% of the drive length, a common occurrence during sediment coring. The recovery of sediment in the core is dependent on the nature of the sediment, which is generally not uniform throughout the core, and frictional forces encountered during driving. Lower recoveries in some samples were a result of: 1) sediment dewatering, 2) compaction of cohesionless and saturated sediment (a result of vibracore sampling) or compression of cohesionless and saturated sediment (a result of MudMole™ sampling), 3) obstruction or blockage during penetration that prevented material from entering the tube, or 4) sediment loss during recovery of the core tube through the water column. Because of these factors, the amount of material in the core tube during field processing (i.e., the recovered depth) typically did not reflect the actual depth below the mudline from which the sediment core was collected (referred to as the *in* *situ* depth). *In situ* depths were calculated in two ways depending on the sample collection method (MudMole™ or vibracorer). The *in situ* depths are provided in Appendix B.

For the MudMole™, incremental penetration and recovery information was collected during sampling, allowing for an accurate characterization of *in situ* conditions throughout the length of the core. Incremental penetration and recovery data were recorded by divers at approximately 1-to-2-ft intervals from inside and outside the core tube with a weighted tape measure. The data were used to generate a graph on the bore log, which provides a record of the core tube penetration and sediment core recovery at regular intervals for each core. When the amount of sediment recovered was less than 100% of the drive interval, these graphs were used to convert the recovered depths recorded during field processing to corresponding *in situ* depths.

For the vibracorer, *in situ* depths were estimated based on the difference between the recovered depth and the drive depth over the entire length of the core.

### 2.4.3 Evaluation of mudline elevations

Mudline elevations were evaluated using multibeam survey data and tidal-corrected water depth data. Bathymetric data was collected in January 2010 by David Evans and Associates using multibeam surveying methods. Bathymetry measurements were recorded every 1 m and were referenced to MLLW (in feet), which is defined as the project datum. Mudline elevations were then assessed for each core location using the computer-aided design/geographic information system (CAD/GIS) surface.

Vertical data were also collected during coring by measuring the depth from the water surface to the top of the sediment surface at each sampling location using a lead line, per the QAPP (Windward 2010). This depth was corrected for tidal influence after sampling using the National Oceanic and Atmospheric Administration's National Ocean Service automated tide gauge at Pier 54. Water depth and lead line measurements are provided on the sediment core logs (Appendix B).

### 2.4.4 Generating sediment core logs

Sediment core processing logs generated in the field were converted into the final electronic format using the software program LogPlot™ 7. The sediment core processing logs included a variety of information, including physical attributes such as sediment particle size and shape, density, color, and consistency; stratification, lenses, or layers; the presence of debris, sheen, odor, or staining; coordinates and mudline elevations; penetration depth and percent recovery, calculated *in situ* depths, and other distinguishing features.

The core logs (Appendix B) record the observations relating to lithology and stratigraphy for each core. The logs also include four major types of information: 1) lithologic profiles based on recovered depths using description categories based on ASTM nomenclature (ASTM 2001b); 2) sampling intervals based on recovered depths and selected analyses; 3) detailed sediment descriptions and observations; and 4) combined lithology and interpreted stratigraphy profiles based on the information described above and organized according to *in situ* depths.

The core logs presented in Appendix B contain final descriptions and assessment of stratigraphy (i.e., depth to native), final mudline elevations, updated sediment descriptions based on laboratory grain size and Atterberg limit test results, and updated interpretations of native contacts based on the above information as well as supplemental information such as dredge records, bathymetry, and historic reports.

## 2.5 FIELD DEVIATIONS FROM THE QAPP

Field deviations from the QAPP (Windward 2010) included modifications to sampling locations, core collection acceptance criteria, and processing and sampling methods. These field deviations did not affect the data quality. EPA was consulted on deviations that involved a change in study design. The deviations included the following:

- No cores were obtained from locations EW10-SC01 and EW10-SC02 despite repeated attempts because of the presence of a hard substrate in the sampling area south of the bridges.
- MudMole™ core sample acceptance criteria were modified at locations EW10-SC03, EW10-SC04, EW10-SC07A, and EW10-SC11 because of the difficulty in obtaining acceptable cores as a result of the hard substrate. The criteria indicated in the QAPP (Windward 2010) were modified from a minimum 14-ft penetration depth (or refusal) and 75% on-deck recovery to acceptance criteria of the best professional judgment of the core collection team. This judgment was based on the initial substrate reconnaissance performed by divers to find the most suitable locations for collecting cores within the range of the target coordinates. Therefore, the first coring attempt in which sediment was recovered at the deepest possible depth was accepted. Cores EW10-SC03, EW10-SC04, and EW10-SC11 were accepted for processing and analysis based on best professional judgment; core EW10-SC07A was re-attempted with the vibracorer (EW10-SC07B) with success rates within the acceptance criteria specified in the QAPP. Samples from EW10-SC07B were submitted for analysis; samples from EW10-SC07A were archived.
- The percent recovery of vibracore sample EW10-SC16 was below the QAPP guidance (Windward 2010). Initial calculations performed by the core collection team yielded a percent recovery within acceptance criteria (76%). During the quality control effort, recovery was recalculated to be 73% recovery. This core was accepted and processed without a second collection attempt.
- The field crew was unable to use the GPS when collecting samples at locations EW10-SC03 and EW10-SC04 because they were located under a bridge. Coordinates were determined using the vessel's range finder based on the proximity to the bridge and proximity to the shoreline.

- Mudline elevations were determined using the 2010 multibeam bathymetric survey conducted by David Evans and Associates, as opposed to the validated data from the tide gauge at Pier 54, as originally scoped in the QAPP (Windward 2010). Multibeam bathymetry data were collected prior to sediment coring and determined to be more accurate than data based on lead line and tidal corrections.
- The method for sampling the Method B cores was modified slightly to ensure that a sufficient amount of sample from the 2-ft sections was placed into jars for chemical analysis. Rather than dividing one-half of the core into 0.5-ft sections and the other half into 2-ft sections and placing the sediment directly into sample jars as shown in Figure 3-2 of the QAPP (Windward 2010), 0.5-ft sections from both vertical halves of the core were first sampled and homogenized, with sediment from each 0.5-ft section being homogenized in a separate bowl. To create the sample for each 2-ft section, equal amounts of sediment from the four individual bowls of sediment were removed and homogenized in a single bowl until sufficient sediment was obtained to fill the jars for the 2-ft section analyses. The remaining sediment in the four bowls with sediment from the 0.5-ft section was placed into jars for the 0.5-ft archive samples.
- Two locations, EW10-SC09 and EW10-SC47, were sampled > 10 m from their target locations (Table 2-2). EPA was consulted on the actual locations as soon as the deviations from target locations were identified. These deviations from the target locations will not affect the usability of the dataset for the purposes of the SRI or the FS.

**Table 2-2. Actual sampling locations that were > 10 m from their target sampling locations**

| Sampling Location ID | Distance from Target Sampling Location (m) | Rationale for Move |
|---|---|---|
| EW10-SC09 | 18.3 | Sampling was difficult in original location; location was adjusted to achieve required penetration. |
| EW10-SC47 | 36.9 | Actual sampling location was more than 10 m from target sampling location as a result of operator error during the entering target coordinates. |

ID – identification

# 3 Laboratory Methods

This section describes the methods used to select samples for chemical analysis, the methods used to chemically analyze sediment samples, and any deviations from the QAPP (Windward 2010) pertaining to laboratory methods.

## 3.1 Samples Selected for Analysis

All samples collected from the 0-to-2- and 2-to-4-ft intervals were analyzed for metals, polychlorinated biphenyl (PCB) Aroclors, semivolatile organic compounds (SVOCs), and conventional parameters; and a subset was analyzed for butyltins and pesticides, as specified in the QAPP (Windward 2010). Some samples may be analyzed for dioxin/furans in the future. Following the first round, two additional rounds of chemical analyses were conducted on archived sediment samples. The second round was conducted on a subset of archived samples collected from depths greater than 4 ft. A meeting was held with EPA on July 15, 2010, to review preliminary unvalidated data and decide which archived samples should be analyzed in the second round. Archived samples were analyzed to characterize chemistry at depth when unvalidated data from the 2-to-4-ft interval samples analyzed during the first round had detected chemical concentrations that exceeded either Washington State Sediment Management Standards (SMS) criteria (i.e., sediment quality standards [SQS] or cleanup screening levels [CSL]) or Dredged Material Management Program (DMMP) guidelines (i.e., screening levels [SLs] or maximum levels [ML]). The third round of analyses was conducted on a subset of archived samples collected from > 6 ft if unvalidated data from the second round indicated that further characterization was necessary based on SMS exceedances at depth. Decisions regarding the analyses to be conducted during the third round were made in consultation with EPA. In addition, archived samples (subsurface and surface sediment) were selected for the analysis of dioxins and furans in consultation with EPA. The dioxin and furan data for all of these samples will be provided in a separate data memo (Windward 2011).

In some cases, depth intervals that lacked chemical characterization were not selected for analysis (i.e., some depth intervals were skipped at particular locations). For example, there may have been a location with SMS exceedances in the 4-to-6-ft sampling interval, but only the 8-to-10-ft interval was analyzed in the second round (skipping the 6-to-8-ft interval). This approach was used to limit the number of additional analyses needed, and such decisions were made in consultation with EPA. If estimates regarding the depth of contamination are needed for locations with skipped intervals, chemical concentrations in the skipped interval(s) will be conservatively assumed to be similar to those in the preceding interval.

Table 3-1 presents the target chemicals and parameters for each sediment core analyzed by interval.

## Table 3-1. Analyses performed on subsurface sediment samples

| Sampling Location ID | Sampling Interval (ft) | Mercury | Other Metals | SVOCs | PCBs | Butyltins | Pesticides | Grain Size | Conventionals[a] |
|---|---|---|---|---|---|---|---|---|---|
| EW10-SB01 | 0 – 2 | X | X | X | X | | | X | X |
| | 3.5 – 5.2 | X | X | X | X | | | X | X |
| | 12.5 – 14.5 | X | X | X | X | | | X | X |
| | 16 – 18 | X | X | X | X | | | X | X |
| | 24.5 – 26.5 | | | X | | | | | |
| EW10-SB02 | 0 – 2 | X | X | X | X | | | X | X |
| | 4 – 6 | X | X | X | X | | | X | X |
| | 12 – 14 | X | X | X | X | | | X | X |
| EW10-SC03 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4 | X | X | X | X | | | X | X |
| EW10-SC04 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4 | X | X | X | X | | | X | X |
| | 4 – 4.5 | | | X | | | | | X |
| EW10-SC05 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4 | X | X | X | X | | | X | X |
| EW10-SC06 | 0 – 2 | X | X | X | X | X | | X | X |
| | 2 – 4 | X | X | X | X | X | | X | X |
| | 4 – 6 | X | | | | | | | X |
| | 6 – 7.4 | X | | | | | | | X |
| | 7.4 – 10 | X | | | | | | | X |
| EW10-SC07B | 0 – 2.3 | X | X | X | X | | | X | X |
| | 2.3 – 4 | X | X | X | X | | | X | X |
| | 4 – 6 | | | | X | | | | X |
| EW10-SC08 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4 | X | X | X | X | | | X | X |
| | 6 – 8 | X | X | X | X | | | | X |
| | 8 – 9.4 | X | | | | | | | X |
| | 9.4 – 11 | X | | | | | | | X |
| EW10-SC09 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4 | X | X | X | X | | | X | X |
| | 6 – 7.2 | X | | X | X | | | | X |
| | 7.2 – 9.2 | X | | X | X | | | | X |
| | 9.2 – 11.2 | X | | | | | | | X |

### Table 3-1. Analyses performed on subsurface sediment samples (cont.)

| Sampling Location ID | Sampling Interval (ft) | Mercury | Other Metals | SVOCs | PCBs | Butyltins | Pesticides | Grain Size | Conventionals[a] |
|---|---|---|---|---|---|---|---|---|---|
| EW10-SC10 | 0 – 2.4 | X | X | X | X | X | | X | X |
| | 2.4 – 4 | X | X | X | X | X | | X | X |
| | 4 – 6 | | | | X | | | | X |
| | 6 – 8 | | | | X | | | | X |
| EW10-SC11 | 0 – 2 | X | X | X | X | | X | X | X |
| | 2 – 4 | X | X | X | X | | X | X | X |
| | 4 – 6 | X | X | X | X | | X | | X |
| | 6 – 8 | X | | | X | | | | X |
| EW10-SC12 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 3.1 | X | X | X | X | | | X | X |
| | 5 – 7 | X | | X | X | | | | X |
| | 7 – 9 | X | | | | | | | X |
| EW10-SC13 | 0 – 1.6 | X | X | X | X | | | X | X |
| | 1.6 – 4 | X | X | X | X | | | X | X |
| EW10-SC14 | 0 – 2.8 | X | X | X | X | | | X | X |
| | 2.8 – 5.3 | X | X | X | X | | | X | X |
| | 5.3 – 7.3 | | | | X | | | | X |
| EW10-SC15 | 0 – 2.3 | X | X | X | X | | | X | X |
| | 2.3 – 4 | X | X | X | X | | | X | X |
| EW10-SC16 | 0 – 1.9 | X | X | X | X | | | X | X |
| | 1.9 – 4 | X | X | X | X | | | X | X |
| | 4 – 6 | X | | | | | | | X |
| | 6 – 8.2 | X | | | | | | | X |
| EW10-SC17 | 0 – 2 | X | X | X | X | X | | X | X |
| | 2 – 4 | X | X | X | X | X | | X | X |
| | 6 – 8 | X | | | X | | | | X |
| | 8 – 10 | X | | | | | | | X |
| | 11.5 – 13 | X | | | X | | | | X |
| EW10-SC18 | 0 – 2 | X | X | X | X | X | | X | X |
| | 2 – 4 | X | X | X | X | X | | X | X |
| | 4 – 6 | X | | X | X | | | | X |
| | 6 – 8 | X | | | X | | | | X |
| EW10-SC19 | 0 – 2.5 | X | X | X | X | | X | X | X |
| | 2.5 – 4 | X | X | X | X | | X | X | X |
| | 4 – 6 | | | X | X | | | | X |

## Table 3-1. Analyses performed on subsurface sediment samples (cont.)

| Sampling Location ID | Sampling Interval (ft) | Mercury | Other Metals | SVOCs | PCBs | Butyltins | Pesticides | Grain Size | Conventionals[a] |
|---|---|---|---|---|---|---|---|---|---|
| EW10-SC20 | 0.4 – 2.4 | X | X | X | X | | | X | X |
| | 2.4 – 4.4 | X | X | X | X | | | X | X |
| EW10-SC21 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4 | X | X | X | X | | | X | X |
| | 5.3 – 7.8 | X | | X | X | | | | X |
| | 7.8 – 10 | X | | | | | | | X |
| EW10-SC22 | 0 – 1.9 | X | X | X | X | | | X | X |
| | 1.9 – 4 | X | X | X | X | | | X | X |
| EW10-SC23 | 0 – 1.3 | X | X | X | X | X | | X | X |
| | 1.3 – 3.2 | X | X | X | X | X | | X | X |
| | 7 – 9 | X | | | | | | | X |
| | 9 – 11 | X | X | X | X | | | | X |
| | 11 – 12.9 | X | | X | | | | | X |
| EW10-SC24 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4.7 | X | X | X | X | | | X | X |
| | 6 – 8 | X | | X | X | | | | X |
| | 8 – 10 | X | | X | X | | | | X |
| EW10-SC25 | 0.8 – 2.8 | X | X | X | X | | | X | X |
| | 2.8 – 4.8 | X | X | X | X | | | X | X |
| EW10-SC26 | 0 – 2.7 | X | X | X | X | X | | X | X |
| | 2.7 – 4 | X | X | X | X | X | | X | X |
| EW10-SC27 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4 | X | X | X | X | | | X | X |
| | 6 – 7.7 | X | X | X | X | | | | X |
| | 7.7 – 10 | X | | | | | | | X |
| | 10 – 12.5 | X | | | | | | | X |
| EW10-SC28 | 1 – 3 | X | X | X | X | | | X | X |
| | 3 – 5 | X | X | X | X | | | X | X |
| | 6.2 – 8 | X | | X | X | | | | X |
| | 8 – 10 | X | | | | | | | X |
| | 10 – 11.7 | X | | | | | | | X |
| EW10-SC29 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 3.9 | X | X | X | X | | | X | X |
| | 9.7 – 11.7 | X | X | X | X | | | | X |

### Table 3-1. Analyses performed on subsurface sediment samples (cont.)

| Sampling Location ID | Sampling Interval (ft) | Mercury | Other Metals | SVOCs | PCBs | Butyltins | Pesticides | Grain Size | Conventionals[a] |
|---|---|---|---|---|---|---|---|---|---|
| EW10-SC30 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4.3 | X | X | X | X | | | X | X |
| | 4.3 – 6 | X | | | X | | | | X |
| | 6 – 8 | X | | | X | | | | X |
| EW10-SC31 | 0.7 – 2.7 | X | X | X | X | | | X | X |
| | 2.7 – 5.3 | X | X | X | X | | | X | X |
| EW10-SC32 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4 | X | X | X | X | | | X | X |
| | 8.9 – 10.9 | X | X | X | X | | | | X |
| | 10.9 – 12.9 | X | | | | | | | X |
| EW10-SC33 | 0 – 2 | X | X | X | X | X | | X | X |
| | 2 – 3.5 | X | X | X | X | X | | X | X |
| | 5.8 – 8 | X | X | X | X | | | | X |
| | 8 – 9.8 | X | | | | | | | X |
| EW10-SC34 | 0.2 – 2.4 | X | X | X | X | | | X | X |
| | 2.4 – 3.9 | X | X | X | X | | | X | X |
| EW10-SC35 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4 | X | X | X | X | | | X | X |
| EW10-SC36 | 0.9 – 3 | X | X | X | X | X | | X | X |
| | 3 – 5 | X | X | X | X | X | | X | X |
| EW10-SC37 | 0 – 2 | X | X | X | X | X | | X | X |
| | 2 – 3.9 | X | X | X | X | X | | X | X |
| EW10-SC38 | 0 – 0.8 | X | X | X | X | | | X | X |
| | 0.8 – 2 | X | X | X | X | | | X | X |
| EW10-SC39 | 0 – 2 | X | X | X | X | | X | X | X |
| | 2 – 3.4 | X | X | X | X | | X | X | X |
| EW10-SC40 | 0 – 1 | X | X | X | X | X | | X | X |
| | 1 – 4 | X | X | X | X | X | | X | X |
| | 4 – 6.8 | X | | | X | | | | X |
| | 6.8 – 8 | X | | | | | | | X |
| EW10-SC41 | 0 – 0.6 | X | X | X | X | | | X | X |
| | 0.6 – 2 | X | X | X | X | | | X | X |

**Table 3-1. Analyses performed on subsurface sediment samples (cont.)**

| Sampling Location ID | Sampling Interval (ft) | Mercury | Other Metals | SVOCs | PCBs | Butyltins | Pesticides | Grain Size | Conventionals[a] |
|---|---|---|---|---|---|---|---|---|---|
| EW10-SC42 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4 | X | X | X | X | | | X | X |
| | 4 – 5.5 | X | | | X | | | | X |
| | 5.5 – 8 | X | | | | | | | X |
| | 8 – 10 | X | | | | | | | X |
| EW10-SC43 | 0 – 1.3 | X | X | X | X | X | | X | X |
| | 1.3 – 4 | X | X | X | X | X | | X | X |
| | 4 – 6 | | | | X | | | | X |
| | 6 – 8 | | | | X | | | | X |
| EW10-SC44 | 0 – 2 | X | X | X | X | X | | X | X |
| | 2 – 4 | X | X | X | X | X | | X | X |
| EW10-SC45 | 0 – 1 | X | X | X | X | | | X | X |
| | 1 – 1.7 | X | X | X | X | | | X | X |
| EW10-SC46 | 0 – 2.3 | X | X | X | X | X | | X | X |
| | 2.3 – 4 | X | X | X | X | X | | X | X |
| EW10-SC47 | 0 – 2 | X | X | X | X | X | | X | X |
| | 2 – 3.6 | X | X | X | X | X | | X | X |
| | 3.6 – 6 | X | | | X | | | | X |
| | 6 – 8 | X | | | | | | | X |
| EW10-SC48 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4.7 | X | X | X | X | | | X | X |
| | 4.7 – 6 | X | X | | X | | | | X |
| | 6 – 8 | X | | | X | | | | X |
| EW10-SC49 | 0 – 1.6 | X | X | X | X | X | | X | X |
| | 1.6 – 4 | X | X | X | X | X | | X | X |
| EW10-SC50 | 0 – 1.6 | X | X | X | X | X | | X | X |
| | 1.6 – 4 | X | X | X | X | X | | X | X |
| EW10-SC51 | 0 – 2 | X | X | X | X | X | | X | X |
| | 2 – 3.8 | X | X | X | X | X | | X | X |
| EW10-SC52 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4 | X | X | X | X | | | X | X |
| | 4 – 6 | | | | X | | | | X |
| EW10-SC53 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4 | X | X | X | X | | | X | X |
| | 5 – 7 | | | | X | | | | X |

### Table 3-1. Analyses performed on subsurface sediment samples (cont.)

| Sampling Location ID | Sampling Interval (ft) | Mercury | Other Metals | SVOCs | PCBs | Butyltins | Pesticides | Grain Size | Conventionals[a] |
|---|---|---|---|---|---|---|---|---|---|
| EW10-SC54 | 0 – 2 | X | X | X | X | | X | X | X |
| | 2 – 4 | X | X | X | X | | X | X | X |
| | 8 – 9.2 | X | X | X | X | | X | | X |
| EW10-SC55 | 0 – 1.8 | X | X | X | X | | | X | X |
| | 1.8 – 4 | X | X | X | X | | | X | X |
| EW10-SC56 | 0 – 2 | X | X | X | X | X | | X | X |
| | 2 – 4 | X | X | X | X | X | | X | X |
| EW10-SC57 | 0 – 2 | X | X | X | X | | X | X | X |
| | 2 – 4 | X | X | X | X | | X | X | X |
| EW10-SC58 | 0 – 1.8 | X | X | X | X | | | X | X |
| | 1.8 – 4 | X | X | X | X | | | X | X |
| | 6 – 8 | | | X | | | | | X |
| EW10-SC59 | 0 – 2 | X | X | X | X | X | | X | X |
| | 2 – 4 | X | X | X | X | X | | X | X |
| EW10-SC60 | 0 – 0.8 | X | X | X | X | | | X | X |
| | 0.8 – 3 | X | X | X | X | | | X | X |
| EW10-SC61 | 0 – 1 | X | X | X | X | | | X | X |
| | 1 – 3 | X | X | X | X | | | X | X |
| EW10-SC62 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 3.3 | X | X | X | X | | | X | X |
| EW10-SC63 | 0 – 2 | X | X | X | X | | | X | X |
| | 2 – 4 | X | X | X | X | | | X | X |
| EW10-SC100 | 0 – 1.1 | | | | | X | | | X |
| | 1.1 – 3 | | | | | X | | | X |
| EW10-SC101 | 0 – 2.3 | | | | | X | | | X |
| | 2.3 – 4 | | | | | X | | | X |
| **Total** | | **179** | **138** | **149** | **165** | **42** | **12** | **129** | **194** |

Note: Thirty-eight samples were analyzed only for mercury, and three samples were analyzed only for mercury and cadmium.

[a] Conventionals included TOC and percent moisture.

PCB – polychlorinated biphenyl

SVOC – semivolatile organic compound

TOC – total organic carbon

Table 3-2 presents the geotechnical analyses performed for each subsurface sediment core and boring sample from 1- and 2-ft sampling intervals.

