

Figure 4-1. Geophysical mapping locations across Oakland Bay in Mason County, Washington.

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qualitative picture of recent geomorphic development at each delta. The data may allow for the extrapolation of wood waste layers outside of Shelton Harbor (if they exist). In conjunction with core-dating and known geologic markers determined from the background analysis described next (e.g., the timing of the stabilization of the modern sea level), it is possible that a sediment budget may be formulated for the various depositional areas.

#### **4.1.2 Sediment Core Dating**

To help evaluate the potential for sediment, and associated contaminant, redistribution throughout the greater Oakland Bay marine system, sediment cores will be collected from three stations. One station will be located along the edge of the alluvial fan associated with north Oakland Bay sedimentation, one station will be located between the two Oakland Bay data points, OB-1 and OB-2 toward the center of the bay (Figure 4-2), and one station will be located in Shelton Harbor along the edge of the alluvial fan created by Goldsborough and Shelton Creeks (Figure 4-3). Cores will be divided into 2 centimeter (cm) intervals and only every third interval will be analyzed for lead-210. It is anticipated that each core will have 20 intervals analyzed for lead-210 and two intervals analyzed for cesium-137.

Lead-210 measurements are routinely employed to date recent marine sediments. Estimates of sedimentation rates may be made from the analysis of profiles of the isotope concentration in sediment cores.

## **4.2 Oakland Bay**

The study consists of a non-random design that utilizes a tiered analysis approach to spatially characterize sediment conditions across the bay. Sampling stations are placed at locations with potential and/or known point and non-point sources, as well as locations selected to characterize boundary and background conditions. Sediment chemistry analyses, wood waste chemistry analyses, bioassay toxicity analyses (sediment), and biota tissue analyses will be completed concurrently. A surface sediment sample will be collected at each station and submitted for analyses. In addition, a 4-foot core will be collected at each sediment sampling station. All core samples will be archived for potential future analyses, based on the results of the surface sample testing. A summary of sample location rationale for Oakland Bay is presented in Table 4-2 and a summary of sample analyses is presented in Table 4-3. Sampling locations within Oakland Bay are presented on Figure 4-2.

### **4.2.1 Sediment**

The Data Gaps report identified six creeks discharging to the bay and two sites with documented or potential releases of hazardous substances. Sampling stations have been established at each of the creek discharge points (stations OB-5 and OB-7 to OB-11) and adjacent to the potential hazardous substance release sites (stations OB-6 and OB-12). Four additional sampling stations

(stations OB-1 to OB-4) will be sampled from the center of the southern portion of Oakland Bay to evaluate conditions resulting from fluvial redistribution processes. A potential background sample location has been established in north Oakland Bay, near a park. As shown in Tables 4-2 and 4-3, samples from all of these locations will be analyzed for the broad spectrum of industrial discharge COPCs. Surface samples will also be analyzed for dioxins/furans. Sediment samples to be collected at tissue sample stations are discussed in Section 4.2.4

#### ***4.2.1.1 Surface Sediment Samples***

Representative surface sediment (0 to 10 cm) samples will be collected at 13 locations within Oakland Bay, including one background location (Figure 4-2). An aliquot from each location will be homogenized and submitted to each laboratory for chemical analysis.

The chemical analyte list, analytical methods, target detection limits (TDLs), and comparative criteria are discussed in Section 7.1.

#### ***4.2.1.2 Subsurface Sediment Cores***

Sediment cores will be collected to determine the vertical extent of potential contamination at point and non-point source discharge locations. Core sampling locations will be co-located at the 13 surface sediment locations (Figure 4-2). Cores will be advanced to 4 ft below the surface using a Vibracore sampler. If pockets of wood waste are encountered, cores will be advanced up to 12 ft. Cores will be archived and submitted for chemical analysis based on surface sediment results. Core collection and evaluation will also include a physical description of the stratigraphy. The chemical analyte list, analytical methods, target detection limits, and comparative criteria are discussed in Section 7.1.