**Table 3-2. Geotechnical analyses performed on EW subsurface sediment core and boring samples collected from 1- and 2-ft sampling intervals**

| Sampling Location ID | Sampling Interval (ft) | Grain Size | Conventionals[a] | Geotechnical[b] |
|---|---|---|---|---|
| EW10-SB01 | 2 – 3.5 | X | | X |
| | 5.5 – 7 | X | | X |
| | 9 – 10.5 | | | X |
| | 10.5 – 12 | X | | X |
| | 14.5 – 16 | | | X |
| | 18 – 19.5 | | | X |
| | 21.5 – 23 | | | X |
| | 23 – 24.5 | X | X | X |
| | 26.5 – 28 | | | X |
| | 28 – 29.5 | X | | X |
| | 30.5 – 32 | | X | X |
| | 34 – 35.5 | | | X |
| | 40.5 – 42 | | | X |
| | 45 – 46.45 | X | | X |
| | 51.5 – 53 | | | X |
| | 59 – 60.5 | X | X | X |
| EW10-SB02 | 2 – 4 | | | X |
| | 6 – 8 | | | X |
| | 14 – 15.5 | X | | X |
| | 18.5 – 20 | | X | X |
| | 19 – 20.5 | X | | X |
| | 22.5 – 24 | | | X |
| | 28.5 – 30 | X | | X |
| | 34.5 – 36 | | | X |
| | 40 – 41.5 | | | X |
| | 50 – 51.5 | X | | X |
| | 55 – 56.5 | | X | X |
| | 60 – 61.5 | | | X |
| EW10-SC05 | 2.1 | | X | X |
| | 4.9 | | X | X |
| EW10-SC11 | 3 | | X | X |
| | 5 | | X | X |
| | 6.7 | | X | X |

| Sampling Location ID | Sampling Interval (ft) | Grain Size | Conventionals[a] | Geotechnical[b] |
|---|---|---|---|---|
| EW10-SC14 | 0.8 | | X | X |
| | 2.4 | | X | X |
| | 7.5 | | X | X |
| EW10-SC20 | 5.5 | | X | X |
| | 10.5 | | X | X |
| EW10-SC22 | 1.0 | | X | X |
| | 4.0 | | X | X |
| EW10-SC30 | 2.0 | | X | X |
| | 6.0 | | X | X |
| | 10.8 | | X | X |
| EW10-SC36 | 0.5 | | X | X |
| | 1.4 | | X | X |
| | 6.0 | | X | X |
| EW10-SC43 | 0.5 | | X | X |
| | 7.6 | | X | X |
| EW10-SC48 | 2 | | X | X |
| | 8.9 | | X | X |
| EW10-SC51 | 2 – 2 | | X | X |
| | 8.9 – 8.9 | | X | X |
| EW10-SC56 | 2 – 2 | | X | X |
| | 4 – 4 | | X | X |
| | 8.5 – 8.5 | | X | X |
| EW10-SC59 | 2 – 2 | | X | X |
| | 3.5 – 3.5 | | X | X |
| EW10-SC63 | 1.2 – 1.2 | | X | X |
| | 3 – 3 | | X | X |
| **Total** | | **11** | **36** | **59** |

[a] Conventionals included measurements of both dry and wet bulk density.

[b] Geotechnical measurements included specific gravity, liquid limit, plastic limit and plastic index.

EW – East Waterway

ID – identification

## 3.2 Methods for Chemical Analyses

All chemical analyses of sediment samples were conducted at ARI, except for pesticide analyses, which were conducted at Columbia Analytical Services, Inc. (CAS). Table 3-3 presents the analytical methods and sample handling requirements.

## Table 3-3. Methods used to analyze subsurface sediment samples

| Chemical | Method | Reference | Maximum Sample Holding Time[a] | Preservative |
|---|---|---|---|---|
| PCBs as Aroclors | GC/ECD | EPA 8082 | 14 days to extract, 40 days to analyze[b, c] | cool/0 – 6 °C |
| Organochlorine pesticides[d] | GC/ECD or HRGC/HRMS | EPA 8081A or EPA 1699M | 14 days to extract, 40 days to analyze[b, c] | cool/0 – 6 °C |
| SVOCs (including PAHs)[e] | GC/MS | EPA 8270D | 14 days to extract, 40 days to analyze[b, c] | cool/0 – 6 °C |
| Selected SVOCs[f] | GC/MS-SIM | EPA 8270-SIM | 14 days to extract, 40 days to analyze[b, c] | cool/0 – 6 °C |
| Mercury | CVAA | EPA 7471A | 28 days[g] | cool/0 – 6 °C |
| Other metals[h] | ICP-AES or ICP-MS | EPA 6010B or EPA 200.8 | 6 months[b] | cool/0– 6 °C |
| Tributyltin, dibutyltin, monobutyltin (as ions) | GC/FPD | Krone et al. (1989) | 14 days to extract, 40 days to analyze[c] | 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 |
| Atterberg limits | sieve | ASTM D4318 | none | none |
| Specific gravity | pycnometer | ASTM D854 | none | none |
| Bulk density | volumetric/ gravimetric | ASTM D2937 | none | none |

a All sample extracts were archived frozen at the laboratory and remain frozen until the Windward project manager authorizes their disposal.

b Sediment may be frozen, with a maximum holding time of 1 year.

c Aqueous rinsate blanks have a maximum holding time of 7 days to extract and 40 days to analyze.

d Target pesticides included 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.

e Target PAHs included anthracene, pyrene, dibenzofuran, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, fluoranthene, total benzofluoranthenes, acenaphthylene, chrysene, benzo(a)pyrene, dibenz(a,h)anthracene, benz(a)anthracene, acenaphthene, phenanthrene, fluorene, 1-methylnaphthalene, naphthalene, 2-methylnaphthalene.

f Selected SVOCs for SIM included 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 2,4-dimethylphenol, 2-methylphenol, benzyl alcohol, butyl benzyl phthalate, dibenz(a,h)anthracene, di-methylphthalate, hexachlorobenzene, hexachlorobutadiene, n-nitrosodimethylamine, n-nitrosodiphenylamine, n-nitroso-di-n-propylamine, and pentachlorophenol.

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

h Other metals included arsenic, antimony, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc. Aqueous rinsate blanks were preserved with nitric acid.

ASTM – American Society for Testing and Materials
CVAA – cold vapor atomic absorption
EPA – US Environmental Protection Agency
GC/ECD – gas chromatography/electron capture detection
GC/FPD – gas chromatography/flame photometric detection
GC/MS – gas chromatography/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

### 3.3 LABORATORY DEVIATIONS FROM THE QAPP

This section discusses laboratory deviations from the QAPP (Windward 2010). ARI and CAS followed the methods and procedures described in the QAPP, with the following exceptions:

- The subsurface sediment QAPP (Windward 2010) specified that organochlorine pesticides would be analyzed using EPA 8081A. Organochlorine pesticides were analyzed using EPA 1699M as well as EPA 8081A. EPA 1699M was used because this method is not susceptible to analytical interference from PCB congeners. The quality of the data has not been negatively affected by this deviation.
- Butyltins were analyzed using gas chromatography/mass spectrometry (GS/MS) with selected ion monitoring (SIM). The surface sediment QAPP (Windward 2010) specified that butyltin would be analyzed using gas chromatography/flame photometric detection (GC/FPD) in error. The quality of the data has not been affected by this deviation.

# 4 Results

This section summarizes the results of chemical and geotechnical analyses conducted on subsurface sediment samples collected in the EW (Sections 4.1 and 4.2, respectively). The results of the data validation, which was conducted by EcoChem, are discussed in Section 4.3.

### 4.1 EW SUBSURFACE SEDIMENT CHEMISTRY RESULTS

The results of the chemical analyses are summarized by chemical group in Section 4.1.1 and by location in Section 4.1.2. Data tables that contain all chemical results by sample ID are presented in Appendix A.

A detailed discussion of the approach used to average laboratory replicates is presented in Appendix C. Methods for calculating concentrations for total PCBs, total polycyclic aromatic hydrocarbons (PAHs), total dichlorodiphenyltrichloroethanes (DDTs), and total chlordane are also presented in Appendix C. The number of significant figures shown for each concentration in all result tables in this section was specified by the analytical laboratory, as described in Appendix C. There was no additional manipulation of significant figures. Laboratory data are presented in Appendix E.

#### 4.1.1 Summary of results by chemical group

This section presents summaries of the chemical results for the following groups of chemicals: metals and mercury, butyltins, SVOCs, PCBs, pesticides, and conventional parameters (i.e., grain size, total organic carbon [TOC], and total solids).

For the purpose of summarizing and presenting the results in this section, each of the samples analyzed was placed into one of five interval categories (0 to 2 ft, 2 to 4 ft, 4 to 6 ft, 6 to 10 ft, and > 10 ft). The actual recovered sample intervals and the interval category assigned for each analyzed sample are presented in Table A-11 in Appendix A.

Data summaries include the number of detections, the range of detected concentrations, the mean of detected concentrations, and the range of reporting limits (RLs) for analytes reported as non-detects.

Tables in this section include comparisons of detected chemical concentrations in subsurface sediment with SMS criteria or DMMP guidelines for chemicals not included in SMS. Some of the SMS criteria are based on organic carbon (OC)-normalized concentrations. If the TOC content of a sediment sample is < 0.5%, then Washington State Department of Ecology guidance does not recommend OC-normalization (Ecology 1995). In addition, OC-normalization is not considered appropriate if the TOC is > 4%. In these cases, the dry-weight concentration was compared with the lowest apparent effects threshold (LAET) and second lowest apparent effects threshold (2LAET) (PTI 1988), which are analogous to the SQS and the CSL, respectively. A total of 37 samples analyzed for chemicals with SMS criteria had TOC concentrations < 0.5%, and 10 samples had TOC concentration > 4.0%. Appendix A contains detailed tables that present the results for each location as compared with SMS, DMMP, or apparent effects threshold (AET) values. Maps 4-1 and 4-2a through 4-2g show subsurface results compared with SMS/DMMP values for all detected results. In addition, Map 4-1 illustrates the core locations relative to the boundaries of dredge events that have been completed in the waterway since 2000.

#### 4.1.1.1 Metals and Mercury

Table 4-1 summarizes the results for the 179 subsurface sediment samples that were collected from 63 locations in the EW and analyzed for metals and mercury. Thirty-eight samples were analyzed only for mercury, and three samples were analyzed only cadmium. Data tables that list the metals results for each sample, including field replicate samples, are presented in Appendix A. Table 4-1 also presents the numbers of samples that had detected concentrations within the following three categories: 1) ≤ SQS/SL, 2) > SQS/SL and ≤ CSL/ML, and 3) > CSL/ML. Map 4-3 shows exceedances of SMS criteria for cadmium. Map 4-4 shows exceedances of SMS criteria for mercury, and Map 4-5 shows exceedances of SMS criteria for zinc. Neither SMS criteria nor DMMP guidelines were available for cobalt, molybdenum, selenium, thallium, or vanadium.

## Table 4-1. Summary of metals and mercury results for EW subsurface sediment samples

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (mg/kg dw) | | | Reporting Limits (mg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria and DMMP Guidelines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS/SL | > SQS/SL and ≤ CSL/ML | > CSL/ML |
| Antimony | 0 – 2 | 1/66 | 8 J | 8 J | na | 6 | 20 | 1 | 0 | 0 |
| | 2 – 4 | 0/59 | nd | nd | nd | 5 | 20 | 0 | 0 | 0 |
| | 4 – 6 | 0/1 | nd | nd | nd | 8 | 8 | 0 | 0 | 0 |
| | 6 – 10 | 0/5 | nd | nd | nd | 6 | 9 | 0 | 0 | 0 |
| | > 10 | 0/4 | nd | nd | nd | 6 | 7 | 0 | 0 | 0 |
| Arsenic | 0 – 2 | 66/66 | 2.0 | 56.7 | 12 | na | na | 63 | 0 | 0 |
| | 2 – 4 | 59/59 | 1.4 | 31.9 | 8.9 | na | na | 62 | 0 | 0 |
| | 4 – 6 | 1/1 | 7.8 | 7.8 | na | na | na | 1 | 0 | 0 |
| | 6 – 10 | 5/5 | 1.5 | 8.4 | 4.7 | na | na | 5 | 0 | 0 |
| | > 10 | 4/4 | 3.4 | 5.6 | 4.3 | na | na | 4 | 0 | 0 |
| Cadmium | 0 – 2 | 51/66 | 0.3 | 45.2 | 3 | 0.2 | 0.3 | 45 | 2 | 4 |
| | 2 – 4 | 33/59 | 0.3 | 18.4 | 3 | 0.2 | 0.3 | 25 | 5 | 3 |
| | 4 – 6 | 3/3 | 1.3 | 2.1 | 1.8 | na | na | 3 | 0 | 0 |
| | 6 – 10 | 4/6 | 0.5 | 2.4 | 1 | 0.2 | 0.3 | 4 | 0 | 0 |
| | > 10 | 4/4 | 0.3 | 0.5 | 0.4 | na | na | 4 | 0 | 0 |
| Chromium | 0 – 2 | 66/66 | 8.9 | 149 | 40 | na | na | 63 | 0 | 0 |
| | 2 – 4 | 59/59 | 9.4 | 131 | 40 | na | na | 62 | 0 | 0 |
| | 4 – 6 | 1/1 | 45.9 | 45.9 | na | na | na | 1 | 0 | 0 |
| | 6 – 10 | 5/5 | 9.5 | 48.9 | 25 | na | na | 5 | 0 | 0 |
| | > 10 | 4/4 | 18.7 | 26.7 | 23.7 | na | na | 4 | 0 | 0 |

**Table 4-1. Summary of metals and mercury results for EW subsurface sediment samples (cont.)**

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (mg/kg dw) | | | Reporting Limits (mg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria and DMMP Guidelines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS/SL | > SQS/SL and ≤ CSL/ML | > CSL/ML |
| Cobalt | 0 – 2 | 66/66 | 3.7 | 13.1 | 8.3 | na | na | nc | nc | nc |
| | 2 – 4 | 59/59 | 3.8 | 16.4 | 7.2 | na | na | nc | nc | nc |
| | 4 – 6 | 1/1 | 11.9 | 11.9 | na | na | na | nc | nc | nc |
| | 6 – 10 | 5/5 | 3.7 | 12.6 | 7.4 | na | na | nc | nc | nc |
| | > 10 | 4/4 | 6.3 | 8.2 | 7.4 | na | na | nc | nc | nc |
| Copper | 0 – 2 | 66/66 | 10.3 | 442 | 96 | na | na | 62 | 0 | 1 |
| | 2 – 4 | 59/59 | 7.9 | 271 | 67 | na | na | 62 | 0 | 0 |
| | 4 – 6 | 1/1 | 62.4 | 62.4 | na | na | na | 1 | 0 | 0 |
| | 6 – 10 | 5/5 | 8.1 | 79.4 | 34 | na | na | 5 | 0 | 0 |
| | > 10 | 4/4 | 21.1 | 32.0 | 26.6 | na | na | 4 | 0 | 0 |
| Lead | 0 – 2 | 56/66 | 4 | 1,450 J | 200 | 2 | 3 | 53 | 0 | 3 |
| | 2 – 4 | 41/59 | 3 J | 525 | 200 | 2 | 3 | 39 | 2 | 0 |
| | 4 – 6 | 1/1 | 1,450 | 1,450 | na | na | na | 0 | 0 | 1 |
| | 6 – 10 | 3/5 | 12 | 85 | 39 | 2 | 3 | 3 | 0 | 0 |
| | > 10 | 4/4 | 7 | 19 | 10 | na | na | 4 | 0 | 0 |
| Mercury | 0 – 2 | 55/66 | 0.03 | 3.37 | 0.6 | 0.02 | 0.03 | 23 | 16 | 16 |
| | 2 – 4 | 43/59 | 0.03 | 3.20 | 0.7 | 0.02 | 0.03 | 20 | 4 | 19 |
| | 4 – 6 | 10/11 | 0.02 | 1.06 | 0.4 | 0.03 | 0.03 | 5 | 1 | 4 |
| | 6 – 10 | 19/34 | 0.03 | 2.54 | 0.5 | 0.02 | 0.03 | 12 | 2 | 5 |
| | > 10 | 7/9 | 0.06 | 0.23 | 0.1 | 0.03 | 0.03 | 7 | 0 | 0 |

### Table 4-1. Summary of metals and mercury results for EW subsurface sediment samples (cont.)

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (mg/kg dw) | | | Reporting Limits (mg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria and DMMP Guidelines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS/SL | > SQS/SL and ≤ CSL/ML | > CSL/ML |
| Molybdenum | 0 – 2 | 57/66 | 0.7 | 11 | 3 | 0.6 | 0.7 | nc | nc | nc |
| | 2 – 4 | 43/59 | 0.7 | 28 | 4 | 0.5 | 0.7 | nc | nc | nc |
| | 4 – 6 | 1/1 | 2.3 | 2.3 | na | na | na | nc | nc | nc |
| | 6 – 10 | 4/5 | 0.9 | 5.2 | 2 | 0.6 | 0.6 | nc | nc | nc |
| | > 10 | 4/4 | 0.7 | 1 | 0.8 | na | na | nc | nc | nc |
| Nickel | 0 – 2 | 66/66 | 7 | 86 | 30 | na | na | 63 | 0 | 0 |
| | 2 – 4 | 59/59 | 7 | 62 | 20 | na | na | 62 | 0 | 0 |
| | 4 – 6 | 1/1 | 45 | 45 | na | na | na | 1 | 0 | 0 |
| | 6 – 10 | 5/5 | 7 | 47 | 20 | na | na | 5 | 0 | 0 |
| | > 10 | 4/4 | 15 | 24 | 20 | na | na | 4 | 0 | 0 |
| Selenium | 0 – 2 | 5/66 | 0.8 | 2 | 1 | 0.6 | 4 | nc | nc | nc |
| | 2 – 4 | 7/59 | 0.8 | 1.4 | 1 | 0.5 | 1 | nc | nc | nc |
| | 4 – 6 | 0/1 | nd | nd | nd | 0.8 | 0.8 | nc | nc | nc |
| | 6 – 10 | 0/5 | nd | nd | nd | 0.6 | 0.9 | nc | nc | nc |
| | > 10 | 0/4 | nd | nd | nd | 0.6 | 0.7 | nc | nc | nc |
| Silver | 0 – 2 | 43/66 | 0.4 | 7 | 2 | 0.4 | 0.4 | 42 | 0 | 1 |
| | 2 – 4 | 25/59 | 0.6 | 6.8 | 3 | 0.3 | 1 | 23 | 0 | 2 |
| | 4 – 6 | 0/1 | nd | nd | nd | 0.5 | 0.5 | 0 | 0 | 0 |
| | 6 – 10 | 1/5 | 0.6 | 0.6 | na | 0.4 | 0.4 | 1 | 0 | 0 |
| | > 10 | 0/4 | nd | nd | nd | 0.4 | 0.4 | 0 | 0 | 0 |

**Table 4-1. Summary of metals and mercury results for EW subsurface sediment samples (cont.)**

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (mg/kg dw) | | | Reporting Limits (mg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria and DMMP Guidelines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS/SL | > SQS/SL and ≤ CSL/ML | > CSL/ML |
| Thallium | 0 – 2 | 3/66 | 0.4 | 0.4 | 0.4 | 0.2 | 0.4 | nc | nc | nc |
| | 2 – 4 | 12/59 | 0.3 | 0.6 | 0.5 | 0.2 | 0.5 | nc | nc | nc |
| | 4 – 6 | 0/1 | nd | nd | nd | 0.3 | 0.3 | nc | nc | nc |
| | 6 – 10 | 0/5 | nd | nd | nd | 0.2 | 0.4 | nc | nc | nc |
| | > 10 | 0/4 | nd | nd | nd | 0.2 | 0.3 | nc | nc | nc |
| Vanadium | 0 – 2 | 66/66 | 36.6 | 82.9 | 60 | na | na | nc | nc | nc |
| | 2 – 4 | 59/59 | 34.8 | 89.6 | 56 | na | na | nc | nc | nc |
| | 4 – 6 | 1/1 | 64.2 | 64.2 | na | na | na | nc | nc | nc |
| | 6 – 10 | 5/5 | 31.7 | 74.2 | 50.9 | na | na | nc | nc | nc |
| | > 10 | 4/4 | 47.1 | 52.7 | 49.8 | na | na | nc | nc | nc |
| Zinc | 0 – 2 | 66/66 | 21 | 6,850 | 300 | na | na | 54 | 6 | 3 |
| | 2 – 4 | 59/59 | 19 | 2,280 | 200 | na | na | 55 | 5 | 2 |
| | 4 – 6 | 1/1 | 133 | 133 | 133 | na | na | 1 | 0 | 0 |
| | 6 – 10 | 5/5 | 19 | 183 | 70 | na | na | 5 | 0 | 0 |
| | > 10 | 4/4 | 38 | 59 | 48 | na | na | 4 | 0 | 0 |

CSL – cleanup screening level
DMMP – Dredged Material Management Program
dw – dry weight
EW – East Waterway
J – estimated concentration
ML – maximum level
na – not applicable
nc – no criteria
nd – not detected
SL – screening level
SMS – Washington State Sediment Management Standards
SQS – sediment quality standards

Seven metals (arsenic, chromium, cobalt, copper, nickel, vanadium, and zinc) were detected in all of the subsurface sediment samples. All metals were detected in at least one sediment sample, and antimony was detected in only 1 of the 135 sediment samples. The remaining metals were detected at frequencies that ranged from 1% to 100% in the various sampling intervals.

Of the 179 samples analyzed for metals (including those samples that were analyzed only for mercury or mercury and cadmium), 43 had detected concentrations of metals > SQS/SL but < CSL/ML, and 64 had detected concentrations of metals > CSL/ML. Detected concentrations of six metals were > CSL/ML: cadmium (7 samples, Map 4-2), copper (1 sample), lead (4 samples), mercury (44 samples, Map 4-3), silver (3 samples) and zinc (5 samples, Map 4-4). The maximum concentrations of cadmium, chromium, selenium, silver, and zinc were detected in the one core that underwent geotechnical analysis, EW10-SB01 (in the 0-to-2-ft interval), located in the mound area. The maximum concentrations of molybdenum, thallium, and vanadium were detected in the 2-to-4-ft interval at location EW10-SC54. The maximum concentrations of antimony and nickel were detected in the 0-to-2-ft interval at location EW10-SC54. The maximum concentrations of arsenic and copper were detected in the 0-to-2-ft interval at location EW10-SC54.

#### *4.1.1.2 Butyltins*

Table 4-2 summarizes the results for the 42 subsurface sediment samples that were collected from 21 locations in the EW and analyzed for butyltins. Data tables that list the butyltin results for each sample, including field replicate samples, are presented in Appendix A. Of the 42 samples analyzed, tributyltin was detected in 19 samples from 21 locations, dibutyltin was detected in 11 samples from 42 locations, and monobutyltin was detected in 4 samples from 42 locations. The highest butyltin concentrations were detected in samples collected at depths of 0 to 2 ft. The maximum concentrations of all butyltins were detected in the 0-to-2-ft interval at location EW10-SC33 (Map 4-6).

**Table 4-2. Summary of butyltin results for EW subsurface sediment samples**

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg/kg dw) | | | Reporting Limits (µg /kg dw) | |
|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max |
| Monobutyltin as ion | 0 – 2 | 4/21 | 4.0 | 19 | 8.2 | 3.4 | 3.8 |
| | 2 – 4 | 0/21 | nd | nd | nd | 3.2 | 3.8 |
| Dibutyltin as ion | 0 – 2 | 10/21 | 5.9 | 160 | 30 | 4.8 | 5.4 |
| | 2 – 4 | 1/21 | 7.1 | 7.1 | na | 4.5 | 5.4 |
| Tributyltin as ion | 0 – 2 | 14/21 | 6.9 J | 280 | 100 | 3.2 | 3.5 |
| | 2 – 4 | 5/21 | 4.5 J | 41 | 23 | 3.0 | 3.6 |

dw – dry weight
EW – East Waterway
J – estimated concentration
na – not applicable
nd – not detected

#### 4.1.1.3 PAHs

Table 4-3 summarizes the results for the 150 subsurface sediment samples that were collected from 63 locations in the EW and analyzed for PAHs. Data tables that list the PAH results for each sample, including field replicate samples, are presented in Appendix A. Table 4-3 also presents the numbers of samples with detected concentrations within the following three categories: 1) ≤ SQS/SL, 2) > SQS/SL and ≤ CSL/ML, and 3) > CSL/ML. TOC concentrations were less than 0.5% or greater than 4.0% in 41 of the 150 samples analyzed for SVOCs. For these samples, dry-weight concentrations of the chemicals were compared with LAET and 2LAET values.

Individual PAH compounds were frequently detected; 120 of the 150 samples analyzed for PAHs had at least one detected PAH compound. The highest concentration of total PAHs (209,000 µg/kg dry weight [dw]) was detected in the sediment interval from 0 to 2 ft at location EW10-SB01. The detected concentrations of total high-molecular-weight PAHs (HPAHs) exceeded the SQS but not the CSL in seven samples and exceeded the CSL in seven samples (Map 4-7). The detected concentrations of the low-molecular-weight PAHs (LPAHs) exceeded the SQS but not the CSL in six samples and exceeded the CSL in seven samples. The maximum concentrations of the 14 individual PAHs and total HPAH and total PAH were all detected in the 0-to-2-ft sediment interval at location EW10-SB01, located in the mound area. The maximum LPAH concentration was detected in the 12.5-to-14.5-ft interval at the same location.

## Table 4-3. Summary of PAH results for EW subsurface sediment samples

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria[a] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| 1-Methylnaphthalene | 0 – 2 | 27/66 | 10 J | 2,600 | 260 | 19 | 53 | nc | nc | nc |
| | 2 – 4 | 21/59 | 13 J | 4,000 | 430 | 19 | 59 | nc | nc | nc |
| | 4 – 6 | 1/6 | 79 | 79 | na | 4.8 | 58 | nc | nc | nc |
| | 6 – 10 | 4/13 | 9.6 | 270 J | 180 | 19 | 91 | nc | nc | nc |
| | > 10 | 5/6 | 17 J | 8,900 | 2,200 | 4.8 | 4.8 | nc | nc | nc |
| 2-Methylnaphthalene | 0 – 2 | 35/66 | 10 J | 2,700 | 170 | 19 | 53 | 33 | 1 | 1 |
| | 2 – 4 | 25/59 | 12 J | 4,400 | 330 | 19 | 59 | 23 | 0 | 2 |
| | 4 – 6 | 1/6 | 71 | 71 | na | 4.8 | 58 | 1 | 0 | 0 |
| | 6 – 10 | 3/13 | 16 | 40 | 25 | 19 | 420 | 3 | 0 | 0 |
| | > 10 | 6/6 | 5.3 J | 4,200 | 760 | na | na | 5 | 0 | 1 |
| Acenaphthene | 0 – 2 | 39/66 | 12 J | 11,000 | 540 | 19 | 53 | 33 | 2 | 4 |
| | 2 – 4 | 26/59 | 15 J | 6,800 | 780 | 19 | 59 | 18 | 2 | 6 |
| | 4 – 6 | 1/6 | 700 | 700 | na | 4.8 | 58 | 0 | 1 | 0 |
| | 6 – 10 | 10/13 | 7.7 | 770 | 170 | 20 | 20 | 7 | 2 | 1 |
| | > 10 | 6/6 | 8.7 | 10,000 | 2,200 | na | na | 2 | 1 | 3 |
| Acenaphthylene | 0 – 2 | 36/66 | 10 J | 780 | 64 | 19 | 91 | 36 | 0 | 0 |
| | 2 – 4 | 13/59 | 15 J | 350 | 84 | 19 | 120 | 13 | 0 | 0 |
| | 4 – 6 | 1/6 | 56 J | 56 J | na | 4.8 | 58 | 1 | 0 | 0 |
| | 6 – 10 | 2/13 | 11 J | 220 J | 120 | 4.8 | 91 | 2 | 0 | 0 |
| | > 10 | 0/6 | nd | nd | nd | 4.8 | 20 | 0 | 0 | 0 |

## Table 4-3. Summary of PAH results for EW subsurface sediment samples (cont.)

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria[a] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| Anthracene | 0 – 2 | 52/66 | 9.7 J | 6,600 | 400 | 19 | 20 | 50 | 2 | 0 |
| | 2 – 4 | 36/59 | 8.7 J | 4,300 | 610 | 19 | 21 | 31 | 5 | 0 |
| | 4 – 6 | 2/6 | 90 | 880 | 480 | 4.8 | 20 | 2 | 0 | 0 |
| | 6 – 10 | 8/13 | 13 | 3,000 | 520 | 20 | 20 | 7 | 1 | 0 |
| | > 10 | 6/6 | 25 | 3,900 | 840 | na | na | 5 | 1 | 0 |
| Benzo(a)anthracene | 0 – 2 | 53/66 | 13 J | 17,000 | 740 | 19 | 20 | 48 | 3 | 2 |
| | 2 – 4 | 37/59 | 16 J | 4,000 | 630 | 19 | 21 | 33 | 0 | 4 |
| | 4 – 6 | 3/6 | 13 J | 1,000 | 400 | 4.8 | 20 | 3 | 0 | 0 |
| | 6 – 10 | 8/13 | 12 | 3,600 | 640 | 19 | 20 | 7 | 0 | 1 |
| | > 10 | 5/6 | 23 | 640 | 190 | 19 | 19 | 5 | 0 | 0 |
| Benzo(a)pyrene | 0 – 2 | 53/66 | 19 J | 12,000 | 770 | 19 | 20 | 48 | 2 | 3 |
| | 2 – 4 | 40/59 | 10 J | 3,000 | 490 | 19 | 20 | 37 | 3 | 0 |
| | 4 – 6 | 3/6 | 19 J | 670 | 310 | 4.8 | 20 | 3 | 0 | 0 |
| | 6 – 10 | 7/13 | 10 | 2,500 | 480 | 19 | 20 | 6 | 1 | 0 |
| | > 10 | 5/6 | 16 J | 200 | 73 | 19 | 19 | 5 | 0 | 0 |
| Benzo(g,h,i)perylene | 0 – 2 | 53/66 | 10 J | 2,000 | 180 | 19 | 20 | 49 | 3 | 0 |
| | 2 – 4 | 33/59 | 11 J | 840 | 150 | 19 | 21 | 32 | 1 | 1 |
| | 4 – 6 | 3/6 | 11 J | 140 | 97 | 4.8 | 20 | 3 | 0 | 0 |
| | 6 – 10 | 7/13 | 8.6 | 880 | 180 | 19 | 20 | 6 | 0 | 1 |
| | > 10 | 4/6 | 6.8 | 50 | 24 | 19 | 20 | 4 | 0 | 0 |

## Table 4-3. Summary of PAH results for EW subsurface sediment samples (cont.)

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria[a] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| Total benzofluoranthenes | 0 – 2 | 54/66 | 32 J | 14,000 | 1,300 | 19 | 20 | 48 | 3 | 2 |
| | 2 – 4 | 41/59 | 17 J | 8,400 | 930 | 19 | 20 | 40 | 0 | 2 |
| | 4 – 6 | 3/6 | 38 J | 1,200 | 520 | 4.8 | 20 | 3 | 0 | 0 |
| | 6 – 10 | 7/13 | 20 | 4,400 | 850 | 19 | 20 | 6 | 0 | 1 |
| | > 10 | 5/6 | 24 J | 300 | 110 | 19 | 19 | 5 | 0 | 0 |
| Chrysene | 0 – 2 | 53/66 | 19 J | 20,000 | 980 | 19 | 20 | 48 | 4 | 1 |
| | 2 – 4 | 36/58 | 16 J | 4,700 | 810 | 19 | 21 | 31 | 2 | 3 |
| | 4 – 6 | 3/6 | 14 J | 1,600 | 640 | 4.8 | 20 | 3 | 0 | 0 |
| | 6 – 10 | 8/13 | 15 J | 3,800 | 720 | 19 | 20 | 7 | 0 | 1 |
| | > 10 | 5/6 | 24 | 650 | 190 | 19 | 19 | 5 | 0 | 0 |
| Dibenzo(a,h)anthracene | 0 – 2 | 51/66 | 6.5 J | 1,200 | 110 | 5.8 | 6.1 | 45 | 3 | 2 |
| | 2 – 4 | 31/59 | 6.8 J | 760 | 94 | 5.8 | 6.2 | 29 | 2 | 1 |
| | 4 – 6 | 2/6 | 44 J | 65 | 55 | 4.8 | 20 | 2 | 0 | 0 |
| | 6 – 10 | 5/13 | 11 J | 430 | 110 | 4.8 | 76 | 4 | 1 | 0 |
| | > 10 | 2/6 | 10 J | 16 | 13 | 4.8 | 19 | 2 | 0 | 0 |
| Dibenzofuran | 0 – 2 | 32/66 | 9.8 J | 2,600 | 240 | 19 | 53 | 28 | 2 | 2 |
| | 2 – 4 | 25/59 | 14 J | 4,000 | 480 | 19 | 59 | 20 | 1 | 4 |
| | 4 – 6 | 1/6 | 200 | 200 | na | 4.8 | 58 | 1 | 0 | 0 |
| | 6 – 10 | 8/13 | 10 | 340 J | 100 | 20 | 20 | 6 | 2 | 0 |
| | > 10 | 6/6 | 7.8 | 5,700 | 1,200 | na | na | 3 | 1 | 2 |

Table 4-3. Summary of PAH results for EW subsurface sediment samples (cont.)

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria[a] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| Fluoranthene | 0 – 2 | 54/66 | 12 J | 50,000 J | 1,900 | 19 | 20 | 48 | 4 | 2 |
| | 2 – 4 | 39/59 | 11 J | 12,000 | 2,000 | 19 | 20 | 30 | 4 | 5 |
| | 4 – 6 | 4/6 | 11 J | 4,200 J | 1,200 | 4.8 | 19 | 3 | 1 | 0 |
| | 6 – 10 | 9/13 | 24 | 8,100 | 1,600 | 20 | 20 | 6 | 2 | 1 |
| | > 10 | 6/6 | 23 | 5,400 J | 1,200 | na | na | 5 | 1 | 0 |
| Fluorene | 0 – 2 | 44/66 | 10 J | 6,100 | 350 | 19 | 53 | 40 | 1 | 3 |
| | 2 – 4 | 31/59 | 11 J | 5,500 | 610 | 19 | 21 | 24 | 2 | 5 |
| | 4 – 6 | 1/6 | 460 | 460 | na | 4.8 | 58 | 0 | 1 | 0 |
| | 6 – 10 | 8/13 | 11 | 900 | 190 | 20 | 20 | 6 | 2 | 0 |
| | > 10 | 6/6 | 9.7 | 6,100 | 1,300 | na | na | 3 | 1 | 2 |
| Indeno(1,2,3-cd)pyrene | 0 – 2 | 52/66 | 11 J | 2,000 | 190 | 19 | 20 | 48 | 3 | 0 |
| | 2 – 4 | 34/59 | 9.9 J | 850 | 150 | 19 | 21 | 33 | 0 | 2 |
| | 4 – 6 | 2/6 | 130 | 140 | 130 | 4.8 | 20 | 2 | 0 | 0 |
| | 6 – 10 | 7/13 | 6.7 | 860 | 170 | 19 | 20 | 6 | 0 | 1 |
| | > 10 | 3/6 | 5.8 | 41 | 27 | 19 | 20 | 3 | 0 | 0 |
| Naphthalene | 0 – 2 | 43/66 | 10 J | 10,000 | 360 | 19 | 53 | 42 | 0 | 1 |
| | 2 – 4 | 29/59 | 17 J | 17,000 | 920 | 19 | 59 | 27 | 0 | 2 |
| | 4 – 6 | 1/6 | 180 | 180 | na | 4.8 | 58 | 1 | 0 | 0 |
| | 6 – 10 | 10/13 | 12 | 950 | 230 | 20 | 20 | 10 | 0 | 0 |
| | > 10 | 6/6 | 15 | 21,000 | 3,900 | na | na | 4 | 0 | 2 |

## Table 4-3. Summary of PAH results for EW subsurface sediment samples (cont.)

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria[a] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| Phenanthrene | 0 – 2 | 53/66 | 16 J | 28,000 | 1,200 | 19 | 20 | 49 | 2 | 2 |
| | 2 – 4 | 37/59 | 16 J | 12,000 | 1,200 | 19 | 21 | 31 | 5 | 1 |
| | 4 – 6 | 3/6 | 11 J | 2,000 | 720 | 4.8 | 20 | 2 | 1 | 0 |
| | 6 – 10 | 9/13 | 40 | 3,700 | 640 | 20 | 20 | 8 | 1 | 0 |
| | > 10 | 6/6 | 21 | 20,000 | 4,100 | na | na | 3 | 2 | 1 |
| Pyrene | 0 – 2 | 55/66 | 12 J | 38,000 | 2,000 | 19 | 20 | 51 | 2 | 1 |
| | 2 – 4 | 40/59 | 9.8 J | 18,000 | 1,900 | 19 | 37 | 36 | 0 | 5 |
| | 4 – 6 | 4/6 | 11 J | 3,300 | 1,000 | 4.8 | 19 | 4 | 0 | 0 |
| | 6 – 10 | 9/13 | 22 | 10,000 | 1,700 | 20 | 20 | 8 | 0 | 1 |
| | > 10 | 6/6 | 88 | 4,500 | 1,000 | na | na | 6 | 0 | 0 |
| Total HPAHs | 0 – 2 | 57/66 | 9.8 J | 156,000 J | 7,900 | 19 | 20 | 50 | 3 | 2 |
| | 2 – 4 | 42/59 | 15 J | 50,000 | 6,300 | 19 | 20 | 37 | 3 | 4 |
| | 4 – 6 | 4/6 | 22 J | 12,300 J | 3,800 | 4.8 | 19 | 4 | 0 | 0 |
| | 6 – 10 | 9/13 | 78 | 35,000 | 6,000 | 20 | 20 | 8 | 0 | 1 |
| | > 10 | 6/6 | 280 J | 11,770 J | 2,700 | na | na | 5 | 1 | 0 |
| Total LPAHs | 0 – 2 | 53/66 | 16 J | 52,000 | 2,600 | 19 | 20 | 50 | 0 | 3 |
| | 2 – 4 | 37/59 | 34 J | 40,000 | 3,600 | 19 | 21 | 31 | 4 | 2 |
| | 4 – 6 | 3/6 | 11 J | 4,300 J | 1,500 | 4.8 | 20 | 3 | 0 | 0 |
| | 6 – 10 | 11/13 | 33 J | 9,300 J | 1,400 | 20 | 20 | 10 | 1 | 0 |
| | > 10 | 6/6 | 79 | 61,000 | 12,000 | na | na | 3 | 1 | 2 |

## Table 4-3. Summary of PAH results for EW subsurface sediment samples (cont.)

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria[a] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| cPAH TEQ – mammal (half DL) | 0 – 2 | 54/66 | 19 J | 16,000 | 1,000 | 14 | 14 | nc | nc | nc |
| | 2 – 4 | 41/59 | 15 J | 4,700 | 670 | 14 | 14 | nc | nc | nc |
| | 4 – 6 | 3/6 | 29 J | 950 | 430 | 4.1 | 17 | nc | nc | nc |
| | 6 – 10 | 8/13 | 15 | 3,600 | 610 | 14 | 17 | nc | nc | nc |
| | > 10 | 5/6 | 23 J | 310 | 110 | 16 | 16 | nc | nc | nc |
| Total PAHs | 0 – 2 | 57/66 | 9.8 J | 209,000 J | 10,000 | 19 | 20 | nc | nc | nc |
| | 2 – 4 | 42/59 | 15 J | 63,000 | 9,400 | 19 | 20 | nc | nc | nc |
| | 4 – 6 | 4/6 | 22 J | 16,600 J | 4,900 | 4.8 | 19 | nc | nc | nc |
| | 6 – 10 | 11/13 | 33 J | 44,000 J | 6,300 | 20 | 20 | nc | nc | nc |
| | > 10 | 6/6 | 400 J | 73,000 J | 15,000 | na | na | nc | nc | nc |

[a] SMS criteria for PAHs are based on organic carbon normalized concentrations. Forty six samples representing all the sediment intervals had TOC values less than 0.5% and eleven samples representing all intervals except the >10ft interval had TOC values greater than 4%. For these samples PAH concentrations were compared to AET values on a dry weight basis because the TOC values were outside the TOC range for normalization.

CSL – cleanup screening level

dw – dry weight

HPAH – high-molecular-weight polycyclic aromatic hydrocarbon

J – estimated concentration

LPAH – low-molecular-weight polycyclic aromatic hydrocarbon

na – not applicable

nc – no criteria

nd – not detected

SMS – Washington State Sediment Management Standards

SQS – sediment quality standards

#### 4.1.1.4 Phthalates

Table 4-4 summarizes the results for the 146 subsurface sediment samples that were collected from 63 locations in the EW and analyzed for phthalates. Data tables that list the phthalate results for each sample, including field replicate samples, are presented in Appendix A. Table 4-4 also presents the numbers of samples with detected concentrations within the following three categories: 1) ≤ SQS/SL, 2) > SQS/SL and ≤ CSL/ML, and 3) > CSL/ML. TOC concentrations were less than 0.5% or greater than 4.0% in 39 of the 146 samples analyzed for SVOCs. For these samples, dry-weight concentrations of the chemicals were compared with LAET and 2LAET values.

All six phthalates analyzed were detected in at least one sample. Bis(2-ethylhexyl) phthalate (BEHP), the most frequently detected phthalate compound, was detected in 110 of 146 samples (Map 4-8). The maximum concentration of BEHP was 5,800 µg/kg dw, which was detected in a sample collected at a 1.3-to-3.2-ft interval at location EW10-SC23. Detected concentrations of butyl benzyl phthalate and BEHP exceeded the SQS but not the CSL in 7 and 17 samples, respectively. Detected concentrations of BEHP exceeded the CSL in 9 samples.

## Table 4-4. Summary of phthalate results for EW subsurface sediment samples

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria[a] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| BEHP | 0 – 2 | 48/66 | 13 J | 4,700 | 730 | 19 | 880 | 32 | 10 | 5 |
| | 2 – 4 | 42/59 | 13 J | 5,800 | 670 | 23 | 470 | 34 | 5 | 4 |
| | 4 – 6 | 5/5 | 18 J | 290 | 91 | na | na | 5 | 0 | 0 |
| | 6 – 10 | 11/12 | 15 J | 1,800 | 230 | 91 | 91 | 9 | 2 | 0 |
| | > 10 | 4/4 | 21 | 220 | 75 | na | na | 4 | 0 | 0 |
| Butyl benzyl phthalate | 0 – 2 | 40/66 | 14 | 130 | 44 | 14 | 91 | 38 | 2 | 0 |
| | 2 – 4 | 19/59 | 21 | 340 | 75 | 14 | 45 | 14 | 5 | 0 |
| | 4 – 6 | 1/5 | 22 J | 22 J | na | 14 | 16 | 1 | 0 | 0 |
| | 6 – 10 | 4/12 | 18 J | 52 J | 31 | 15 | 16 | 4 | 0 | 0 |
| | > 10 | 0/4 | nd | nd | nd | 15 | 15 | 0 | 0 | 0 |
| Diethyl phthalate | 0 – 2 | 5/66 | 10 J | 22 | 16 | 19 | 91 | 5 | 0 | 0 |
| | 2 – 4 | 3/59 | 16 J | 86 | 41 | 19 | 150 | 3 | 0 | 0 |
| | 4 – 6 | 0/5 | nd | nd | nd | 14 | 58 | 0 | 0 | 0 |
| | 6 – 10 | 1/12 | 20 | 20 | na | 15 | 20 | 1 | 0 | 0 |
| | > 10 | 1/4 | 11 J | 11 J | na | 15 | 20 | 1 | 0 | 0 |
| Dimethyl phthalate | 0 – 2 | 10/66 | 10 J | 500 | 80 | 14 | 91 | 10 | 0 | 0 |
| | 2 – 4 | 3/59 | 15 | 40 | 24 | 14 | 150 | 3 | 0 | 0 |
| | 4 – 6 | 0/5 | nd | nd | nd | 14 | 16 | 0 | 0 | 0 |
| | 6 – 10 | 0/12 | nd | nd | nd | 15 | 16 | 0 | 0 | 0 |
| | > 10 | 0/4 | nd | nd | nd | 15 | 15 | 0 | 0 | 0 |

## Table 4-4. Summary of phthalate results for EW subsurface sediment samples (cont.)

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria[a] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| Di-n-butyl phthalate | 0 – 2 | 15/66 | 10 J | 180 | 41 | 19 | 88 | 14 | 0 | 0 |
| | 2 – 4 | 11/59 | 10 J | 88 | 30 | 19 | 150 | 12 | 0 | 0 |
| | 4 – 6 | 0/5 | nd | nd | nd | 19 | 58 | 0 | 0 | 0 |
| | 6 – 10 | 1/12 | 180 | 180 | na | 19 | 420 | 1 | 0 | 0 |
| | > 10 | 0/4 | nd | nd | nd | 19 | 20 | 0 | 0 | 0 |
| Di-n-octyl phthalate | 0 – 2 | 0/66 | nd | nd | nd | 19 | 91 | 0 | 0 | 0 |
| | 2 – 4 | 1/59 | 31 | 31 | na | 19 | 150 | 0 | 0 | 0 |
| | 4 – 6 | 1/5 | 86 | 86 | na | 19 | 58 | 1 | 0 | 0 |
| | 6 – 10 | 0/12 | nd | nd | nd | 19 | 420 | 0 | 0 | 0 |
| | > 10 | 0/4 | nd | nd | nd | 19 | 20 | 0 | 0 | 0 |

[a] SMS criteria for phthalates are based on organic carbon normalized concentrations. Forty six samples representing all the sediment intervals had TOC values less than 0.5% and eleven samples representing all intervals except the >10ft interval had TOC values greater than 4%. For these samples phthalate concentrations were compared to AET values on a dry weight basis because the TOC values were outside the TOC range for normalization.

BEHP – bis(2-ethylhexyl) phthalate

CSL – cleanup screening level

DMMP – Dredged Material Management Program

dw – dry weight

J – estimated concentration

ML – maximum level

na – not applicable

nc – no criteria

nd – not detected

SL – screening level

SMS – Washington State Sediment Management Standards

SQS – sediment quality standards

#### 4.1.1.5 Other SVOCs

Table 4-5 summarizes results for 146 subsurface sediment samples from 63 locations in the EW that were analyzed for SVOCs other than PAHs and phthalates. Complete SVOC results for all samples are presented in Appendix A. Table 4-5 also presents the numbers of samples with detected concentrations within the following three categories: 1) ≤ SQS/SL, 2) > SQS/SL and ≤ CSL/ML, and 3) > CSL/ML. TOC concentrations were less than 0.5% or greater than 4.0% in 39 of the 146 samples analyzed for SVOCs. For these samples, dry-weight concentrations of the chemicals were compared with LAET and 2LAET values.

Fifteen other SVOCs were detected at least one sample. Detected concentrations of 1,4-dichlorobenzene exceeded the SQS in one sample and exceeded the CSL in two samples. Detected concentrations of 1,4-dichlorobenzene exceeded the CSL in six samples. Detected concentrations of 2,4-dimethylphenol exceeded the CSL in five samples. Detected concentrations of 2-methylphenol exceeded the CSL in one sample. Detected concentrations of n-nitrosodiphenylamine exceeded the CSL in one sample. The results for other SVOCs are provided in Map 4-9.