### **4.2.2 Wood Waste**

Wood waste cores will be collected to help measure the vertical extent of wood waste debris in areas of historical log rafting activities. Historical wood rafting operations have been identified at Chapman Cove (station OB-22), along the shoreline north of the Shelton Marina (station OB-23), and across Hammersley Inlet east of Shelton Harbor (station OB-21). One surface and one core sample will be collected at each of these locations (Figure 4-2). Samples from these three locations will be analyzed for industrial and wood waste COPCs. Surface samples will also be analyzed for dioxins/furans. One subsurface wood waste core sediment sample collected from beneath the wood waste also will be submitted for bioassay analysis.

Subsurface cores will be advanced to the bottom of the wood waste or to a maximum depth of 12 ft. The cores will be composited into discrete 1-ft intervals, up to the vertical extent of wood waste debris. The samples collected from the 1-2 ft interval will be analyzed for wood waste COPCs. The remaining sample intervals will be archived. If encountered, the first 1 ft of native sediment beneath the wood waste will be collected and analyzed for industrial and wood waste COPCs. Bioassay samples will be collected and may be submitted, as described in the following section.

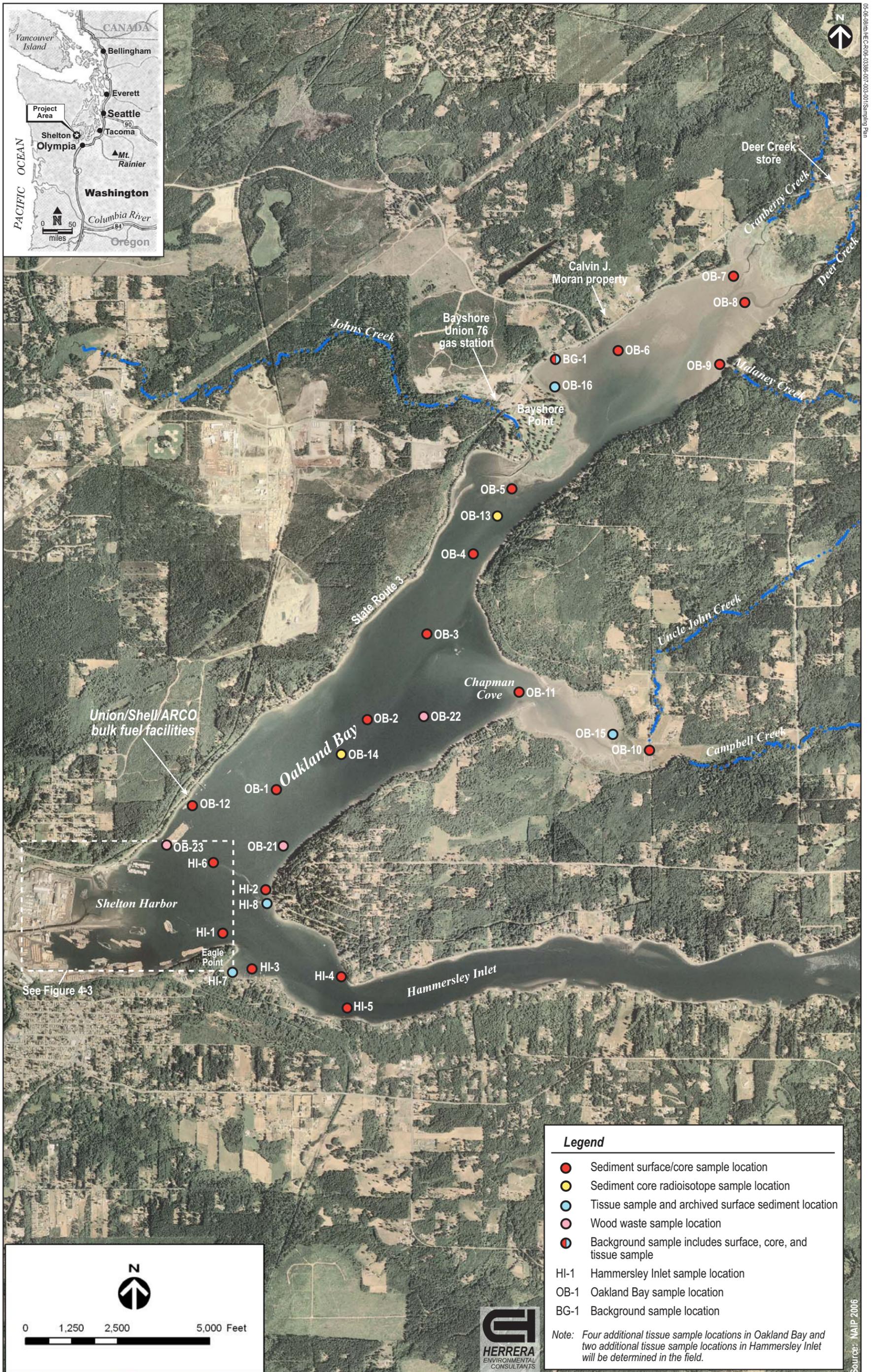


Figure 4-2. Sediment and tissue sample locations (to be collected) in Oakland Bay and Hammersley Inlet in Mason County, Washington.

05-08-08/ME/CA/06-0338-007/403.001/Sampling Plan

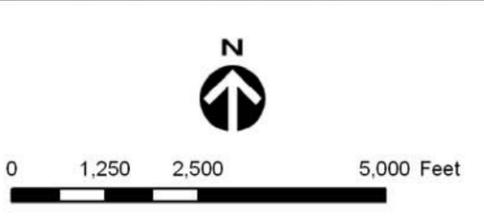
Source: NAIP 2006

**Legend**

- Sediment surface/core sample location
- Sediment core radioisotope sample location
- Tissue sample and archived surface sediment location
- Wood waste sample location
- Background sample includes surface, core, and tissue sample

HI-1 Hammersley Inlet sample location  
 OB-1 Oakland Bay sample location  
 BG-1 Background sample location

*Note: Four additional tissue sample locations in Oakland Bay and two additional tissue sample locations in Hammersley Inlet will be determined in the field.*



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Figure 4-3. Sediment, wood waste, and tissue sample locations (to be collected) in Shelton Harbor, Shelton, Washington.

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**Table 4-2. Rationale for samples to be collected from Oakland Bay.**

Sample ID <sup>a</sup>	Description <sup>b</sup>	Sample Justification
OB-01-SS-00	Surface	Characterization of Oakland Bay. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-01-SC-12	Subsurface	Characterization of Oakland Bay. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-02-SS-00	Surface	Characterization of Oakland Bay. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-02-SC-12	Subsurface	Characterization of Oakland Bay. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-03-SS-00	Surface	Characterization of Oakland Bay. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-03-SC-12	Subsurface	Characterization of Oakland Bay. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-04-SS-00	Surface	Characterization of Oakland Bay. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-04-SC-12	Subsurface	Characterization of Oakland Bay. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-05-SS-00	Surface	Johns Creek – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-05-SC-12	Subsurface	Johns Creek – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-06-SS-00	Surface	Concrete tank with wood preservative along shoreline. Analyze for COPCs (SVOCs, pesticides, PCB, TPH, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-06-SC-12	Subsurface	Concrete tank with wood preservative along shoreline. Analyze for COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-07-SS-00	Surface	Cranberry Creek – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-07-SC-12	Subsurface	Cranberry Creek – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-08-SS-00	Surface	Deer Creek – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.

**Table 4-2 (continued). Rationale for samples to be collected from Oakland Bay.**

Sample ID <sup>a</sup>	Description <sup>b</sup>	Sample Justification
OB-08-SC-12	Subsurface	Deer Creek – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-09-SS-00	Surface	Malaney Creek – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-09-SC-12	Subsurface	Malaney Creek – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-10-SS-00	Surface	Uncle John and Campbell Creeks – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-10-SC-12	Subsurface	Uncle John Creek – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-11-SS-00	Surface	Chapman Cove – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-11-SC-12	Subsurface	Chapman Cove – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-12-SS-00	Surface	Former bulk fuel storage along shoreline. Analyze for COPCs (SVOCs, pesticides, PCB, TPH, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-12-SC-12	Subsurface	Former bulk fuel storage along shoreline. Analyze for COPCs (SVOCs, pesticides, PCB, TPH, and metals). Samples analyzed based on surface sample sediment results.
OB-13-RI-04	Sediment Core	Sediment core dating. Collect along edge of alluvial flume at mouth of Johns Creek.
OB-14-RI-04	Sediment Core	Sediment core dating. Collect from deepest area in central portion of Oakland Bay.
OB-15-TS-00	Tissue	Located in Chapman Cove. COPCs (SVOCs and metals) for delineation of site. PBT (PCB congeners, and dioxin/furans) for HHRA/ERA assessment.
OB-15-SS-00	Surface	Co-located surface sediment sample. COPCs (SVOCs and metals) for delineation of site. PBT (PCB congeners, PCBs as Aroclors, and dioxin/furans) for HHRA/ERA assessment.
OB-16-TS-00	Tissue	Located near Bayshore Point. COPCs (SVOCs and metals) for delineation of site. PBT (PCB congeners, and dioxin/furans) for HHRA/ERA assessment.
OB-16-SS-00	Surface	Co-located surface sediment sample. COPCs (SVOCs and metals) for delineation of site. PBT (PCB congeners, PCBs as Aroclors, and dioxin/furans) for HHRA/ERA assessment.