## Table 4-5. Summary of other SVOC results for EW subsurface sediment samples

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| 1,2,4-Trichlorobenzene | 0 – 2 | 4/66 | 6.0 | 20 | 12 | 5.8 | 61 | 3[a] | 1[a] | 0[a] |
| | 2 – 4 | 4/59 | 7.4 | 62 | 33 | 5.8 | 60 | 2[a] | 0[a] | 2[a] |
| | 4 – 6 | 0/5 | nd | nd | nd | 5.8 | 6.2 | 0[a] | 0[a] | 0[a] |
| | 6 – 10 | 0/12 | nd | nd | nd | 5.9 | 14 | 0[a] | 0[a] | 0[a] |
| | > 10 | 0/4 | nd | nd | nd | 5.9 | 6.0 | 0[a] | 0[a] | 0[a] |
| 1,2-Dichlorobenzene | 0 – 2 | 0/66 | nd | nd | nd | 5.8 | 61 | 0[a] | 0[a] | 0[a] |
| | 2 – 4 | 1/59 | 19 J | 19 J | na | 5.8 | 60 | 1[a] | 0[a] | 0[a] |
| | 4 – 6 | 0/5 | nd | nd | nd | 5.8 | 6.2 | 0[a] | 0[a] | 0[a] |
| | 6 – 10 | 0/12 | nd | nd | nd | 5.9 | 6.2 | 0[a] | 0[a] | 0[a] |
| | > 10 | 0/4 | nd | nd | nd | 5.9 | 6.0 | 0[a] | 0[a] | 0[a] |
| 1,3-Dichlorobenzene | 0 – 2 | 0/66 | nd | nd | nd | 19 | 91 | nc | nc | nc |
| | 2 – 4 | 1/59 | 52 | 52 | na | 19 | 150 | nc | nc | nc |
| | 4 – 6 | 0/5 | nd | nd | nd | 19 | 58 | nc | nc | nc |
| | 6 – 10 | 0/12 | nd | nd | nd | 19 | 420 | nc | nc | nc |
| | > 10 | 0/4 | nd | nd | nd | 19 | 20 | nc | nc | nc |
| 1,4-Dichlorobenzene | 0 – 2 | 38/66 | 5.8 | 310 | 39 | 5.8 | 61 | 32[a] | 3[a] | 3[a] |
| | 2 – 4 | 14/59 | 8.3 | 380 | 77 | 5.8 | 60 | 11[a] | 0[a] | 3[a] |
| | 4 – 6 | 0/5 | nd | nd | nd | 5.8 | 6.2 | 0[a] | 0[a] | 0[a] |
| | 6 – 10 | 2/12 | 8.5 | 17 | 13 | 5.9 | 6.2 | 2[a] | 0[a] | 0[a] |
| | > 10 | 0/4 | nd | nd | nd | 5.9 | 6.0 | 0[a] | 0[a] | 0[a] |

Table 4-5. Summary of other SVOC results for EW subsurface sediment samples (cont.)

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| 2,4-Dimethylphenol | 0 – 2 | 6/66 | 6.1 J | 130 | 47 | 5.8 | 61 | 3 | 0 | 3 |
| | 2 – 4 | 4/59 | 9.2 | 71 | 35 | 5.8 | 60 | 2 | 0 | 2 |
| | 4 – 6 | 0/5 | nd | nd | nd | 5.8 | 6.2 | 0 | 0 | 0 |
| | 6 – 10 | 2/12 | 6.0 | 8.7 | 7.4 | 5.9 | 6.2 | 2 | 0 | 0 |
| | > 10 | 0/4 | nd | nd | nd | 5.9 | 19 | 0 | 0 | 0 |
| 2-Methylphenol | 0 – 2 | 3/66 | 8.5 | 82 | 35 | 5.8 | 61 | 2 | 0 | 1 |
| | 2 – 4 | 2/59 | 7.4 | 22 J | 15 | 5.8 | 60 | 2 | 0 | 0 |
| | 4 – 6 | 0/5 | nd | nd | nd | 5.8 | 6.2 | 0 | 0 | 0 |
| | 6 – 10 | 0/12 | nd | nd | nd | 5.9 | 6.2 | 0 | 0 | 0 |
| | > 10 | 2/4 | 9.5 | 24 | 17 | 6.0 | 6.0 | 2 | 0 | 0 |
| 4-Methylphenol | 0 – 2 | 20/66 | 11 J | 130 | 29 | 19 | 91 | 20 | 0 | 0 |
| | 2 – 4 | 9/59 | 11 J | 280 | 63 | 19 | 150 | 9 | 0 | 0 |
| | 4 – 6 | 0/5 | nd | nd | nd | 19 | 58 | 0 | 0 | 0 |
| | 6 – 10 | 0/12 | nd | nd | nd | 19 | 420 | 0 | 0 | 0 |
| | > 10 | 0/4 | nd | nd | nd | 19 | 20 | 0 | 0 | 0 |
| 4-Nitroaniline | 0 – 2 | 0/65 | nd | nd | nd | 96 | 450 | nc | nc | nc |
| | 2 – 4 | 0/59 | nd | nd | nd | 95 | 750 | nc | nc | nc |
| | 4 – 6 | 0/5 | nd | nd | nd | 97 | 290 | nc | nc | nc |
| | 6 – 10 | 1/12 | 140 J | 140 J | na | 96 | 2,100 | nc | nc | nc |
| | > 10 | 0/4 | nd | nd | nd | 96 | 98 | nc | nc | nc |

**Table 4-5. Summary of other SVOC results for EW subsurface sediment samples (cont.)**

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| Benzoic acid | 0 – 2 | 1/66 | 65 J | 65 J | na | 190 | 910 | 1 | 0 | 0 |
| | 2 – 4 | 2/59 | 47 J | 71 J | 59 | 190 | 1,500 | 2 | 0 | 0 |
| | 4 – 6 | 0/5 | nd | nd | nd | 190 | 580 | 0 | 0 | 0 |
| | 6 – 10 | 0/12 | nd | nd | nd | 190 | 4,200 | 0 | 0 | 0 |
| | > 10 | 0/4 | nd | nd | nd | 190 | 200 | 0 | 0 | 0 |
| Carbazole | 0 – 2 | 37/66 | 11 J | 2,500 | 180 | 19 | 53 | nc | nc | nc |
| | 2 – 4 | 15/59 | 12 J | 460 | 130 | 19 | 120 | nc | nc | nc |
| | 4 – 6 | 1/5 | 100 | 100 | na | 19 | 58 | nc | nc | nc |
| | 6 – 10 | 6/12 | 19 J | 280 J | 120 | 19 | 76 | nc | nc | nc |
| | > 10 | 3/4 | 120 | 750 | 370 | 20 | 20 | nc | nc | nc |
| Hexachlorobenzene | 0 – 2 | 0/66 | nd | nd | nd | 1.4 | 61 | 0[a] | 0[a] | 0[a] |
| | 2 – 4 | 0/59 | nd | nd | nd | 0.98 | 60 | 0[a] | 0[a] | 0[a] |
| | 4 – 6 | 1/5 | 0.65 | 0.65 | na | 5.8 | 6.2 | 1[a] | 0[a] | 0[a] |
| | 6 – 10 | 0/12 | nd | nd | nd | 0.074 | 6.2 | 0[a] | 0[a] | 0[a] |
| | > 10 | 0/4 | nd | nd | nd | 5.9 | 6.0 | 0[a] | 0[a] | 0[a] |
| n-Nitroso-di-n-propylamine | 0 – 2 | 0/66 | nd | nd | nd | 29 | 310 | nc | nc | nc |
| | 2 – 4 | 1/59 | 350 | 350 | 350 | 29 | 190 | nc | nc | nc |
| | 4 – 6 | 1/5 | 49 | 49 | na | 29 | 31 | nc | nc | nc |
| | 6 – 10 | 3/12 | 34 J | 59 J | 46 | 29 | 31 | nc | nc | nc |
| | > 10 | 0/4 | nd | nd | nd | 29 | 30 | nc | nc | nc |

## Table 4-5. Summary of other SVOC results for EW subsurface sediment samples (cont.)

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| n-Nitrosodiphenylamine | 0 – 2 | 1/66 | 12 | 12 | na | 5.8 | 91 | 1 [a] | 0 [a] | 0 [a] |
| | 2 – 4 | 0/59 | nd | nd | nd | 5.8 | 60 | 0[a] | 0[a] | 0[a] |
| | 4 – 6 | 0/5 | nd | nd | nd | 5.8 | 16 | 0[a] | 0[a] | 0[a] |
| | 6 – 10 | 0/12 | nd | nd | nd | 5.9 | 46 | 0[a] | 0[a] | 0[a] |
| | > 10 | 1/4 | 160 | 160 | na | 6.0 | 20 | 0 [a] | 0 [a] | 1 [a] |
| Pentachlorophenol | 0 – 2 | 0/66 | nd | nd | nd | 29 | 310 | 0 | 0 | 0 |
| | 2 – 4 | 2/59 | 52 | 81 | 67 | 29 | 300 | 2 | 0 | 0 |
| | 4 – 6 | 0/5 | nd | nd | nd | 29 | 31 | 0 | 0 | 0 |
| | 6 – 10 | 0/12 | nd | nd | nd | 29 | 31 | 0 | 0 | 0 |
| | > 10 | 0/4 | nd | nd | nd | 29 | 30 | 0 | 0 | 0 |
| Phenol | 0 – 2 | 6/66 | 16 J | 100 | 37 | 19 | 91 | 6 | 0 | 0 |
| | 2 – 4 | 0/59 | nd | nd | nd | 19 | 150 | 0 | 0 | 0 |
| | 4 – 6 | 0/5 | nd | nd | nd | 19 | 58 | 0 | 0 | 0 |
| | 6 – 10 | 2/12 | 29 | 33 | 31 | 19 | 420 | 2 | 0 | 0 |
| | > 10 | 0/4 | nd | nd | nd | 19 | 20 | 0 | 0 | 0 |

[a] SMS criteria for these SVOCs are based on organic carbon normalized concentrations. Forty six samples representing all the sediment intervals had TOC values less than 0.5% and eleven samples representing all intervals except the >10ft interval had TOC values greater than 4%. For these samples SVOC concentrations were compared to AET values on a dry weight basis because the TOC values were outside the TOC range for normalization.

CSL – cleanup screening level
DMMP – Dredged Material Management Program
dw – dry weight
J – estimated concentration
na – not applicable
nc – no criteria
nd – not detected
SL – screening level
SMS – Washington State Sediment Management Standards
SQS – sediment quality standards

#### 4.1.1.6 PCB Aroclors

Table 4-6 summarizes the results for 165 subsurface sediment samples that were collected from 63 locations in the EW and analyzed for PCB Aroclors. Results are presented for both individual Aroclors and total PCBs. Data tables that list PCB Aroclor and total PCB results for all samples are presented in Appendix A.

Table 4-6 also presents the numbers of samples with detected total PCB concentrations within the following three categories: 1) ≤ SQS, 2) > SQS and ≤ CSL, and 3) > CSL. TOC concentrations were < 0.5 or > 4.0% in 46 of the 165 samples analyzed for PCBs; for these samples, the dry-weight concentrations of PCBs were compared with LAET and 2LAET values. Map 4-10 shows exceedances of SMS criteria for total PCBs for each of the subsurface locations by depth.

Four of the seven Aroclors were detected in at least one sediment sample. The most frequently detected Aroclors were 1254 and 1260 (detected in 99 and 105 of the 165 samples, respectively), consistent with surface sediment data. In 59 samples, no PCB Aroclors were detected. The maximum total PCB concentration (17,600 µg/kg dw) was detected in the 1.3-to-3.2-ft interval at location EW10-SC23. Total PCBs exceeded the SQS but not the CSL in 39 of the 165 samples and exceeded the CSL in 43 of the 165 samples.

## Table 4-6. Summary of PCB results for EW subsurface sediment samples

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria[a] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| Aroclor-1242 | 0 – 2 | 11/66 | 44 | 430 J | 190 | 3.8 | 390 | nc | nc | nc |
| | 2 – 4 | 5/59 | 4.7 | 840 | 270 | 3.8 | 600 | nc | nc | nc |
| | 4 – 6 | 0/16 | nd | nd | nd | 3.8 | 20 | nc | nc | nc |
| | 6 – 10 | 0/19 | nd | nd | nd | 3.8 | 49 | nc | nc | nc |
| | > 10 | 0/5 | nd | nd | nd | 3.9 | 20 | nc | nc | nc |
| Aroclor-1248 | 0 – 2 | 32/66 | 9.9 | 2,100 | 420 | 3.8 | 490 | nc | nc | nc |
| | 2 – 4 | 24/59 | 6.4 J | 3,200 | 600 | 3.8 | 790 | nc | nc | nc |
| | 4 – 6 | 3/16 | 53 | 120 | 81 | 3.8 | 48 | nc | nc | nc |
| | 6 – 10 | 2/19 | 220 | 340 | 280 | 3.8 | 170 | nc | nc | nc |
| | > 10 | 0/5 | nd | nd | nd | 3.9 | 20 | nc | nc | nc |
| Aroclor-1254 | 0 – 2 | 53/66 | 6.7 | 4,200 | 590 | 3.8 | 4.0 | nc | nc | nc |
| | 2 – 4 | 38/59 | 6.7 | 6,500 | 900 | 3.8 | 4.0 | nc | nc | nc |
| | 4 – 6 | 6/16 | 4.5 | 150 | 73 | 3.8 | 77 | nc | nc | nc |
| | 6 – 10 | 2/19 | 310 | 620 | 460 | 3.8 | 1,200 | nc | nc | nc |
| | > 10 | 0/5 | nd | nd | nd | 3.9 | 20 | nc | nc | nc |
| Aroclor-1260 | 0 – 2 | 53/66 | 4.9 | 5,800 | 650 | 3.8 | 4.0 | nc | nc | nc |
| | 2 – 4 | 39/59 | 5.5 | 7,900 | 850 | 3.8 | 38 | nc | nc | nc |
| | 4 – 6 | 10/16 | 4.8 | 280 | 95 | 3.8 | 3.9 | nc | nc | nc |
| | 6 – 10 | 3/19 | 170 | 950 | 630 | 3.8 | 20 | nc | nc | nc |
| | > 10 | 0/5 | nd | nd | nd | 3.9 | 20 | nc | nc | nc |

**Table 4-6. Summary of PCB results for EW subsurface sediment samples (cont.)**

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded SMS Criteria[a] | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SQS | > SQS and ≤ CSL | > CSL |
| Total PCBs | 0 – 2 | 53/66 | 11.6 | 10,000 | 1,500 | 3.8 | 4.0 | 3 | 27 | 23 |
| | 2 – 4 | 40/59 | 5.5 | 17,600 | 2,100 | 3.8 | 6.0 | 15 | 7 | 18 |
| | 4 – 6 | 10/16 | 9.8 | 430 | 160 | 3.8 | 3.9 | 6 | 4 | 0 |
| | 6 – 10 | 3/19 | 700 | 1,720 | 1,100 | 3.8 | 20 | 0 | 1 | 2 |
| | > 10 | 0/5 | nd | nd | nd | 3.9 | 29 | 0 | 0 | 0 |

[a] SMS criteria for these SVOCs are based on organic carbon normalized concentrations. Forty six samples representing all the sediment intervals had TOC values less than 0.5% and eleven samples representing all intervals except the >10ft interval had TOC values greater than 4%. For these samples SVOC concentrations were compared to AET values on a dry weight basis because the TOC values were outside the TOC range for normalization.

CSL – cleanup screening level

dw – dry weight

J – estimated concentration

N – tentative identification

nc – no criteria

nd – not detected

PCB – polychlorinated biphenyl

SMS – Washington State Sediment Management Standards

SQS – sediment quality standards

#### 4.1.1.7 Organochlorine pesticides

Chemical analyses were conducted for organochlorine pesticides in 12 subsurface sediment samples that were collected from five locations in the EW. Ten organochlorine pesticides were detected. Ten samples from the 0-to-2-ft and 2-to-4-ft sampling intervals were initially analyzed by EPA using Method 8081. DDT isomers and alpha-chlordane were detected in these intervals. This method is susceptible to analytical interference associated with the presence of PCBs which results in a positive bias in results for organochlorine pesticides. Two additional samples were submitted for GC/MS/MS analysis for pesticides. This analysis is not subject to interference from PCBs. Three DDT isomers (2,4′-dichlorodiphenyldichloroethane [DDD], 4,4′-DDD, and 4,4′-dichlorodiphenyldichloroethylene [DDE]) were detected in at least one of these samples. Alpha-chlordane, and cis- and trans-nonachlor were also detected. The results presented in Table 4-7 are the results of the Method 8081 analysis except the results identified as GC/MS/MS results

.

## Table 4-7. Summary of pesticide results for EW subsurface sediment samples

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded DMMP Guidelines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SL | > SL and ≤ ML | > ML |
| 2,4′-DDD | 0 – 2 | 1/5 | 64 | 64 | na | 2.7 | 22 | nc | nc | nc |
| | 2 – 4 | 1/5 | 240 | 240 | na | 2.0 | 40 | nc | nc | nc |
| | 4 – 6 | 1/1 | 2.1[a] | 2.1[a] | na | na | na | nc | nc | nc |
| | 6 – 10 | 1/1 | 0.011 J[a] | 0.011 J[a] | na | na | na | nc | nc | nc |
| 2,4′-DDE | 0 – 2 | 0/5 | nd | nd | nd | 2.7 | 30 | nc | nc | nc |
| | 2 – 4 | 1/5 | 120 J | 120 J | na | 2.0 | 40 | nc | nc | nc |
| | 4 – 6 | 0/1 | nd | nd | nd | 0.23 [a] | 0.23 [a] | nc | nc | nc |
| | 6 – 10 | 0/1 | nd | nd | nd | 0.035 [a] | 0.035 [a] | nc | nc | nc |
| 4,4′-DDD | 0 – 2 | 1/5 | 240 | 240 | | 2.7 | 22 | nc | nc | nc |
| | 2 – 4 | 2/5 | 5.4 | 1,000 | 500 | 2.0 | 40 | nc | nc | nc |
| | 4 – 6 | 1/1 | 7.5 J[a] | 7.5 J[a] | na | na | na | nc | nc | nc |
| | 6 – 10 | 1/1 | 0.060[a] | 0.060[a] | na | na | na | nc | nc | nc |
| 4,4′-DDE | 0 – 2 | 0/5 | nd | nd | nd | 2.7 | 30 | nc | nc | nc |
| | 2 – 4 | 1/5 | 100 J | 100 J | na | 2.0 | 64 | nc | nc | nc |
| | 4 – 6 | 1/1 | 5.3[a] | 5.3[a] | na | na | na | nc | nc | nc |
| | 6 – 10 | 0/1 | nd | nd | nd | 0.035 [a] | 0.035 [a] | nc | nc | nc |
| Total DDTs | 0 – 2 | 1/5 | 300 | 300 | na | 13 | 85 | 0 | 0 | 1 |
| | 2 – 4 | 3/5 | 5.4 | 1,400 J | 500 | 2.0 | 2.0 | 1 | 0 | 2 |
| | 4 – 6 | 1/1 | 14.9 J [a] | 14.9 J [a] | na | na | na | 0 | 1 | 0 |
| | 6 – 10 | 1/1 | 0.07 J [a] | 0.07 J [a] | na | na | na | 1 | 0 | 0 |
| alpha-Chlordane | 0 – 2 | 1/5 | 33 | 33 | 33 | 1.4 | 11 | nc | nc | nc |
| | 2 – 4 | 0/5 | nd | nd | nd | 0.98 | 32 | nc | nc | nc |
| | 4 – 6 | 1/1 | 0.54 [a] | 0.54 [a] | 0.54 [a] | na | na | nc | nc | nc |
| | 6 – 10 | 0/1 | nd | nd | nd | 0.035 [a] | 0.035 [a] | nc | nc | nc |

## Table 4-7. Summary of pesticide results for EW subsurface sediment samples (cont.)

| Chemical | Sampling Interval (ft) | Detection Frequency | Detected Concentrations (µg /kg dw) | | | Reporting Limits (µg/kg dw) | | No. of Detected Concentrations that Exceeded DMMP Guidelines | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Mean | Min | Max | ≤ SL | > SL and ≤ ML | > ML |
| beta-Chlordane[b] | 4 – 6 | 1/1 | 0.95 [a] | 0.95 [a] | na | na | na | nc | nc | nc |
| | 6 – 10 | 0/1 | nd | nd | nd | 0.035 [a] | 0.035 [a] | nc | nc | nc |
| Total chlordane | 0 – 2 | 1/5 | 33 | 33 | na | 2.7 | 22 | nc | nc | nc |
| | 2 – 4 | 0/5 | nd | nd | nd | 2.0 | 110 | nc | nc | nc |
| | 4 – 6 | 1/1 | 1.87 J [a] | 1.87 J [a] | na | na | na | nc | nc | nc |
| | 6 – 10 | 0/1 | nd | nd | nd | 0.14 [a] | 0.14 [a] | nc | nc | nc |
| cis-Nonachlor | 0 – 2 | 0/5 | nd | nd | nd | 2.7 | 30 | nc | nc | nc |
| | 2 – 4 | 0/5 | nd | nd | nd | 2.0 | 64 | nc | nc | nc |
| | 4 – 6 | 1/1 | 0.11 J [a] | 0.11 J [a] | na | na | na | nc | nc | nc |
| | 6 – 10 | 0/1 | nd | nd | nd | 0.14 [a] | 0.14 [a] | nc | nc | nc |
| trans-Nonachlor | 0 – 2 | 0/5 | nd | nd | nd | 2.7 | 30 | nc | nc | nc |
| | 2 – 4 | 0/5 | nd | nd | nd | 2.0 | 64 | nc | nc | nc |
| | 4 – 6 | 1/1 | 0.27 [a] | 0.27 [a] | na | na | na | nc | nc | nc |
| | 6 – 10 | 0/1 | nd | nd | nd | 0.035 [a] | 0.035 [a] | nc | nc | nc |

[a] Results of GC/MS/MS analysis

[b] Beta-chlordane was not a target chemical in the original EPA 8270 analysis and was only analyzed in the samples submitted for GC/MS/MS analysis.

CSL – cleanup screening level
DDD – dichlorodiphenyldichloroethane
DDE – dichlorodiphenyldichloroethylene
DDT – dichlorodiphenyltrichloroethane
DMMP – Dredged Material Management Program
dw – dry weight
J – estimated concentration
na – not applicable
nc – no criteria
nd – not detected
SL – screening level

#### 4.1.1.8 Grain size, TOC, and total solids

Table 4-8 summarizes grain size, TOC, and total solids results for subsurface sediment samples that were collected from 63 locations in the EW. Samples from depth intervals greater than 4 ft were not analyzed for grain size because these samples were frozen, and freezing affects grain size. Data tables that provide the results for each sample, including field replicates, are presented in Appendix A.

**Table 4-8. Summary of grain size and conventional results for EW subsurface chemistry sediment**

| Chemical | Sampling Interval (ft) | Number of Samples | Unit | Minimum | Maximum | Mean |
|---|---|---|---|---|---|---|
| **Grain Size** | | | | | | |
| Total gravel | 0 – 2 | 66 | % dw | 0.1 | 35.6 | 5 |
| | 2 – 4 | 59 | % dw | 0.1 | 60.1 | 3 |
| | 4 – 6 | 1 | % dw | 14.8 | 14.8 | na |
| | > 10 | 3 | % dw | 1.3 | 7.7 | 4.5 |
| Total sand | 0 – 2 | 66 | % dw | 3.8 | 89.8 | 41 |
| | 2 – 4 | 59 | % dw | 10.4 | 95.9 | 47 |
| | 4 – 6 | 1 | % dw | 17.1 | 17.1 | na |
| | > 10 | 3 | % dw | 23.5 | 60.3 | 47.0 |
| Total silt | 0 – 2 | 66 | % dw | 7.4 | 68.5 | 37 |
| | 2 – 4 | 56 | % dw | 4 | 64.3 | 40 |
| | 4 – 6 | 1 | % dw | 37.8 | 37.8 | na |
| | > 10 | 3 | % dw | 24.5 | 59.2 | 37.9 |
| Total clay | 0 – 2 | 66 | % dw | 2.2 | 37.0 | 19 |
| | 2 – 4 | 56 | % dw | 1.9 | 39.9 | 17 |
| | 4 – 6 | 1 | % dw | 30.2 | 30.2 | na |
| | > 10 | 3 | % dw | 8.3 | 17.4 | 12 |
| Total fines (percent silt+clay) | 0 – 2 | 66 | % dw | 9.6 | 96.0 | 56 |
| | 2 – 4 | 56 | % dw | 6.0 | 88.9 | 50 |
| | 4 – 6 | 1 | % dw | 68.0 | 68.0 | na |
| | > 10 | 3 | % dw | 35.2 | 76.6 | 50.1 |
| **Conventionals** | | | | | | |
| TOC | 0 – 2 | 68 | % dw | 0.323 | 5.38 | 1.65 |
| | 2 – 4 | 61 | % dw | 0.093 | 7.40 | 1.6 |
| | 4 – 6 | 19 | % dw | 0.098 | 4.32 | 1.0 |
| | 6 – 10 | 37 | % dw | 0.165 | 4.39 | 1.12 |
| | > 10 | 10 | % dw | 0.489 | 1.56 | 0.828 |

| Chemical | Sampling Interval (ft) | Number of Samples | Unit | Minimum | Maximum | Mean |
|---|---|---|---|---|---|---|
| Total solids | 0 – 2 | 68 | % ww | 40.80 | 79.80 | 63.66 |
| | 2 – 4 | 61 | % ww | 40.70 | 90.30 | 67.15 |
| | 4 – 6 | 19 | % ww | 47.87 | 89.70 | 72.3 |
| | 6 – 10 | 37 | % ww | 50.73 | 84.00 | 71.5 |
| | > 10 | 10 | % ww | 68.63 | 77.00 | 73.55 |

dw – dry weight
EW – East Waterway
na- not applicable
TOC – total organic carbon
ww – wet weight

Percent fines in subsurface sediment samples ranged from 6.0 to 96%, with mean percentages in the various depth intervals ranging from 50 to 68%. TOC ranged from 0.074 to 6.88%, with mean percentages in depth intervals ranging from 0.093 to 7.40%. Forty-six samples had TOC of less than 0.5%, and eleven samples had TOC greater than 4.0%. Total solids ranged from 37.40 to 85.10%, and mean total solids ranged from 47.87 to 90.30%.

### 4.1.2 Summary of results by sampling location

This section summarizes the analytical results for each sampling location. Table 4-9 summarizes the detected concentrations of chemicals that exceeded SMS criteria or DMMP guidelines for each sampling location.

Some of the SMS criteria are based on organic carbon (OC)-normalized concentrations. If the TOC content of a sediment sample is < 0.5%, then Washington State Department of Ecology guidance does not recommend OC-normalization (Ecology 1995). In addition, OC-normalization is not considered appropriate if the TOC is > 4%. In these cases, the dry-weight concentration was compared with the lowest apparent effects threshold (LAET) and second lowest apparent effects threshold (2LAET) (PTI 1988), which are analogous to the SQS and the CSL, respectively. A total of 37 samples analyzed for chemicals with SMS criteria had TOC concentrations < 0.5%, and 10 samples had TOC concentration > 4.0%. Samples and analytes that were evaluated based on comparison to the AET values are indicated in Table 4-9.

Exceedance factors were calculated as the ratio of the sample concentration to the SMS or DMMP value. Exceedance factors greater than one are associated with sample concentrations above the SMS or DMMP value. Of the 65 locations, 50 had at least one sample with an exceedance of an SMS criterion or DMMP guideline. There were no exceedances at 15 locations (EW10-SC20, EW10-SC25, EW10-SC34, EW10-SC38, EW10-SC41, EW10-SC44, EW10-SC45, EW10-SC46, EW10-SC51, EW10-SC56, EW10-SC59, EW10-SC62, EW10-SC63, EW10-SC100, and EW10-SC101). The locations with the greatest number of detected chemical exceedances were EW10-SB01 (51 exceedances), EW10-SC54

(44 exceedances, EW10-SC29 (37exceedances), EW10-SC09 (31 exceedances), and EW10-SC32 (27 exceedances).

As discussed in Section 3.1, three rounds of analyses were conducted to characterize sediment at depth. Samples at each location were analyzed as necessary until a depth interval with no exceedances of SMS criteria or DMMP guidelines was reached; any remaining deeper samples were archived. As presented in Table 4-9, EW10-SC54 was the only core in which there was an exceedance in the deepest core interval. It is unknown whether there are exceedances below the depth of the core at this sampling location.

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SB01** | | | | | | | | |
| 0 – 2 | 0 – 2 | SMS chemicals | cadmium | 45.2 | mg/kg dw | **8.9** | **6.7** | no |
| | | | lead | 580 | mg/kg dw | **1.3** | **1.1** | no |
| | | | mercury | 2.48 | mg/kg dw | **6.0** | **4.2** | no |
| | | | silver | 7 | mg/kg dw | **1.1** | **1.1** | no |
| | | | zinc | 6,850 | mg/kg dw | **17** | **7.1** | no |
| | | | acenaphthene | 390 | mg/kg OC | **24** | **6.8** | no |
| | | | anthracene | 240 | mg/kg OC | **1.1** | 0.20 | no |
| | | | benzo(a)anthracene | 610 | mg/kg OC | **5.5** | **2.3** | no |
| | | | benzo(a)pyrene | 430 | mg/kg OC | **4.3** | **2.0** | no |
| | | | benzo(g,h,i)perylene | 72 | mg/kg OC | **2.3** | 0.92 | no |
| | | | total benzofluoranthenes | 500 | mg/kg OC | **2.2** | **1.1** | no |
| | | | chrysene | 720 | mg/kg OC | **6.5** | **1.6** | no |
| | | | dibenzo(a,h)anthracene | 43 | mg/kg OC | **3.6** | **1.3** | no |
| | | | dibenzofuran | 86 | mg/kg OC | **5.7** | **1.5** | no |
| | | | fluoranthene | 1,800 J | mg/kg OC | **11** | **1.5** | no |
| | | | fluorene | 220 | mg/kg OC | **9.6** | **2.8** | no |
| | | | indeno(1,2,3-cd)pyrene | 72 | mg/kg OC | **2.1** | 0.82 | no |
| | | | phenanthrene | 1,000 | mg/kg OC | **10** | **2.1** | no |
| | | | pyrene | 1,400 | mg/kg OC | **1.4** | **1.0** | no |
| | | | total HPAHs | 5,590 J | mg/kg OC | **5.8** | **1.1** | no |
| | | | total LPAHs | 1,900 | mg/kg OC | **5.1** | **2.4** | no |
| | | | BEHP | 110 | mg/kg OC | **2.3** | **1.4** | no |
| | | | total PCBs | 270 | mg/kg OC | **23** | **4.2** | no |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SB01** | | | | | | | | |
| 3.5 – 5.2 | 3.5 – 5.2 | SMS chemicals | mercury | 1.07 | mg/kg dw | **2.6** | **1.8** | no |
| | | | zinc | 597 | mg/kg dw | **1.5** | 0.62 | no |
| | | | 2-methylnaphthalene | 110 | mg/kg OC | **2.9** | **1.7** | no |
| | | | acenaphthene | 130 | mg/kg OC | **8.1** | **2.3** | no |
| | | | dibenzofuran | 93 | mg/kg OC | **6.2** | **1.6** | no |
| | | | fluoranthene | 370 J | mg/kg OC | **2.3** | 0.31 | no |
| | | | fluorene | 120 | mg/kg OC | **5.2** | **1.5** | no |
| | | | naphthalene | 300 | mg/kg OC | **3.0** | **1.8** | no |
| | | | phenanthrene | 480 | mg/kg OC | **4.8** | **1.0** | no |
| | | | total HPAHs | 1,040 J | mg/kg OC | **1.1** | 0.20 | no |
| | | | total LPAHs | 1,110 | mg/kg OC | **3.0** | **1.4** | no |
| 12.5 – 14.5 | 12.5 – 14.5 | SMS chemicals | 2-methylnaphthalene | 560 | mg/kg OC | **15** | **8.8** | no |
| | | | acenaphthene | 1,300 | mg/kg OC | **81** | **23** | no |
| | | | anthracene | 520 | mg/kg OC | **2.4** | 0.43 | no |
| | | | dibenzofuran | 760 | mg/kg OC | **51** | **13** | no |
| | | | fluoranthene | 720 J | mg/kg OC | **4.5** | 0.60 | no |
| | | | fluorene | 820 | mg/kg OC | **36** | **10** | no |
| | | | naphthalene | 2,800 | mg/kg OC | **28** | **16** | no |
| | | | phenanthrene | 2,700 | mg/kg OC | **27** | **5.6** | no |
| | | | total HPAHs | 1,580 J | mg/kg OC | **1.6** | 0.30 | no |
| | | | total LPAHs | 8,200 | mg/kg OC | **22** | **11** | no |
| | | | n-nitrosodiphenylamine | 21 | mg/kg OC | **1.9** | **1.9** | no |
| 16 – 18 | 16 – 18 | SMS chemicals | acenaphthene | 190 | mg/kg OC | **12** | **3.3** | no |
| | | | dibenzofuran | 99 | mg/kg OC | **6.6** | **1.7** | no |
| | | | fluorene | 95 | mg/kg OC | **4.1** | **1.2** | no |
| | | | naphthalene | 240 | mg/kg OC | **2.4** | **1.4** | no |
| | | | phenanthrene | 280 | mg/kg OC | **2.8** | 0.58 | no |
| | | | total LPAHs | 840 | mg/kg OC | **2.3** | **1.1** | no |
| 24.5 – 26.5 | 24.5 – 26.5 | PAHs | acenapthene | 1,000 | µg/kg dw | **2.0** | **1.4** | yes |

Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SB02** | | | | | | | | |
| 0 – 2 | 0 – 2 | SMS chemicals | cadmium | 7.1 | mg/kg dw | **1.4** | **1.1** | no |
| | | | mercury | 1.20 | mg/kg dw | **2.9** | **2.0** | no |
| | | | zinc | 848 | mg/kg dw | **2.1** | 0.88 | no |
| | | | 2-methylnaphthalene | 100 | mg/kg OC | **2.6** | **1.6** | no |
| | | | acenaphthene | 170 | mg/kg OC | **11** | **3.0** | no |
| | | | dibenzofuran | 99 | mg/kg OC | **6.6** | **1.7** | no |
| | | | fluoranthene | 270 J | mg/kg OC | **1.7** | 0.23 | no |
| | | | fluorene | 130 | mg/kg OC | **5.7** | **1.6** | no |
| | | | naphthalene | 380 | mg/kg OC | **3.8** | **2.2** | no |
| | | | phenanthrene | 320 | mg/kg OC | **3.2** | 0.67 | no |
| | | | total LPAHs | 1,100 | mg/kg OC | **3.0** | **1.4** | no |
| | | | BEHP | 61 | mg/kg OC | **1.3** | 0.78 | no |
| | | | 2,4-dimethylphenol | 80 | µg/kg dw | **2.8** | **2.8** | no |
| | | | total PCBs | 120 | mg/kg OC | **10** | **1.8** | no |
| 4 – 6 | 4 – 6 | SMS chemicals | lead | 1,450 | mg/kg dw | **3.2** | **2.7** | no |
| | | | mercury | 1.06 | mg/kg dw | **2.6** | **1.8** | no |
| | | | acenaphthene | 49 | mg/kg OC | **3.1** | 0.86 | no |
| | | | fluoranthene | 300 J | mg/kg OC | **1.9** | 0.25 | no |
| | | | fluorene | 32 | mg/kg OC | **1.4** | 0.41 | no |
| | | | phenanthrene | 140 | mg/kg OC | **1.4** | 0.29 | no |
| 12 – 14 | 12 – 14 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC03** | | | | | | | | |
| 0 – 2 | 0 – 2.7 | SMS chemicals | mercury | 0.52 | mg/kg dw | **1.3** | 0.88 | no |
| | | | total PCBs | 48.5 J | mg/kg OC | **4.0** | 0.75 | no |
| 2 – 4 | 2.7 – 5.7 | SMS chemicals | na | na | na | ne | ne | ne |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) Recovered Depth | Sampling Interval (ft) In Situ Depth | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] SQS/SL | Exceedance Factor[a] CSL/ML | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| **EW10-SC04** | | | | | | | | |
| 0 – 2 | 0 – 2.7 | SMS chemicals | total PCBs | 130 J | mg/kg OC | **11** | **2.0** | no |
| 2 – 4 | 2.7 – 5.4 | SMS chemicals | acenaphthene | 19 J | mg/kg OC | **1.2** | 0.33 | no |
| | | | fluorene | 26 J | mg/kg OC | **1.1** | 0.33 | no |
| | | | phenanthrene | 130 J | mg/kg OC | **1.3** | 0.27 | no |
| 4 – 4.5 | 5.4 – 6.1 | SVOCs | na | na | na | ne | ne | ne |
| **EW10-SC05** | | | | | | | | |
| 0 – 2 | 0 – 1.9 | SMS chemicals | total PCBs | 12.4 JN | mg/kg OC | **1.0** | 0.19 | no |
| 2 – 4 | 1.9 – 4.2 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC06** | | | | | | | | |
| 0 – 2 | 0 – 2.1 | SMS chemicals and organometals | mercury | 0.90 | mg/kg dw | **2.2** | **1.5** | no |
| | | | total PCBs | 70 | mg/kg OC | **5.8** | **1.1** | no |
| 2 – 4 | 2.1 – 4.3 | SMS chemicals and organometals | mercury | 0.80 | mg/kg dw | **2.0** | **1.4** | no |
| 4 – 6 | 4.3 – 6.8 | mercury | mercury | 0.71 | mg/kg dw | **1.7** | **1.2** | no |
| 6 – 7.4 | 6.8 – 8.7 | mercury | na | na | na | ne | ne | ne |
| 7.4 – 10 | 8.7 – 12.3 | mercury | na | na | na | ne | ne | ne |
| **EW10-SC07B** | | | | | | | | |
| 0 – 2.3 | 0 – 2.4 | SMS chemicals | total PCBs | 45 J | mg/kg OC | **3.8** | 0.69 | no |
| 2.3 – 4 | 2.4 – 4.2 | SMS chemicals | total PCBs | 14 | mg/kg OC | **1.2** | 0.22 | no |
| 4 – 6 | 4.2 – 6.2 | PCBs | na | na | na | ne | ne | ne |
| **EW10-SC08** | | | | | | | | |
| 0 – 2 | 0 – 2.5 | SMS chemicals | mercury | 0.49 | mg/kg dw | **1.2** | 0.83 | no |
| | | | total PCBs | 96.6 | mg/kg OC | **8.0** | **1.5** | no |
| 2 – 4 | 2.5 – 4.3 | SMS chemicals | cadmium | 5.6 | mg/kg dw | **1.1** | 0.84 | no |
| | | | mercury | 1.00 | mg/kg dw | **2.4** | **1.7** | no |
| | | | BEHP | 140 | mg/kg OC | **3.0** | **1.8** | no |
| | | | total PCBs | 300 | mg/kg OC | **25** | **4.6** | no |
| 6 – 8 | 6.6 – 9.2 | SMS chemicals | mercury | 0.43 | mg/kg dw | **1.0** | 0.73 | no |
| 8 – 9.4 | 9.2 – 11 | mercury | na | na | na | ne | ne | ne |
| 9.4 – 11 | 11 – 12.9 | mercury | na | na | na | ne | ne | ne |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC09** | | | | | | | | |
| 0 – 2 | 0 – 2.1 | SMS chemicals | mercury | 0.51 J | mg/kg dw | **1.2** | 0.86 | no |
| | | | total PCBs | 29.3 | mg/kg OC | **2.4** | 0.45 | no |
| 2 – 4 | 2.1 – 4.3 | SMS chemicals | mercury | 0.89 J | mg/kg dw | **2.2** | **1.5** | no |
| | | | anthracene | 1,400 | µg/kg dw | **1.5** | 0.32 | yes |
| | | | benzo(a)anthracene | 2,400 | µg/kg dw | **1.8** | **1.5** | yes |
| | | | benzo(a)pyrene | 2,300 | µg/kg dw | **1.4** | 0.77 | yes |
| | | | chrysene | 3,500 | µg/kg dw | **2.5** | **1.3** | yes |
| | | | dibenzo(a,h)anthracene | 240 J | µg/kg dw | **1.0** | 0.44 | yes |
| | | | fluoranthene | 3,000 | µg/kg dw | **1.8** | **1.2** | yes |
| | | | pyrene | 4,300 J | µg/kg dw | **1.7** | **1.3** | yes |
| | | | total HPAHs | 19,400 J | µg/kg dw | **1.6** | **1.1** | yes |
| | | | butyl benzyl phthalate | 76 | µg/kg dw | **1.2** | 0.084 | yes |
| | | | total PCBs | 1,900 | µg/kg dw | **15** | **1.9** | yes |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC09** | | | | | | | | |
| 6 – 7.2 | 6.4 – 7.7 | mercury, SVOCs and PCBs | mercury | 0.74 | mg/kg dw | **1.8** | **1.3** | no |
| | | | acenaphthene | 770 | µg/kg dw | **1.5** | **1.1** | yes |
| | | | anthracene | 3,000 | µg/kg dw | **3.1** | 0.68 | yes |
| | | | benzo(a)anthracene | 3,600 | µg/kg dw | **2.8** | **2.3** | yes |
| | | | benzo(a)pyrene | 2,500 | µg/kg dw | **1.6** | 0.83 | yes |
| | | | benzo(g,h,i)perylene | 880 | µg/kg dw | **1.3** | **1.2** | yes |
| | | | total benzofluoranthenes | 4,400 | µg/kg dw | **1.4** | **1.2** | yes |
| | | | chrysene | 3,800 | µg/kg dw | **2.7** | **1.4** | yes |
| | | | dibenzo(a,h)anthracene | 430 | µg/kg dw | **1.9** | 0.80 | yes |
| | | | fluoranthene | 8,100 | µg/kg dw | **4.8** | **3.2** | yes |
| | | | fluorene | 900 | µg/kg dw | **1.7** | 0.90 | yes |
| | | | indeno(1,2,3-cd)pyrene | 860 | µg/kg dw | **1.4** | **1.2** | yes |
| | | | phenanthrene | 3,700 | µg/kg dw | **2.5** | 0.69 | yes |
| | | | pyrene | 10,000 | µg/kg dw | **3.8** | **3.0** | yes |
| | | | total HPAHs | 35,000 | µg/kg dw | **2.9** | **2.1** | yes |
| | | | total LPAHs | 9,300 J | µg/kg dw | **1.8** | 0.72 | yes |
| | | | BEHP | 1,800 | µg/kg dw | **1.4** | 0.95 | yes |
| | | | total PCBs | 1,720 | µg/kg dw | **13** | **1.7** | yes |
| 7.2 – 9.2 | 7.7 – 9.8 | mercury, SVOCs and PCBs | na | na | na | ne | ne | ne |
| 9.2 – 11.2 | 9.8 – 12.0 | mercury | na | na | na | ne | ne | ne |
| **EW10-SC10** | | | | | | | | |
| 0 – 2.4 | 0 – 2.6 | SMS chemicals and organometals | total PCBs | 28 JN | mg/kg OC | **2.3** | 0.43 | no |
| 2.4 – 4 | 2.6 – 4.3 | SMS chemicals and organometals | total PCBs | 18 JN | mg/kg OC | **1.5** | 0.28 | no |
| 4 – 6 | 4.3 – 6.4 | PCBs | na | na | na | ne | ne | ne |
| 6 – 8 | 6.4 – 8.5 | PCBs | na | na | na | ne | ne | ne |

Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC11** | | | | | | | | |
| 0 – 2 | 0 – 1.8 | SMS chemicals and pesticides | mercury | 0.45 | mg/kg dw | **1.1** | 0.76 | no |
| | | | total PCBs | 40 | mg/kg OC | **3.3** | 0.62 | no |
| 2 – 4 | 1.8 – 4.0 | SMS chemicals and pesticides | cadmium | 5.2 | mg/kg dw | **1.0** | 0.78 | no |
| | | | mercury | 1.26 | mg/kg dw | **3.1** | **2.1** | no |
| | | | BEHP | 60 | mg/kg OC | **1.3** | 0.77 | no |
| | | | total PCBs | 120 | mg/kg OC | **10** | **1.8** | no |
| | | | total DDTs | 100 J | µg/kg dw | **14** | **1.4** | no |
| 4 – 6 | 4.0 – 6.1 | SMS chemicals and pesticides | mercury | 0.73 | mg/kg dw | **1.8** | **1.2** | no |
| | | | total PCBs | 16 | mg/kg OC | **1.3** | 0.25 | no |
| | | | total DDTs | 14.9 J | µg/kg dw | **2.2** | 0.22 | no |
| 6 – 8 | 6.1 – 9.1 | mercury and PCBs | na | na | na | ne | ne | ne |
| **EW10-SC12** | | | | | | | | |
| 0 – 2 | 0 – 2.2 | SMS chemicals | mercury | 0.84 | mg/kg dw | **2.0** | **1.4** | no |
| | | | BEHP | 52 | mg/kg OC | **1.1** | 0.67 | no |
| | | | total PCBs | 120 J | mg/kg OC | **10** | **1.8** | no |
| 2 – 3.1 | 2.2 – 3.6 | SMS chemicals | mercury | 3.20 | mg/kg dw | **7.8** | **5.4** | no |
| | | | BEHP | 51 | mg/kg OC | **1.1** | 0.65 | no |
| | | | total PCBs | 85 | mg/kg OC | **7.1** | **1.3** | no |
| 5 – 7 | 5.6 – 7.8 | mercury, SVOCs and PCBs | na | na | na | ne | ne | ne |
| 7 – 9 | 7.8 – 10 | mercury | na | na | na | ne | ne | ne |
| **EW10-SC13** | | | | | | | | |
| 0 – 1.6 | 0 – 1.9 | SMS chemicals | mercury | 0.49 J | mg/kg dw | **1.2** | 0.83 | no |
| | | | total PCBs | 66.8 | mg/kg OC | **5.6** | **1.0** | no |
| 1.6 – 4 | 1.9 – 4.7 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC14** | | | | | | | | |
| 0 – 2.8 | 0 – 3.2 | SMS chemicals | total PCBs | 42 | mg/kg OC | **3.5** | 0.65 | no |
| 2.8 – 5.3 | 3.2 – 6.1 | SMS chemicals | total PCBs | 87.1 | mg/kg OC | **7.3** | **1.3** | no |
| 5.3 – 7.3 | 6.1 – 8.4 | PCBs | na | na | na | ne | ne | ne |

Table 4-9. **Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC15** | | | | | | | | |
| 0 – 2.3 | 0 – 2.3 | SMS chemicals | mercury | 0.70 | mg/kg dw | **1.7** | **1.2** | no |
| | | | total PCBs | 58.1 | mg/kg OC | **4.8** | 0.89 | no |
| 2.3 – 4 | 2.3 – 4.0 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC16** | | | | | | | | |
| 0 – 1.9 | 0 – 2.6 | SMS chemicals | mercury | 0.43 J | mg/kg dw | **1.0** | 0.73 | no |
| | | | BEHP | 49 | mg/kg OC | **1.0** | 0.63 | no |
| | | | 1,4-dichlorobenzene | 4.2 | mg/kg OC | **1.4** | 0.47 | no |
| | | | total PCBs | 168 | mg/kg OC | **14** | **2.6** | no |
| 1.9 – 4 | 2.6 – 5.5 | SMS chemicals | mercury | 0.47 J | mg/kg dw | **1.1** | 0.80 | no |
| 4 – 6 | 5.5 – 8.3 | mercury | na | na | na | ne | ne | ne |
| 6 – 8.2 | 8.3 – 11.3 | mercury | na | na | na | ne | ne | ne |
| **EW10-SC17** | | | | | | | | |
| 0 – 2 | 0 – 2.1 | SMS chemicals | mercury | 0.54 J | mg/kg dw | **1.3** | 0.92 | no |
| | | | total PCBs | 32 | mg/kg OC | **2.7** | 0.49 | no |
| 2 – 4 | 2.1 – 4.1 | SMS chemicals | mercury | 1.35 J | mg/kg dw | **3.3** | **2.3** | no |
| | | | total PCBs | 88.7 | mg/kg OC | **7.4** | **1.4** | no |
| 6 – 8 | 6.2 – 8.2 | mercury and PCBs | mercury | 2.54 | mg/kg dw | **6.2** | **4.3** | no |
| | | | total PCBs | 950 | µg/kg dw | **7.3** | 0.95 | yes |
| 8 – 10 | 8.2 – 10.3 | mercury | mercury | 0.80 | mg/kg dw | **2.0** | **1.4** | no |
| 11.5 – 13 | 11.8 – 13.4 | mercury and PCBs | na | na | na | ne | ne | ne |
| **EW10-SC18** | | | | | | | | |
| 0 – 2 | 0 – 2.1 | SMS chemicals and organometals | mercury | 0.56 | mg/kg dw | **1.4** | 0.95 | no |
| | | | total PCBs | 83.3 | mg/kg OC | **6.9** | **1.3** | no |
| 2 – 4 | 2.1 – 4.1 | SMS chemicals and organometals | mercury | 0.65 | mg/kg dw | **1.6** | **1.1** | no |
| | | | BEHP | 48 | mg/kg OC | **1.0** | 0.62 | no |
| | | | total PCBs | 88.9 | mg/kg OC | **7.4** | **1.4** | no |
| 4 – 6 | 4.1 – 6.2 | mercury, SVOCs and PCBs | total PCBs | 24.5 | mg/kg OC | **2.0** | 0.38 | no |
| 6 – 8 | 6.2 – 8.2 | mercury and PCBs | na | na | na | ne | ne | ne |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC19** | | | | | | | | |
| 0 – 2.5 | 0 – 2.6 | SMS chemicals and pesticides | mercury | 0.57 | mg/kg dw | **1.4** | 0.97 | no |
| | | | BEHP | 58 | mg/kg OC | **1.2** | 0.74 | no |
| | | | 1,4-dichlorobenzene | 9.8 | mg/kg OC | **3.2** | **1.1** | no |
| | | | total PCBs | 92.6 | mg/kg OC | **7.7** | **1.4** | no |
| 2.5 – 4 | 2.6 – 4.1 | SMS chemicals and pesticides | total PCBs | 330 | µg/kg dw | **2.5** | 0.33 | yes |
| 4 – 6 | 4.1 – 6.2 | SVOCs and PCBs | na | na | ne | ne | ne | ne |
| **EW10-SC20** | | | | | | | | |
| 0.4 – 2.4 | 0.4 – 2.6 | SMS chemicals | na | na | ne | ne | ne | ne |
| 2.4 – 4.4 | 2.6 – 4.8 | SMS chemicals | na | na | ne | ne | ne | ne |
| **EW10-SC21** | | | | | | | | |
| 0 – 2 | 0 – 2.1 | SMS chemicals | mercury | 0.45 | mg/kg dw | **1.1** | 0.76 | no |
| | | | BEHP | 59 | mg/kg OC | **1.3** | 0.76 | no |
| | | | 1,4-dichlorobenzene | 15 | mg/kg OC | **4.8** | **1.7** | no |
| | | | total PCBs | 82.9 | mg/kg OC | **6.9** | **1.3** | no |
| 2 – 4 | 2.1 – 4.2 | SMS chemicals | mercury | 0.73 | mg/kg dw | **1.8** | **1.2** | no |
| | | | BEHP | 160 | mg/kg OC | **3.4** | **2.1** | no |
| | | | 1,4-dichlorobenzene | 11 | mg/kg OC | **3.5** | **1.2** | no |
| | | | total PCBs | 110 | mg/kg OC | **9.2** | **1.7** | no |
| 5.3 – 7.8 | 5.5 – 8.2 | mercury, SVOCs and PCBs | na | na | na | ne | ne | ne |
| 7.8 – 10 | 8.2 – 10.4 | mercury | na | na | na | ne | ne | ne |
| **EW10-SC22** | | | | | | | | |
| 0 – 1.9 | 0 – 2.0 | SMS chemicals | total PCBs | 133 | µg/kg dw | **1.0** | 0.13 | yes |
| 1.9 – 4 | 2.0 – 4.1 | SMS chemicals | na | na | na | ne | ne | ne |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC23** | | | | | | | | |
| 0 – 1.3 | 0 – 1.3 | SMS chemicals and organometals | total PCBs | 33 | mg/kg OC | **2.8** | 0.51 | no |
| 1.3 – 3.2 | 1.3 – 3.1 | SMS chemicals and organometals | cadmium | 18.4 | mg/kg dw | **3.6** | **2.7** | no |
| | | | lead | 455 | mg/kg dw | **1.0** | 0.86 | no |
| | | | mercury | 1.64 | mg/kg dw | **4.0** | **2.8** | no |
| | | | silver | 6.5 | mg/kg dw | **1.1** | **1.1** | no |
| | | | zinc | 2,280 | mg/kg dw | **5.6** | **2.4** | no |
| | | | acenaphthene | 800 | µg/kg dw | **1.6** | **1.1** | yes |
| | | | anthracene | 2,900 | µg/kg dw | **3.0** | 0.66 | yes |
| | | | benzo(a)anthracene | 4,000 | µg/kg dw | **3.1** | **2.5** | yes |
| | | | benzo(a)pyrene | 3,000 | µg/kg dw | **1.9** | **1.0** | yes |
| | | | benzo(g,h,i)perylene | 690 | µg/kg dw | **1.0** | 0.96 | yes |
| | | | total benzofluoranthenes | 8,400 | µg/kg dw | **2.6** | **2.3** | yes |
| | | | chrysene | 4,700 | µg/kg dw | **3.4** | **1.7** | yes |
| | | | dibenzo(a,h)anthracene | 760 | µg/kg dw | **3.3** | **1.4** | yes |
| | | | fluoranthene | 10,000 | µg/kg dw | **5.9** | **4.0** | yes |
| | | | fluorene | 1,100 | µg/kg dw | **2.0** | **1.1** | yes |
| | | | indeno(1,2,3-cd)pyrene | 720 | µg/kg dw | **1.2** | **1.0** | yes |
| | | | pyrene | 18,000 | µg/kg dw | **6.9** | **5.5** | yes |
| | | | total HPAHs | 50,000 | µg/kg dw | **4.2** | **2.9** | yes |
| | | | total LPAHs | 6,900 | µg/kg dw | **1.3** | 0.53 | yes |
| | | | BEHP | 5,800 | µg/kg dw | **4.5** | **3.1** | yes |
| | | | butyl benzyl phthalate | 340 | µg/kg dw | **5.4** | 0.38 | yes |
| | | | total PCBs | 17,600 | µg/kg dw | **140** | **18** | yes |
| 7 – 9 | 7.3 – 9.3 | mercury | mercury | 0.76 | mg/kg dw | **1.9** | **1.3** | no |
| 9 – 11 | 9.3 – 11.4 | SMS chemicals | Fluoranthene | 170 | mg/kg OC | **1.1** | 0.14 | no |
| 11 – 12.9 | 11.4 – 13.4 | mercury and PAHs | na | na | na | ne | ne | ne |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC24** | | | | | | | | |
| 0 – 2 | 0 – 2.1 | SMS chemicals | mercury | 0.49 J | mg/kg dw | **1.2** | 0.83 | no |
| | | | 1,4-dichlorobenzene | 5.4 | mg/kg OC | **1.7** | 0.60 | no |
| | | | total PCBs | 74.5 | mg/kg OC | **6.2** | **1.1** | no |
| 2 – 4.7 | 2.1 – 4.9 | SMS chemicals | mercury | 0.67 J | mg/kg dw | **1.6** | **1.1** | no |
| | | | BEHP | 99 | mg/kg OC | **2.1** | **1.3** | no |
| | | | butyl benzyl phthalate | 5.3 | mg/kg OC | **1.1** | 0.083 | no |
| | | | 1,4-dichlorobenzene | 9.9 | mg/kg OC | **3.2** | **1.1** | no |
| | | | total PCBs | 90.7 | mg/kg OC | **7.6** | **1.4** | no |
| 6 – 8 | 6.2 – 8.3 | mercury, SVOCs and PCBs | acenaphthene | 33 | mg/kg OC | **2.1** | 0.58 | no |
| | | | dibenzofuran | 16 | mg/kg OC | **1.1** | 0.28 | no |
| | | | fluoranthene | 220 | mg/kg OC | **1.4** | 0.18 | no |
| | | | fluorene | 29 | mg/kg OC | **1.3** | 0.37 | no |
| | | | BEHP | 73 | mg/kg OC | **1.6** | 0.94 | no |
| | | | total PCBs | 85 | mg/kg OC | **7.1** | **1.3** | no |
| 8 – 10 | 8.3 – 10.4 | mercury, SVOCs and PCBs | na | na | na | ne | ne | ne |
| **EW10-SC25** | | | | | | | | |
| 0.8 – 2.8 | 0.9 – 3.0 | SMS chemicals | na | na | na | ne | ne | ne |
| 2.8 – 4.8 | 3.0 – 5.2 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC26** | | | | | | | | |
| 0 – 2.7 | 0 – 2.9 | SMS chemicals and organometals | total PCBs | 38 | mg/kg OC | **3.2** | 0.58 | no |
| 2.7 – 4 | 2.9 – 4.2 | SMS chemicals and organometals | na | na | na | ne | ne | ne |

Table 4-9. **Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | | | | | Exceedance Factor[a] | | |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | Chemicals Analyzed | Chemical | Concentration | Unit | SQS/SL | CSL/ML | AET Substitution |
| **EW10-SC27** | | | | | | | | |
| 0 – 2 | 0 – 2.1 | SMS chemicals | cadmium | 11.3 | mg/kg dw | **2.2** | **1.7** | no |
| | | | mercury | 1.16 | mg/kg dw | **2.8** | **2.0** | no |
| | | | zinc | 998 | mg/kg dw | **2.4** | **1.0** | no |
| | | | fluoranthene | 2,400 | µg/kg dw | **1.4** | 0.96 | yes |
| | | | pyrene | 2,800 | µg/kg dw | **1.1** | 0.85 | yes |
| | | | BEHP | 4,700 | µg/kg dw | **3.6** | **2.5** | yes |
| | | | butyl benzyl phthalate | 110 | µg/kg dw | **1.7** | 0.12 | yes |
| | | | total PCBs | 3,600 | µg/kg dw | **28** | **3.6** | yes |
| 2 – 4 | 2.1 – 4.2 | SMS chemicals | cadmium | 9.8 | mg/kg dw | **1.9** | **1.5** | no |
| | | | lead | 525 | mg/kg dw | **1.2** | 0.99 | no |
| | | | mercury | 1.81 | mg/kg dw | **4.4** | **3.1** | no |
| | | | zinc | 1,180 | mg/kg dw | **2.9** | **1.2** | no |
| | | | acenaphthene | 160 | mg/kg OC | **10** | **2.8** | no |
| | | | dibenzofuran | 91 | mg/kg OC | **6.1** | **1.6** | no |
| | | | fluoranthene | 310 | mg/kg OC | **1.9** | 0.26 | no |
| | | | fluorene | 140 | mg/kg OC | **6.1** | **1.8** | no |
| | | | phenanthrene | 310 | mg/kg OC | **3.1** | 0.65 | no |
| | | | total LPAHs | 780 | mg/kg OC | **2.1** | **1.0** | no |
| | | | BEHP | 57 | mg/kg OC | **1.2** | 0.73 | no |
| | | | total PCBs | 200 | mg/kg OC | **17** | **3.1** | no |
| 6 – 7.7 | 6.4 – 8.2 | SMS chemicals | mercury | 1.18 | mg/kg dw | **2.9** | **2.0** | no |
| 7.7 – 10 | 8.2 – 10.6 | mercury | na | na | na | ne | ne | ne |
| 10 – 12.5 | 10.6 – 13.3 | mercury | na | na | na | ne | ne | ne |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC28** | | | | | | | | |
| 1 – 3 | 1.2 – 3.5 | SMS chemicals | mercury | 0.59 J | mg/kg dw | **1.4** | **1.0** | no |
| | | | 1,2,4-trichlorobenzene | 1.1 | mg/kg OC | **1.4** | 0.61 | no |
| | | | 1,4-dichlorobenzene | 4.7 | mg/kg OC | **1.5** | 0.52 | no |
| | | | total PCBs | 52 | mg/kg OC | **4.3** | 0.80 | no |
| 3 – 5 | 3.5 – 5.9 | SMS chemicals | mercury | 1.18 J | mg/kg dw | **2.9** | **2.0** | no |
| | | | 1,2,4-trichlorobenzene | 2.2 | mg/kg OC | **2.7** | **1.2** | no |
| | | | 1,4-dichlorobenzene | 16 | mg/kg OC | **5.2** | **1.8** | no |
| | | | total PCBs | 400 | mg/kg OC | **33** | **6.2** | no |
| 6.2 – 8 | 7.3 – 9.4 | mercury, SVOCs and PCBs | na | na | na | ne | ne | ne |
| 8 – 10 | 9.4 – 11.8 | mercury | mercury | 0.53 | mg/kg dw | **1.3** | 0.90 | no |
| 10 – 11.7 | 11.8 – 13.8 | mercury | na | na | na | ne | ne | ne |
| **EW10-SC29** | | | | | | | | |
| 0 – 2 | 0 – 2.3 | SMS chemicals | cadmium | 7.3 | mg/kg dw | **1.4** | **1.1** | no |
| | | | mercury | 3.37 | mg/kg dw | **8.2** | **5.7** | no |
| | | | zinc | 854 | mg/kg dw | **2.1** | 0.89 | no |
| | | | acenaphthene | 850 | µg/kg dw | **1.7** | **1.2** | yes |
| | | | anthracene | 2,000 | µg/kg dw | **2.1** | 0.45 | yes |
| | | | benzo(a)anthracene | 2,500 | µg/kg dw | **1.9** | **1.6** | yes |
| | | | benzo(a)pyrene | 1,700 | µg/kg dw | **1.1** | 0.57 | yes |
| | | | total benzofluoranthenes | 3,400 | µg/kg dw | **1.1** | 0.94 | yes |
| | | | chrysene | 2,800 | µg/kg dw | **2.0** | **1.0** | yes |
| | | | dibenzo(a,h)anthracene | 240 | µg/kg dw | **1.0** | 0.44 | yes |
| | | | fluoranthene | 6,900 | µg/kg dw | **4.1** | **2.8** | yes |
| | | | pyrene | 6,600 | µg/kg dw | **2.5** | **2.0** | yes |
| | | | total HPAHs | 25,200 | µg/kg dw | **2.1** | **1.5** | yes |
| | | | BEHP | 1,400 | µg/kg dw | **1.1** | 0.74 | yes |
| | | | total PCBs | 10,000 | µg/kg dw | **77** | **10** | yes |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC29** | | | | | | | | |
| 2 – 3.9 | 2.3 – 4.4 | SMS chemicals | cadmium | 5.7 | mg/kg dw | **1.1** | 0.85 | no |
| | | | mercury | 2.41 | mg/kg dw | **5.9** | **4.1** | no |
| | | | zinc | 546 | mg/kg dw | **1.3** | 0.57 | no |
| | | | 2-methylnaphthalene | 4,400 | µg/kg dw | **6.6** | **3.1** | yes |
| | | | acenaphthene | 6,800 | µg/kg dw | **14** | **9.3** | yes |
| | | | anthracene | 4,300 | µg/kg dw | **4.5** | 0.98 | yes |
| | | | benzo(a)anthracene | 1,900 | µg/kg dw | **1.5** | **1.2** | yes |
| | | | chrysene | 2,000 | µg/kg dw | **1.4** | 0.71 | yes |
| | | | dibenzofuran | 4,000 | µg/kg dw | **7.4** | **5.7** | yes |
| | | | fluoranthene | 8,700 | µg/kg dw | **5.1** | **3.5** | yes |
| | | | fluorene | 5,200 | µg/kg dw | **9.6** | **5.2** | yes |
| | | | naphthalene | 17,000 | µg/kg dw | **8.1** | **7.1** | yes |
| | | | phenanthrene | 7,000 | µg/kg dw | **4.7** | **1.3** | yes |
| | | | pyrene | 4,600 | µg/kg dw | **1.8** | **1.4** | yes |
| | | | total HPAHs | 22,400 | µg/kg dw | **1.9** | **1.3** | yes |
| | | | total LPAHs | 40,000 | µg/kg dw | **7.7** | **3.1** | yes |
| | | | 2,4-dimethylphenol | 71 | µg/kg dw | **2.4** | **2.4** | no |
| 9.7 – 11.7 | 10.9 – 13.2 | SMS chemicals | acenaphthene | 54 | mg/kg OC | **3.4** | 0.95 | no |
| | | | dibenzofuran | 39 | mg/kg OC | **2.6** | 0.67 | no |
| | | | fluorene | 59 | mg/kg OC | **2.6** | 0.75 | no |
| | | | phenanthrene | 230 | mg/kg OC | **2.3** | 0.48 | no |
| | | | total LPAHs | 440 | mg/kg OC | **1.2** | 0.56 | no |
| **EW10-SC30** | | | | | | | | |
| 0 – 2 | 0 – 2.0 | SMS chemicals | mercury | 0.53 | mg/kg dw | **1.3** | 0.90 | no |
| | | | total PCBs | 39 | mg/kg OC | **3.3** | 0.60 | no |
| 2 – 4.3 | 2.0 – 4.4 | SMS chemicals | mercury | 0.45 | mg/kg dw | **1.1** | 0.76 | no |
| | | | total PCBs | 38 | mg/kg OC | **3.2** | 0.58 | no |
| 4.3 – 6 | 4.4 – 6.1 | mercury and PCBs | total PCBs | 32 | mg/kg OC | **2.7** | 0.49 | no |
| 6 – 8 | 6.1 – 8.2 | mercury and PCBs | na | na | na | ne | ne | ne |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | | | | | Exceedance Factor[a] | | |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | Chemicals Analyzed | Chemical | Concentration | Unit | SQS/SL | CSL/ML | AET Substitution |
| **EW10-SC31** | | | | | | | | |
| 0.7 – 2.7 | 0.7 – 2.9 | SMS chemicals | total PCBs | 38 | mg/kg OC | **3.2** | 0.58 | no |
| 2.7 – 5.3 | 2.9 – 5.7 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC32** | | | | | | | | |
| 0 – 2 | 0 – 2.0 | SMS chemicals | cadmium | 6.1 | mg/kg dw | **1.2** | 0.91 | no |
| | | | mercury | 1.27 | mg/kg dw | **3.1** | **2.2** | no |
| | | | zinc | 599 | mg/kg dw | **1.5** | 0.62 | no |
| | | | acenaphthene | 35 | mg/kg OC | **2.2** | 0.61 | no |
| | | | dibenzofuran | 24 | mg/kg OC | **1.6** | 0.41 | no |
| | | | fluorene | 38 | mg/kg OC | **1.7** | 0.48 | no |
| | | | BEHP | 60 | mg/kg OC | **1.3** | 0.77 | no |
| | | | 2,4-dimethylphenol | 38 | µg/kg dw | **1.3** | **1.3** | no |
| | | | total PCBs | 120 | mg/kg OC | **10** | **1.8** | no |
| 2 – 4 | 2.0 – 4.0 | SMS chemicals | cadmium | 6.9 | mg/kg dw | **1.4** | **1.0** | no |
| | | | mercury | 2.95 | mg/kg dw | **7.2** | **5.0** | no |
| | | | silver | 6.8 | mg/kg dw | **1.1** | **1.1** | no |
| | | | zinc | 623 | mg/kg dw | **1.5** | 0.65 | no |
| | | | acenaphthene | 1,400 | µg/kg dw | **2.8** | **1.9** | yes |
| | | | anthracene | 1,400 | µg/kg dw | **1.5** | 0.32 | yes |
| | | | chrysene | 1,900 | µg/kg dw | **1.4** | 0.68 | yes |
| | | | dibenzofuran | 730 | µg/kg dw | **1.4** | **1.0** | yes |
| | | | fluoranthene | 5,000 | µg/kg dw | **2.9** | **2.0** | yes |
| | | | fluorene | 1,700 | µg/kg dw | **3.1** | **1.7** | yes |
| | | | phenanthrene | 5,000 | µg/kg dw | **3.3** | 0.93 | yes |
| | | | pyrene | 3,700 | µg/kg dw | **1.4** | **1.1** | yes |
| | | | total HPAHs | 15,400 | µg/kg dw | **1.3** | 0.91 | yes |
| | | | total LPAHs | 9,800 | µg/kg dw | **1.9** | 0.75 | yes |
| | | | butyl benzyl phthalate | 67 | µg/kg dw | **1.1** | 0.074 | yes |
| | | | 1,2,4-trichlorobenzene | 62 | µg/kg dw | **2.0** | **1.2** | yes |
| | | | 2,4-dimethylphenol | 41 J | µg/kg dw | **1.4** | **1.4** | no |
| | | | total PCBs | 6,200 | µg/kg dw | **48** | **6.2** | yes |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC32** | | | | | | | | **EW10-SC31** |
| 8.9 – 10.9 | 9.0 – 11 | SMS chemicals | na | na | na | ne | ne | ne |
| 10.9 – 12.9 | 11 – 13 | mercury | na | na | na | ne | ne | ne |
| **EW10-SC33** | | | | | | | | |
| 0 – 2 | 0 – 2.1 | SMS chemicals and organometals | cadmium | 5.3 | mg/kg dw | **1.0** | 0.79 | no |
| | | | mercury | 1.95 J | mg/kg dw | **4.8** | **3.3** | no |
| | | | zinc | 578 | mg/kg dw | **1.4** | 0.60 | no |
| | | | total PCBs | 98 | mg/kg OC | **8.2** | **1.5** | no |
| 2 – 3.5 | 2.1 – 3.7 | SMS chemicals and organometals | mercury | 0.99 J | mg/kg dw | **2.4** | **1.7** | no |
| | | | zinc | 494 | mg/kg dw | **1.2** | 0.51 | no |
| | | | acenaphthene | 18 | mg/kg OC | **1.1** | 0.32 | no |
| | | | fluoranthene | 210 | mg/kg OC | **1.3** | 0.18 | no |
| | | | BEHP | 59 | mg/kg OC | **1.3** | 0.76 | no |
| | | | total PCBs | 160 | mg/kg OC | **13** | **2.5** | no |
| 5.8 – 8 | 6.1 – 8.4 | SMS chemicals | na | na | na | ne | ne | ne |
| 8 – 9.8 | 8.4 – 10.2 | mercury | na | na | na | ne | ne | ne |
| **EW10-SC34** | | | | | | | | |
| 0.2 – 2.4 | 0.2 – 2.6 | SMS chemicals | na | na | na | ne | ne | ne |
| 2.4 – 3.9 | 2.6 – 4.2 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC35** | | | | | | | | |
| 0 – 2 | 0 – 2.1 | SMS chemicals | BEHP | 130 | mg/kg OC | **2.8** | **1.7** | no |
| | | | total PCBs | 55 | mg/kg OC | **4.6** | 0.85 | no |
| 2 – 4 | 2.1 – 4.2 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC36** | | | | | | | | |
| 0.9 – 3 | 1.0 – 3.3 | SMS chemicals and organometals | total PCBs | 17.7 J | mg/kg OC | **1.5** | 0.27 | no |
| 3 – 5 | 3.3 – 5.6 | SMS chemicals and organometals | na | na | na | ne | ne | ne |
| **EW10-SC37** | | | | | | | | |
| 0 – 2 | 0 – 2.1 | SMS chemicals and organometals | total PCBs | 66 | mg/kg OC | **5.5** | **1.0** | no |
| 2 – 3.9 | 2.1 – 4.0 | SMS chemicals and organometals | na | na | na | ne | ne | ne |

Table 4-9. **Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC38** | | | | | | | | |
| 0 – 0.8 | 0 – 0.8 | SMS chemicals | na | na | na | ne | ne | ne |
| 0.8 – 2 | 0.8 – 2.1 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC39** | | | | | | | | |
| 0 – 2 | 0 – 2.1 | SMS chemicals and pesticides | total PCBs | 30.8 | mg/kg OC | **2.6** | 0.47 | no |
| 2 – 3.4 | 2.1 – 3.6 | SMS chemicals and pesticides | na | na | na | ne | ne | ne |
| **EW10-SC40** | | | | | | | | |
| 0 – 1 | 0 – 1.1 | SMS chemicals and organometals | mercury | 0.82 | mg/kg dw | **2.0** | **1.4** | no |
| | | | total PCBs | 31 | mg/kg OC | **2.6** | 0.48 | no |
| 1 – 4 | 1.1 – 4.2 | SMS chemicals and organometals | mercury | 0.57 | mg/kg dw | **1.4** | 0.97 | no |
| 4 – 6.8 | 4.2 – 7.2 | mercury and PCBs | na | na | na | ne | ne | ne |
| 6.8 – 8 | 7.2 – 8.4 | mercury | na | na | na | ne | ne | ne |
| **EW10-SC41** | | | | | | | | |
| 0 – 0.6 | 0 – 0.6 | SMS chemicals | na | na | na | ne | ne | ne |
| 0.6 – 2 | 0.6 – 2.0 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC42** | | | | | | | | |
| 0 – 2 | 0 – 2.0 | SMS chemicals | mercury | 0.83 | mg/kg dw | **2.0** | **1.4** | no |
| | | | total PCBs | 63.0 | mg/kg OC | **5.3** | 0.97 | no |
| 2 – 4 | 2.0 – 4.1 | SMS chemicals | mercury | 1.52 | mg/kg dw | **3.7** | **2.6** | no |
| | | | total PCBs | 54.1 | mg/kg OC | **4.5** | 0.83 | no |
| 4 – 5.5 | 4.1 – 5.6 | mercury and PCBs | mercury | 0.42 | mg/kg dw | **1.0** | 0.71 | no |
| 5.5 – 8 | 5.6 – 8.1 | mercury | na | na | na | ne | ne | ne |
| 8 – 10 | 8.1 – 10.1 | mercury | na | na | na | ne | ne | ne |
| **EW10-SC43** | | | | | | | | |
| 0 – 1.3 | 0 – 1.5 | SMS chemicals and organometals | total PCBs | 62.2 | mg/kg OC | **5.2** | 0.96 | no |
| 1.3 – 4 | 1.5 – 4.6 | SMS chemicals and organometals | total PCBs | 78.9 | mg/kg OC | **6.6** | **1.2** | no |
| 4 – 6 | 4.6 – 6.9 | PCBs | na | na | na | ne | ne | ne |
| 6 – 8 | 6.9 – 9.3 | PCBs | na | na | ne | ne | ne | ne |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC44** | | | | | | | | |
| 0 – 2 | 0 – 2.0 | SMS chemicals and organometals | na | na | na | ne | ne | ne |
| 2 – 4 | 2.0 – 4.0 | SMS chemicals and organometals | na | na | na | ne | ne | ne |
| **EW10-SC45** | | | | | | | | |
| 0 – 1 | 0 – 1.0 | SMS chemicals | na | na | na | ne | ne | ne |
| 1 – 1.7 | 1.0 – 1.7 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC46** | | | | | | | | |
| 0 – 2.3 | 0 – 2.5 | SMS chemicals and organometals | na | na | na | ne | ne | ne |
| 2.3 – 4 | 2.5 – 4.3 | SMS chemicals and organometals | na | na | na | ne | ne | ne |
| **EW10-SC47** | | | | | | | | |
| 0 – 2 | 0 – 2.4 | SMS chemicals and organometals | mercury | 0.64 | mg/kg dw | **1.6** | **1.1** | no |
| | | | total PCBs | 240 | mg/kg OC | **20** | **3.7** | no |
| 2 – 3.6 | 2.4 – 4.5 | SMS chemicals and organometals | mercury | 0.48 | mg/kg dw | **1.2** | 0.81 | no |
| | | | total PCBs | 17.4 J | mg/kg OC | **1.5** | 0.27 | no |
| 3.6 – 6 | 4.5 – 7.1 | mercury and PCBs | na | na | na | ne | ne | ne |
| 6 – 8 | 7.1 – 9.5 | mercury | na | na | na | ne | ne | ne |
| **EW10-SC48** | | | | | | | | |
| 0 – 2 | 0 – 2.1 | SMS chemicals | mercury | 0.49 J | mg/kg dw | **1.2** | 0.83 | no |
| | | | BEHP | 54 | mg/kg OC | **1.1** | 0.69 | no |
| | | | total PCBs | 107 | mg/kg OC | **8.9** | **1.6** | no |
| 2 – 4.7 | 2.1 – 4.9 | SMS chemicals | cadmium | 5.5 | mg/kg dw | **1.1** | 0.82 | no |
| | | | mercury | 1.40 J | mg/kg dw | **3.4** | **2.4** | no |
| | | | total PCBs | 120 | mg/kg OC | **10** | **1.8** | no |
| 4.7 – 6 | 4.9 – 6.2 | Metals and PCBs | mercury | 0.76 | mg/kg dw | **1.9** | **1.3** | no |
| | | | total PCBs | 21 | mg/kg OC | **1.8** | 0.32 | no |
| 6 – 8 | 6.2 – 8.3 | mercury and PCBs | na | na | na | ne | ne | ne |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC49** | | | | | | | | |
| 0 – 1.6 | 0 – 1.6 | SMS chemicals and organometals | mercury | 0.54 | mg/kg dw | **1.3** | 0.92 | no |
| | | | BEHP | 140 | mg/kg OC | **3.0** | **1.8** | no |
| | | | total PCBs | 36 | mg/kg OC | **3.0** | 0.55 | no |
| 1.6 – 4 | 1.6 – 4.0 | SMS chemicals and organometals | na | na | na | ne | ne | ne |
| **EW10-SC50** | | | | | | | | |
| 0 – 1.6 | 0 – 1.9 | SMS chemicals and organometals | lead | 1,450 J | mg/kg dw | **3.2** | **2.7** | no |
| | | | mercury | 2.09 J | mg/kg dw | **5.1** | **3.5** | no |
| | | | zinc | 1,020 | mg/kg dw | **2.5** | **1.1** | no |
| | | | total PCBs | 26 J | mg/kg OC | **2.2** | 0.40 | no |
| 1.6 – 4 | 1.9 – 4.7 | SMS chemicals and organometals | na | na | na | ne | ne | ne |
| **EW10-SC51** | | | | | | | | |
| 0 – 2 | 0 – 2.3 | SMS chemicals and organometals | na | na | na | ne | ne | ne |
| 2 – 3.8 | 2.3 – 4.3 | SMS chemicals and organometals | na | na | na | ne | ne | ne |
| **EW10-SC52** | | | | | | | | |
| 0 – 2 | 0 – 2.2 | SMS chemicals | mercury | 0.64 J | mg/kg dw | **1.6** | **1.1** | no |
| | | | BEHP | 94 | mg/kg OC | **2.0** | **1.2** | no |
| | | | total PCBs | 160 | mg/kg OC | **13** | **2.5** | no |
| 2 – 4 | 2.2 – 4.4 | SMS chemicals | total PCBs | 22.9 | mg/kg OC | **1.9** | 0.35 | no |
| 4 – 6 | 4.4 – 6.6 | PCBs | na | na | na | ne | ne | ne |
| **EW10-SC53** | | | | | | | | |
| 0 – 2 | 0 – 2.3 | SMS chemicals | total PCBs | 68 | mg/kg OC | **5.7** | **1.0** | no |
| 2 – 4 | 2.3 – 4.6 | SMS chemicals | total PCBs | 162 | mg/kg OC | **14** | **2.5** | no |
| 5 – 7 | 5.7 – 8.0 | PCBs | na | na | na | ne | ne | ne |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC54** | | | | | | | | |
| 0 – 2 | 0 – 2.8 | SMS chemicals and pesticides | lead | 535 J | mg/kg dw | **1.2** | **1.0** | no |
| | | | mercury | 0.58 J | mg/kg dw | **1.4** | 0.98 | no |
| | | | zinc | 664 | mg/kg dw | **1.6** | 0.69 | no |
| | | | 2-methylnaphthalene | 53 | mg/kg OC | **1.4** | 0.83 | no |
| | | | acenaphthene | 110 | mg/kg OC | **6.9** | **1.9** | no |
| | | | benzo(a)anthracene | 270 | mg/kg OC | **2.5** | **1.0** | no |
| | | | benzo(a)pyrene | 280 | mg/kg OC | **2.8** | **1.3** | no |
| | | | benzo(g,h,i)perylene | 75 | mg/kg OC | **2.4** | 0.96 | no |
| | | | total benzofluoranthenes | 450 | mg/kg OC | **2.0** | **1.0** | no |
| | | | chrysene | 280 | mg/kg OC | **2.5** | 0.61 | no |
| | | | dibenzo(a,h)anthracene | 49 | mg/kg OC | **4.1** | **1.5** | no |
| | | | dibenzofuran | 40 | mg/kg OC | **2.7** | 0.69 | no |
| | | | fluoranthene | 700 | mg/kg OC | **4.4** | 0.58 | no |
| | | | fluorene | 120 | mg/kg OC | **5.2** | **1.5** | no |
| | | | indeno(1,2,3-cd)pyrene | 80 | mg/kg OC | **2.4** | 0.91 | no |
| | | | phenanthrene | 640 | mg/kg OC | **6.4** | **1.3** | no |
| | | | total HPAHs | 2,900 | mg/kg OC | **3.0** | 0.55 | no |
| | | | total LPAHs | 1,200 | mg/kg OC | **3.2** | **1.5** | no |
| | | | BEHP | 75 | mg/kg OC | **1.6** | 0.96 | no |
| | | | butyl benzyl phthalate | 7.0 | mg/kg OC | **1.4** | 0.11 | no |
| | | | 2,4-dimethylphenol | 130 | µg/kg dw | **4.5** | **4.5** | no |
| | | | 2-methylphenol | 82 | µg/kg dw | **1.3** | **1.3** | no |
| | | | total PCBs | 110 | mg/kg OC | **9.2** | **1.7** | no |
| | | | total DDTs | 300 | µg/kg dw | **43** | **4.3** | no |
| | | | total chlordane | 33 | µg/kg dw | **3.3** | | no |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | | | | | Exceedance Factor[a] | | |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | Chemicals Analyzed | Chemical | Concentration | Unit | SQS/SL | CSL/ML | AET Substitution |
| **EW10-SC54** | | | | | | | | **EW10-SC54** |
| 2 – 4 | 2.8 – 5.7 | SMS chemicals and pesticides | cadmium | 6.2 | mg/kg dw | **1.2** | 0.93 | no |
| | | | mercury | 1.83 J | mg/kg dw | **4.5** | **3.1** | no |
| | | | zinc | 591 | mg/kg dw | **1.4** | 0.62 | no |
| | | | anthracene | 1,500 | µg/kg dw | **1.6** | 0.34 | yes |
| | | | benzo(a)anthracene | 2,800 | µg/kg dw | **2.2** | **1.8** | yes |
| | | | benzo(a)pyrene | 2,500 | µg/kg dw | **1.6** | 0.83 | yes |
| | | | benzo(g,h,i)perylene | 840 | µg/kg dw | **1.3** | **1.2** | yes |
| | | | total benzofluoranthenes | 4,600 | µg/kg dw | **1.4** | **1.3** | yes |
| | | | chrysene | 4,000 | µg/kg dw | **2.9** | **1.4** | yes |
| | | | dibenzo(a,h)anthracene | 400 J | µg/kg dw | **1.7** | 0.74 | yes |
| | | | fluoranthene | 7,500 | µg/kg dw | **4.4** | **3.0** | yes |
| | | | indeno(1,2,3-cd)pyrene | 850 | µg/kg dw | **1.4** | **1.2** | yes |
| | | | pyrene | 7,100 | µg/kg dw | **2.7** | **2.2** | yes |
| | | | total HPAHs | 30,600 J | µg/kg dw | **2.6** | **1.8** | yes |
| | | | butyl benzyl phthalate | 190 | µg/kg dw | **3.0** | 0.21 | yes |
| | | | total PCBs | 3,200 | µg/kg dw | **25** | **3.2** | yes |
| | | | total DDTs | 1,400 J | µg/kg dw | **200** | **20** | no |
| 8 – 9.2 | 11.3 – 13 | SMS chemicals and pesticides | acenaphthene | 25 | mg/kg OC | **1.6** | 0.44 | no |
| | | | dibenzofuran | 16 | mg/kg OC | **1.1** | 0.28 | no |
| **EW10-SC55** | | | | | | | | |
| 0 – 1.8 | 0 – 2.3 | SMS chemicals | total PCBs | 40 | mg/kg OC | **3.3** | 0.62 | no |
| 1.8 – 4 | 2.3 – 5.1 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC56** | | | | | | | | |
| 0 – 2 | 0 – 2.2 | SMS chemicals and organometals | na | na | na | ne | ne | ne |
| 2 – 4 | 2.2 – 4.3 | SMS chemicals and organometals | na | na | na | ne | ne | ne |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC57** | | | | | | | | |
| 0 – 2 | 0 – 2.0 | SMS chemicals and pesticides | acenaphthene | 28 | mg/kg OC | **1.8** | 0.49 | no |
| | | | benzo(a)anthracene | 130 | mg/kg OC | **1.2** | 0.48 | no |
| | | | benzo(a)pyrene | 180 | mg/kg OC | **1.8** | 0.86 | no |
| | | | total benzofluoranthenes | 340 | mg/kg OC | **1.5** | 0.76 | no |
| | | | chrysene | 170 | mg/kg OC | **1.5** | 0.37 | no |
| | | | dibenzo(a,h)anthracene | 14 | mg/kg OC | **1.2** | 0.42 | no |
| | | | fluoranthene | 290 | mg/kg OC | **1.8** | 0.24 | no |
| | | | phenanthrene | 180 | mg/kg OC | **1.8** | 0.38 | no |
| | | | total HPAHs | 1,730 | mg/kg OC | **1.8** | 0.33 | no |
| | | | 1,4-dichlorobenzene | 12 | mg/kg OC | **3.9** | **1.3** | no |
| | | | total PCBs | 48 | mg/kg OC | **4.0** | 0.74 | no |
| 2 – 4 | 2.0 – 4.1 | SMS chemicals and pesticides | na | na | na | ne | ne | ne |
| **EW10-SC58** | | | | | | | | |
| 0 – 1.8 | 0 – 2.0 | SMS chemicals | copper | 442 | mg/kg dw | **1.1** | **1.1** | no |
| | | | mercury | 1.23 | mg/kg dw | **3.0** | **2.1** | no |
| | | | zinc | 459 | mg/kg dw | **1.1** | 0.48 | no |
| | | | benzo(a)anthracene | 200 | mg/kg OC | **1.8** | 0.74 | no |
| | | | benzo(a)pyrene | 270 | mg/kg OC | **2.7** | **1.3** | no |
| | | | benzo(g,h,i)perylene | 45 | mg/kg OC | **1.5** | 0.58 | no |
| | | | total benzofluoranthenes | 600 | mg/kg OC | **2.6** | **1.3** | no |
| | | | chrysene | 310 | mg/kg OC | **2.8** | 0.67 | no |
| | | | dibenzo(a,h)anthracene | 25 | mg/kg OC | **2.1** | 0.76 | no |
| | | | indeno(1,2,3-cd)pyrene | 48 | mg/kg OC | **1.4** | 0.55 | no |
| | | | total HPAHs | 2,110 | mg/kg OC | **2.2** | 0.40 | no |
| | | | BEHP | 77 | mg/kg OC | **1.6** | 0.99 | no |
| | | | total PCBs | 120 J | mg/kg OC | **10** | **1.8** | no |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC58** | | | | | | | | |
| 1.8 – 4 | 2.0 – 4.4 | SMS chemicals | acenaphthene | 79 | mg/kg OC | **4.9** | **1.4** | no |
| | | | dibenzofuran | 39 | mg/kg OC | **2.6** | 0.67 | no |
| | | | fluoranthene | 500 J | mg/kg OC | **3.1** | 0.42 | no |
| | | | fluorene | 73 | mg/kg OC | **3.2** | 0.92 | no |
| | | | phenanthrene | 280 | mg/kg OC | **2.8** | 0.58 | no |
| | | | total HPAHs | 1,240 J | mg/kg OC | **1.3** | 0.23 | no |
| | | | total LPAHs | 540 | mg/kg OC | **1.5** | 0.69 | no |
| 6 – 8 | 4.4 – 6.7 | PAHs | na | na | na | ne | ne | ne |
| **EW10-SC59** | | | | | | | | |
| 0 – 2 | 0 – 2.0 | SMS chemicals and organometals | na | na | na | ne | ne | ne |
| 2 – 4 | 2.0 – 4.1 | SMS chemicals and organometals | na | na | na | ne | ne | ne |
| **EW10-SC60** | | | | | | | | |
| 0 – 0.8 | 0 – 0.9 | SMS chemicals | mercury | 0.69 | mg/kg dw | **1.7** | **1.2** | no |
| | | | total PCBs | 16 | mg/kg OC | **1.3** | 0.25 | no |
| 0.8 – 3 | 0.9 – 3.3 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC61** | | | | | | | | |
| 0 – 1 | 0 – 1.1 | SMS chemicals | total PCBs | 30 JN | mg/kg OC | **2.5** | 0.46 | no |
| 1 – 3 | 1.1 – 3.2 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC62** | | | | | | | | |
| 0 – 2 | 0 – 2.2 | SMS chemicals | na | na | na | ne | ne | ne |
| 2 – 3.3 | 2.2 – 3.6 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC63** | | | | | | | | |
| 0 – 2 | 0 – 2.1 | SMS chemicals | na | na | na | ne | ne | ne |
| 2 – 4 | 2.1 – 4.2 | SMS chemicals | na | na | na | ne | ne | ne |
| **EW10-SC100** | | | | | | | | |
| 0 – 1.1 | 0 – 1.1 | Organometals | na | na | na | ne | ne | ne |
| 1.1 – 3 | 1.1 – 3.1 | Organometals | na | na | na | ne | ne | ne |

**Table 4-9. Summary of results for chemicals with detected concentrations that exceeded SMS criteria or DMMP guidelines by sampling location (cont.)**

| Sampling Interval (ft) | | Chemicals Analyzed | Chemical | Concentration | Unit | Exceedance Factor[a] | | AET Substitution |
|---|---|---|---|---|---|---|---|---|
| Recovered Depth | In Situ Depth | | | | | SQS/SL | CSL/ML | |
| **EW10-SC101** | | | | | | | | |
| 0 – 2.3 | 0 – 2.4 | Organometals | na | na | na | ne | ne | ne |
| 2.3 – 4 | 2.4 – 4.2 | Organometals | na | na | na | ne | ne | ne |

[a] The exceedance factor is the ratio of detected concentration to SMS criteria or DMMP guidelines.

**Bold** indicates exceedance factors greater than one for the SQS/SL and greater than or equal to one for the CSL/ML

AET – apparent effects threshold
BEHP – bis(2-ethylhexyl) phthalate
CSL – cleanup screening level
DDT – dichlorodiphenyltrichloroethane
DMMP – Dredged Material Management Program
dw – dry weight
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
J – estimated concentration
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
ML – maximum level
N – tentative identification
na – not applicable
ne– no exceedances
OC– organic carbon
PCB – polychlorinated biphenyl
SL – screening level
SMS – Washington State Sediment Management Standards
SQS – sediment quality standards
SVOC – semivolatile organic compound

## 4.2 PHYSICAL RESULTS

This section presents the lithology and stratigraphy descriptions and the geotechnical results for the subsurface sediment cores.

### 4.2.1 Lithology and stratigraphy

The physical attributes of sediment strata are referred to as lithology and stratigraphy. Lithology refers to the physical characteristics of the sediment and consists of the dominant soil type (e.g., sand or silt), grain size percentages, texture (e.g., fine or medium grained), sorting (e.g., well sorted, poorly sorted, or mixed), shape and structure, and the color and mineralogy of particles (Krumbein and Sloss 1963). Stratigraphy defines the individual sediment beds or groups of beds differentiated above or below by unity of color, texture, or gross appearance (Krumbein and Sloss 1963). Stratigraphy is an interpretation based on lithology and site knowledge. The lithology of each core was recorded in the field according to nomenclature described in ASTM D-2488 (ASTM 2001b) and the core log field key (Appendix B). Lithology descriptions were determined and recorded on the basis of visual differences observed in the sediment profile, including features such as density, consistency, moisture content, color, composition, grain size, organic matter content, or other notable characteristics. Sediment was grouped into three stratigraphic units identified for the EW based primarily on density, color, sediment type, texture, and fill horizons (e.g., sand cover). Other information used to delineate these units included presence of anthropogenic matter, bathymetry, proximity to shoreline, and dredge events.
Maps 4-11a through 4-11d show the vertical stratigraphic profile of each core and depth below mudline. These data are also included on the core logs (Appendix B). The profile includes the following units:

- **Recent –** This upper unit consisted of recently deposited material dominated by unconsolidated organic silt and inorganic silt. The surface fraction of silt often contained up to 20% fine sand and 10% gravel. This material was characterized by higher moisture content, soft to medium stiff density, smooth and homogenous texture, and higher visible organic matter compared with the underlying materials. Shell fragments, decomposed wood, and anthropogenic materials were often present scattered throughout the unit (rather than in distinct layers as is common in lower units). A hydrogen sulfide odor was common.
- **Transition –** This middle unit formed a transition zone between Recent and Native units. A transition zone has characteristics that are neither Recent or Native but often a mix of the two. It consisted of a mixture of silty sand and sandy silt matrices with a higher density and a higher percentage of sand compared with those of the Recent unit. Within this matrix, stratified beds of silty sand or silt and lenses (pockets) of silt were also present. Organic silt, layers of decomposed wood, and shell fragments were often present. Some

multicolored sand grains (red, beige, black, white, and gray) were located within the units.

- **Native –** This lower unit was predominantly a sand matrix (95% and non-silty) with laminated and stratified beds of slightly silty to silty sand, and silt. The sand matrix consisted of multicolored grains of red, beige, black, white, and gray. Layers of undecomposed wood and shells were often present in the matrix. The native sand unit typically graded to stiff, inorganic silt as depth increased.
- **Other –** Other units are detailed below:
  - **Fill –** This upper unit was present in cores located in close proximity to the shoreline. The fill unit was dominated by light gray, subrounded, gravelly sand and sandy gravel. Gravel was up to 3 in. in diameter.
  - **Sand Cover –** The sand cover was placed between Stations 3000 to 4900 during the Phase I removal, which was completed in 2005, and was present in the top 1 ft of cores collected from this area. The sand cover was primarily very fine to very coarse-grained brown sand that was distinctly different in appearance from other strata within the EW as a result of color and sorting.

### 4.2.2 Geotechnical results

The grain size and specific gravity results for the samples that underwent geotechnical analysis are presented in (Table 4-10). Total fines ranged from 4.0 to 80.9%. The only sample with a substantial amount of gravel was the 5.5-to-7-ft interval of sample EW10-SB01, with 42.7% gravel.

**Table 4-10. Summary of grain size and specific gravity results for EW subsurface sediment samples that underwent geotechnical analysis**

| Sample ID | Sampling Interval (ft) | Total Gravel (% dw) | Total Sand (% dw) | Total Silt (% dw) | Total Clay (% dw) | Total Fines (percent silt+clay) (% dw) | Specific Gravity (SU dw) |
|---|---|---|---|---|---|---|---|
| EW10-SB01-2-3.5 | 2 – 3.5 | 4.3 | 34.2 | 38.5 | 22.9 | 61.4 | na |
| EW10-SB01-5.5-7 | 5.5 – 7 | 42.9 | 53.1 | 2.6 | 1.4 | 4.0 | na |
| EW10-SB01-10.5-12 | 10.5 – 12 | 5.0 | 77.3 | 12.5 | 5.3 | 17.8 | na |
| EW10-SB01-23-24.5 | 23 – 24.5 | 0.1 | 63.3 | 30.6 | 6.1 | 36.7 | 2.70 |
| EW10-SB01-28-29.5 | 28 – 29.5 | 0.1 U | 94.9 | 3.9 | 1.2 | 5.1 | na |
| EW10-SB01-30.5-32 | 30.5 – 32 | na | na | na | na | na | 2.68 |
| EW10-SB01-45-46.5 | 45 – 46.45 | 0.1 U | 83.5 | 13.8 | 7.1 | 20.9 | na |
| EW10-SB01-59-60.5 | 59 – 60.5 | 0.1 U | 36.1 | 54.7 | 9.1 | 63.8 | 2.70 |
| EW10-SB02-4-6A | 4 – 6 | 11.9 | 21.4 | 43.0 | 23.9 | 66.9 | na |
| EW10-SB02-14-15.5 | 14 – 15.5 | 1.4 | 14.1 | 64.6 | 19.9 | 84.5 | na |
| EW10-SB02-18.5-20 | 18.5 – 20 | na | na | na | na | na | 2.71 |
| EW10-SB02-19-20.5 | 19 – 20.5 | 0.1 | 53.7 | 39.2 | 7.0 | 46.2 | na |

| Sample ID | Sampling Interval (ft) | Total Gravel (% dw) | Total Sand (% dw) | Total Silt (% dw) | Total Clay (% dw) | Total Fines (percent silt+clay) (% dw) | Specific Gravity (SU dw) |
|---|---|---|---|---|---|---|---|
| EW10-SB02-28.5-30 | 28.5 – 30 | 0.1 U | 63.8 | 30.6 | 5.6 | 36.2 | na |
| EW10-SB02-50-51.5 | 50 – 51.5 | 0.1 | 19.2 | 67.8 | 13.1 | 80.9 | na |
| EW10-SB02-55-56.5 | 55 – 56.5 | na | na | na | na | na | 2.65 |
| EW10-SC05-2.1 | 2.1 | na | na | na | na | na | 2.62 |
| EW10-SC05-4.9 | 4.9 | na | na | na | na | na | 2.72 |
| EW10-SC11-3 | 3 | na | na | na | na | na | 2.67 |
| EW10-SC11-5 | 5 | na | na | na | na | na | 2.68 |
| EW10-SC11-6.7 | 6.7 | na | na | na | na | na | 2.68 |
| EW10-SC14-0.8 | 0.8 | na | na | na | na | na | 2.44 |
| EW10-SC14-2.4 | 2.4 | na | na | na | na | na | 2.67 |
| EW10-SC14-7.5 | 7.5 | na | na | na | na | na | 2.68 |
| EW10-SC20-5.5 | 5.5 | na | na | na | na | na | 2.70 |
| EW10-SC20-10.5 | 10.5 | na | na | na | na | na | 2.67 |
| EW10-SC22-1 | 1 | na | na | na | na | na | 2.69 |
| EW10-SC22-4 | 4 | na | na | na | na | na | 2.70 |
| EW10-SC30-2.0 | 2 | na | na | na | na | na | 2.51 |
| EW10-SC30-6.0 | 6 | na | na | na | na | na | 2.62 |
| EW10-SC30-10.8 | 10.8 | na | na | na | na | na | 2.67 |
| EW10-SC36-0.5 | 0.5 | na | na | na | na | na | 2.70 |
| EW10-SC36-1.4 | 1.4 | na | na | na | na | na | 2.64 |
| EW10-SC36-6 | 6 | na | na | na | na | na | 2.71 |
| EW10-SC43-0.5 | 0.5 | na | na | na | na | na | 2.64 |
| EW10-SC43-7.6 | 7.6 | na | na | na | na | na | 2.68 |
| EW10-SC48-2 | 2 | na | na | na | na | na | 2.40 |
| EW10-SC48-8.9 | 8.9 | na | na | na | na | na | 2.56 |
| EW10-SC51-2 | 2 | na | na | na | na | na | 2.54 |
| EW10-SC51-8.9 | 8.9 | na | na | na | na | na | 2.62 |
| EW10-SC56-2 | 2 | na | na | na | na | na | 2.68 |
| EW10-SC56-4 | 4 | na | na | na | na | na | 2.67 |
| EW10-SC56-8.5 | 8.5 | na | na | na | na | na | 2.67 |
| EW10-SC59-2 | 2 | na | na | na | na | na | 2.66 |
| EW10-SC59-3.5 | 3.5 | na | na | na | na | na | 2.64 |
| EW10-SC63-1.2 | 1.2 | na | na | na | na | na | 2.60 |
| EW10-SC63-3 | 3 | na | na | na | na | na | 2.59 |

dw – dry weight
EW – East Waterway
ID – identification
na – not applicable
SU – standard unit

Geotechnical analyses were performed on sediment from 13 cores that were spatially distributed throughout the EW (EW10-SC05, EW10-SC11, EW10-SC14, EW10-SC20, EW10-SC22, EW10-SC30, EW10-SC36, EW10-SC43, EW10-SC48, EW10-SC51, EW10-SC56, EW10-SC59, and EW10-SC63). Analyses included Atterberg limits (i.e., liquid limit, plastic limit, and plastic index), specific gravity, and bulk density (dry and wet); results are summarized by sampling interval in Table 4-11. Sample depths are also shown on the core logs (Appendix B). Geotechnical results for the borings collected using a hollow-stem auger in the mound area outside of Slip 27 are provided in Appendix I.

**Table 4-11. Summary of geotechnical results for EW subsurface sediment samples**

| Sample ID | Sampling Interval (ft) | Liquid Limit (% dw) | Plastic Limit (% dw) | Plasticity Index (% dw) | Bulk Density | | Moisture Content (geotechnical) (% dw) |
|---|---|---|---|---|---|---|---|
| | | | | | Dry (pcf) | Wet (pcf) | |
| EW10-SB01-2-3.5 | 2 – 3.5 | 57.5 | 31.5 | 26.0 | na | na | 84.74 |
| EW10-SB01-5.5-7 | 5.5 – 7 | na | na | na | na | na | 20.58 |
| EW10-SB01-9-10.5 | 9 – 10.5 | na | na | na | na | na | 7.20 |
| EW10-SB01-10.5-12 | 10.5 – 12 | na | na | na | na | na | 28.42 |
| EW10-SB01-14.5-16 | 14.5 – 16 | na | na | na | na | na | 26.82 |
| EW10-SB01-18-19.5 | 18 – 19.5 | na | na | na | na | na | 32.52 |
| EW10-SB01-21.5-23 | 21.5 – 23 | na | na | na | na | na | 27.34 |
| EW10-SB01-23-24.5 | 23 – 24.5 | na | na | na | na | na | 33.57 |
| EW10-SB01-26.5-28 | 26.5 – 28 | na | na | na | na | na | 27.09 |
| EW10-SB01-28-29.5 | 28 – 29.5 | na | na | na | na | na | 25.92 |
| EW10-SB01-30.5-32 | 30.5 – 32 | na | na | na | na | na | 31.78 |
| EW10-SB01-34-35.5 | 34 – 35.5 | na | na | na | na | na | 40.40 |
| EW10-SB01-40.5-42 | 40.5 – 42 | na | na | na | na | na | 33.57 |
| EW10-SB01-45-46.5 | 45 – 46.45 | na | na | na | na | na | 29.36 |
| EW10-SB01-51.5-53 | 51.5 – 53 | na | na | na | na | na | 35.27 |
| EW10-SB01-59-60.5 | 59 – 60.5 | na | na | na | na | na | 34.92 |
| EW10-SB02-2-4 | 2 – 4 | na | na | na | na | na | 91.73 |
| EW10-SB02-6-8 | 6 – 8 | 37.3 | 22.3 | 15.0 | na | na | 56.16 |
| EW10-SB02-14-15.5 | 14 – 15.5 | na | na | na | na | na | 49.48 |
| EW10-SB02-18.5-20 | 18.5 – 20 | na | na | na | na | na | 36.21 |
| EW10-SB02-19-20.5 | 19 – 20.5 | na | na | na | na | na | 37.20 |
| EW10-SB02-22.5-24 | 22.5 – 24 | na | na | na | na | na | 34.83 |
| EW10-SB02-28.5-30 | 28.5 – 30 | na | na | na | na | na | 35.45 |
| EW10-SB02-34.5-36 | 34.5 – 36 | na | na | na | na | na | 37.45 |
| EW10-SB02-40-41.5 | 40 – 41.5 | na | na | na | na | na | 41.56 |

| Sample ID | Sampling Interval (ft) | Liquid Limit (% dw) | Plastic Limit (% dw) | Plasticity Index (% dw) | Bulk Density | | Moisture Content (geotechnical) (% dw) |
|---|---|---|---|---|---|---|---|
| | | | | | Dry (pcf) | Wet (pcf) | |
| EW10-SB02-50-51.5 | 50 – 51.5 | na | na | na | na | na | 37.53 |
| EW10-SB02-55-56.5 | 55 – 56.5 | na | na | na | na | na | 37.25 |
| EW10-SB02-60-61.5 | 60 – 61.5 | 33.8 | 26.7 | 7.1 | na | na | 40.58 |
| EW10-SC05-2.1 | 2.1 | na | na | na | 77.7 | 95.5 | 22.94 |
| EW10-SC05-4.9 | 4.9 | na | na | na | 81.4 | 101.2 | 24.30 |
| EW10-SC11-3 | 3 | 88.7 | 31.4 | 57.3 | 37.8 | 79.4 | 110.3 |
| EW10-SC11-5 | 5 | 61.5 | 22.5 | 39.0 | 52.7 | 84.2 | 59.69 |
| EW10-SC11-6.7 | 6.7 | na | na | na | 83.4 | 105.6 | 26.56 |
| EW10-SC14-0.8 | 0.8 | 72.3 | 25.8 | 46.5 | 34.1 | 66.7 | 95.70 |
| EW10-SC14-2.4 | 2.4 | na | na | na | 92.4 | 106.6 | 15.36 |
| EW10-SC14-7.5 | 7.5 | na | na | na | 78.2 | 99.8 | 27.67 |
| EW10-SC20-5.5 | 5.5 | 32.0 | 24.2 | 7.8 | 84.0 | 114.3 | 36.01 |
| EW10-SC20-10.5 | 10.5 | na | na | na | 83.7 | 107.8 | 28.73 |
| EW10-SC22-1 | 1 | na | na | na | 89.0 | 119.4 | 34.23 |
| EW10-SC22-4 | 4 | na | na | na | 85.4 | 110.3 | 29.13 |
| EW10-SC30-2.0 | 2 | 68.5 | 29.4 | 39.1 | 39.8 | 72.4 | 82.02 |
| EW10-SC30-6.0 | 6 | na | na | na | 80.6 | 106.6 | 32.21 |
| EW10-SC30-10.8 | 10.8 | na | na | na | 83.3 | 107.1 | 28.59 |
| EW10-SC36-0.5 | 0.5 | na | na | na | 96.6 | 109.7 | 13.61 |
| EW10-SC36-1.4 | 1.4 | na | na | na | 78.4 | 103.7 | 32.28 |
| EW10-SC36-6 | 6 | na | na | na | 85.0 | 107.9 | 26.96 |
| EW10-SC43-0.5 | 0.5 | na | na | na | 83.4 | 117.2 | 40.55 |
| EW10-SC43-7.6 | 7.6 | na | na | na | 98.8 | 124.6 | 26.17 |
| EW10-SC48-2 | 2 | 78.7 | 26.0 | 52.8 | 46.9 | 85.2 | 81.61 |
| EW10-SC48-8.9 | 8.9 | na | na | na | 82.0 | 107.6 | 31.27 |
| EW10-SC51-2 | 2 | na | na | na | 67.6 | 93.7 | 38.52 |
| EW10-SC51-8.9 | 8.9 | na | na | na | 69.8 | 90.5 | 29.64 |
| EW10-SC56-2 | 2 | na | na | na | 54.4 | 72.0 | 32.46 |
| EW10-SC56-4 | 4 | na | na | na | 75.1 | 102.6 | 36.62 |
| EW10-SC56-8.5 | 8.5 | na | na | na | 84.8 | 111.9 | 31.92 |
| EW10-SC59-2 | 2 | na | na | na | 81.9 | 106.0 | 29.46 |
| EW10-SC59-3.5 | 3.5 | na | na | na | 80.3 | 107.3 | 33.55 |
| EW10-SC63-1.2 | 1.2 | na | na | na | 60.2 | 81.6 | 35.56 |
| EW10-SC63-3 | 3 | 37.0 | 28.8 | 8.2 | 69.6 | 98.9 | 42.06 |

dw – dry weight
EW – East Waterway
ID – identification
na – not analyzed
pcf – pounds per cubic foot

## 4.3 CHEMICAL DATA VALIDATION RESULTS

The chemical analyses were conducted using the sample delivery group (SDG) assignments listed in Table 4-12. Independent data validation was performed on all results by EcoChem. A minimum of 20% of sediment results per analysis underwent full-level data validation; the rest of the sediment results underwent summary-level data validation. The level of data validation performed by EcoChem met the requirements specified in the subsurface sediment QAPP (Windward 2010).

The data validation included a review of all quality control summary forms, including initial calibration, continuing calibration verification (CCV), internal standard, surrogate, laboratory control sample (LCS), laboratory control sample duplicate (LCSD), matrix spike/ matrix spike duplicate (MS/MSD), standard reference material (SRM), and interference check sample summary forms. The majority of the data did not require qualification or were qualified with a J, indicating an estimated value. Twenty-six results for twelve chemicals were rejected as a result of data validation. Rejected results will not be used for any purpose. Based on the information reviewed, the overall data quality was considered acceptable for all uses, as qualified. Issues that resulted in the qualification of data are summarized below. Detailed information regarding every qualified sample is presented in Appendix D.

**Table 4-12. Level of data validation performed and numbers of samples in each SDG for EW subsurface sediment samples**

| SDG | Laboratory | Validation Level | Numbers of Sediment Samples Analyzed | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | PCBs | SVOCs | Mercury | Other Metals | Butyltins | Pesticides | TOC and Total Solids | Grain Size | Geotechnical Parameters[a] |
| QP28 | ARI | full | 4 | 4 | 4 | 4 | 0 | 0 | 4 | 4 | 0 |
| QP39 | ARI | full | 3 | 3 | 3 | 3 | 0 | 0 | 3 | 3 | 0 |
| QL24 | ARI | summary | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| QL26 | ARI | compliance screening | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| QL56 | ARI | full | 18 | 18 | 18 | 18 | 0 | 0 | 18 | 18 | 0 |
| QL84 | ARI | summary | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| QL86 | ARI | full | 20 | 20 | 20 | 20 | 0 | 0 | 20 | 20 | 0 |
| QM30 | ARI | summary | 20 | 20 | 20 | 20 | 0 | 0 | 20 | 20 | 0 |
| QM44 | ARI | full | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| QM57 | ARI | summary | 20 | 20 | 20 | 20 | 0 | 0 | 24 | 24 | 0 |
| QM68 | ARI | full | 0 | 0 | 0 | 0 | 18 | 0 | 0 | 0 | 0 |
| QM75 | ARI | summary | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| QM80 | ARI | summary | 14 | 14 | 14 | 14 | 0 | 0 | 14 | 14 | 0 |
| QN06 | ARI | summary | 20 | 20 | 20 | 20 | 0 | 0 | 20 | 20 | 0 |
| QN38 | ARI | summary | 18 | 18 | 18 | 18 | 0 | 0 | 18 | 18 | 0 |
| QN43 | ARI | summary | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| QO05 | ARI | full/summary | 0 | 0 | 0 | 0 | 10S | 8 F | 0 | 0 | 0 |
| QO07 | ARI | summary | 0 | 0 | 0 | 0 | 14 | 2 | 0 | 0 | 0 |
| RB27 | ARI | full/summary | 11 S | 6 F | 20S | 2 S | 0 | 0 | 20 S | 0 | 0 |
| RB28 | ARI | full/summary | 10 S | 9 F | 20 F | 5 F | 0 | 0 | 21 F | 0 | 0 |
| RB29 | ARI | full/summary | 12 F | 4 F | 14 S | 3 S[c] | 0 | 0 | 20 S | 0 | 0 |
| RB47 | ARI | summary | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 |
| RH22 | ARI | summary | 7 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| SDG | Laboratory | Validation Level | Numbers of Sediment Samples Analyzed | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | PCBs | SVOCs | Mercury | Other Metals | Butyltins | Pesticides | TOC and Total Solids | Grain Size | Geotechnical Parameters[a] |
| RN92 | ARI | summary | 0 | 1[d] | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| K1008332 | CAS | full | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| Percentage of samples that underwent full validation | | | 32% | 40% | 44% | 34% | 42% | 77% | 31% | 32% | 23% |

[a] Geotechnical parameters included specific gravity, bulk density (wet and dry), and Atterberg limits.

[b] Two samples from SDG RB27 were analyzed for cadmium.

[c] One sample from SDG RB29 was analyzed for cadmium.

[d] One sample from SDG RN92 was analyzed for PAHs.

ARI – Analytical Resources, Inc.

CAS – Columbia Analytical Services, Inc.

F – full validation

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

S – summary validation

SVOC – semivolatile organic compound

TOC – total organic carbon

SDG – sample delivery group

SVOC – semivolatile organic compound

### 4.3.1 SVOCs and organometals

- One hundred and ten results for benzyl alcohol were rejected because of extremely low LCS recoveries (less than 10%). This chemical is known to be difficult to quantify in sediment, so no re-analysis was performed.
- Results for the following chemicals were rejected because of extremely low MS/MSD recoveries (less than 10%): 2 results for 4-chloroaniline; 3 results for aniline; 2 results for 3,3-dichlorobenzidine; 4 results for hexachlorocyclopentadiene; 2 results for benzyl alcohol; 2 results for pentachlorophenol; and 1 result each for 3-nitroaniline, 4-nitroaniline, 4-nitrophenol, and 4-chloro-3-methylphenol. Associated LCS recoveries were acceptable, so no re-analysis was performed. Only the results for the sample spiked to create the MS/MSD were rejected; other samples in the batch were not qualified.
- Results for the following two chemicals were requalified as non-detected (U-qualified) because of method blank contamination: BEHP (33 results ranging from 17 to 880 µg/kg dw), pyrene (1 result at 37 µg/kg dw).
- Results for various chemicals were qualified as estimated (J- or UJ-qualified) because CCV, LCS/LCSD, MS/MSD, SRM, or surrogate percent recoveries or relative percent differences (RPDs) were outside of control limits. Results qualified as estimated included the following: 111 results for pentachlorophenol, 62 results for 2,4-dimethylphenol, 61 results for hexachlorocyclopentadiene, 40 results for dibenzo(a,h)anthracene, 32 results for benzyl alcohol, 20 results for 2-nitrophenol, 15 results for bis(2-chloroisopropyl)ether, 14 results for dibutyltin, 14 results for tributyltin, 11 results for n-nitrosodiphenylamine, 9 results for butyl benzyl phthalate, 7 results for fluoranthene, 3 results for benzo(g,h,i)perylene, 3 results for dimethylphthalate, 2 results for 1,2,4-trichlorobenzene, 2 results for 2-methylphenol, 2 results for chrysene, 2 results for indeno(1,2,3-cd)pyrene, and 1 result each for 1-methylnaphthalene, 2,4,6-trichlorophenol, 2-methylnaphthalene, 3-nitroaniline, 4-chloroaniline, 4-nitroaniline, acenaphthene, aniline, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzoic acid, carbazole, dibenzofuran, di-n-octyl phthalate, fluorene, naphthalene, phenanthrene, and phenol.
- Fifteen results for dibenzo(a,h)anthracene were J- or UJ-qualified as estimated because the associated internal standard recoveries were outside of control limits.
- Five other SVOCs were qualified by ARI to indicate that chromatographic interference in the sample prevented adequate resolution of the compound at the standard RLs (Y-qualified). The Y-qualified results were U-qualified during data validation, including: 32 results for n-nitrosodiphenylamine, 11 results for n-nitroso-di-n-propylamine, 2 results for 2,4-dimethylphenol, and 1 result each for 2-methylphenol and pentachlorophenol.

### 4.3.2 Metals

- Results for various chemicals were J- or UJ-qualified as estimated because MS/MSD recoveries or laboratory replicate RPDs were outside of control limits. J- or UJ-qualified results included: 144 results for antimony, 14 results for arsenic, 32 results for copper, 14 results for lead, 34 results for mercury, and 18 results for zinc.

### 4.3.3 Pesticides

- Two results for aldrin were rejected because the internal standard recoveries for aldrin-$^{13}C_{12}$ were outside of control limits.
- Two results for delta-benzene hexachloride (BHC) were rejected because of extremely low LCS recoveries (less than 10%).
- The RPDs between the results of dual-column analyses for 4,4′-DDE and 2,4′-DDE, in one sample for each chemical, were greater than the control limit of ± 40%. These results were J-qualified to indicate estimated concentrations.
- One result for 4,4′-DDD was J-qualified as estimated because the result exceeded the calibrated linear range of the analytical instrument.
- Four chemicals were qualified by ARI to indicate that non-target background interference in the sample prevented adequate resolution of the compound at the standard RLs (Y-qualified). The Y-qualified results were U-qualified during data validation, including: 4 results for 4,4′-DDT, 2 results for gamma chlordane, 1 result for delta-BHC, and 1 result for heptachlor epoxide.
- One result for hexachlorobenzene was U-qualified because of method blank contamination.

### 4.3.4 PCBs

- The RPDs between the results of dual-column analyses for several Aroclors were greater than the control limit of ± 40%. These results were J- or NJ-qualified to indicate estimated concentrations. Qualified results included: 9 results for Aroclor 1254, 8 results for Aroclor 1248, and 1 result for Aroclor 1242.
- One result for Aroclor 1260 was J-qualified as estimated because MS/MSD recoveries were outside of control limits.
- When more than one Aroclor is present in a sample, the potential exists for a high bias from the contribution of one Aroclor to another caused by common peaks or peaks that cannot be completely resolved. Analytical peaks are selected, and Aroclor ID is made based on the best resolution possible for that particular sample. In this analysis, Aroclor concentrations were reported based on the individual Aroclors that provided the best match to the observed sample pattern. Thirteen results for two different Aroclors were Y-qualified by the laboratory as

non-detects at elevated RLs because of overlapping Aroclor patterns. The Y-qualifier indicated that chromatographic interference in the sample prevented adequate resolution of the compound at the standard RLs. These results were U-qualified during data validation.

### 4.3.5 Conventionals and grain size

No qualification of data was necessary.

# 5 References


ASTM. 2001a. Standard practice for classification of soils for engineering purposes (unified soil classification system). D 2487-00. ASTM annual book of standards. Vol 04.08. American Society for Testing and Materials, Consohocken, PA.

ASTM. 2001b. Standard practice for description and identification of soils (visual-manual procedure). D 2488-00. ASTM annual book of standards. Vol 04.08. American Society for Testing and Materials, Consohocken, PA.

Ecology. 1995. Sediment management standards. WAC 173-204. Washington State Department of Ecology, Toxics Cleanup Program, Sediment Management Unit, Olympia, WA.

Krumbein WC, Sloss LL. 1963. Stratigraphy and sedimentation. 2nd ed. W.H. Freeman and Co., San Francisco, CA.

Plumb R, Jr. 1981. Procedures for handling and chemical analysis of sediment and water samples. Waterways Experiment Station, US Army Corps of Engineers, Vicksburg, MS.

PTI. 1988. Sediment quality values refinement: Volume I. Update and evaluation of Puget Sound AET. Prepared for Puget Sound Estuary Program (PSEP), US Environmental Protection Agency, Region 10. PTI Environmental Services, Inc., Bellevue, WA.

Windward. 2010. Quality assurance project plan: subsurface sediment sampling for chemical analyses and toxicity testing of the East Waterway. East Waterway Operable Unit supplemental remedial investigation/feasibility study. Windward Environmental LLC, Seattle, WA.

Windward. 2011. Data report: Results of dioxin and furan analyses of archived surface and subsurface sediment samples. Final. East Waterway Operable Unit supplemental remedial investigation/feasibility study. Windward Environmental LLC, Seattle, WA.