**Table 4-2 (continued). Rationale for samples to be collected from Oakland Bay.**

Sample ID <sup>a</sup>	Description <sup>b</sup>	Sample Justification
OB-17-TS-00	Tissue	Location TBD. COPCs (SVOCs and metals) for delineation of site. PBT (PCB congeners, and dioxin/furans) for HHRA/ERA assessment.
OB-17-SS-00	Surface	Co-located surface sediment sample. COPCs (SVOCs and metals) for delineation of site. PBT (PCB congeners, PCBs as Aroclors, and dioxin/furans) for HHRA/ERA assessment.
OB-18-TS-00	Tissue	Location TBD. COPCs (SVOCs and metals) for delineation of site. PBT (PCB congeners, and dioxin/furans) for HHRA/ERA assessment.
OB-18-SS-00	Surface	Co-located surface sediment sample. COPCs (SVOCs and metals) for delineation of site. PBT (PCB congeners, PCBs as Aroclors, and dioxin/furans) for HHRA/ERA assessment.
OB-19-TS-00	Tissue	Location TBD. COPCs (SVOCs and metals) for delineation of site. PBT (PCB congeners, and dioxin/furans) for HHRA/ERA assessment.
OB-19-SS-00	Surface	Co-located surface sediment sample. COPCs (SVOCs and metals) for delineation of site. PBT (PCB congeners, PCBs as Aroclors, and dioxin/furans) for HHRA/ERA assessment.
OB-20-TS-00	Tissue	Location TBD. COPCs (SVOCs and metals) for delineation of site. PBT (PCB congeners, and dioxin/furans) for HHRA/ERA assessment.
OB-20-SS-00	Surface	Co-located surface sediment sample. COPCs (SVOCs and metals) for delineation of site. PBT (PCB congeners, PCBs as Aroclors, and dioxin/furans) for HHRA/ERA assessment.
OB-21-WS-00	Wood Waste	Historic log rafting area north of Munson Point. Potential COPCs (SVOCs, wood resin, and metals) for characterization of area (wood debris). PBT (chlorinated pesticides, PCBs, and dioxin/furans) for HHRA/ERA assessment.
OB-21-WC-12	Wood Waste	Historic log rafting area north of Munson Point. Potential COPCs (SVOCs, wood resin, and metals) for characterization of area (wood debris). PBT (chlorinated pesticides and PCBs) for HHRA/ERA assessment.
OB-21-WC-XX	Subsurface	Historic log rafting area north of Munson Point. Potential COPCs (SVOCs, wood resin, and metals) for characterization of area (wood debris). PBT (chlorinated pesticides and PCBs) for HHRA/ERA assessment. Potential bioassay to assess sediment toxicity on benthic organisms.
OB-22-WS-00	Wood Waste	Historic log rafting area near Chapman Cove. Potential COPCs (SVOCs, wood resin, metals, and TPH) for characterization of area (wood debris). PBT (chlorinated pesticides, PCBs, and dioxin/furans) for HHRA/ERA assessment. Bioassay to assess sediment toxicity on benthic organisms.
OB-22-WC-12	Wood Waste	Historic log rafting area near Chapman Cove. Potential COPCs (SVOCs, wood resin, and metals) for characterization of area (wood debris). PBT (chlorinated pesticides and PCBs) for HHRA/ERA assessment.
OB-22-WC-XX	Subsurface	Historic log rafting area near Chapman Cove. Potential COPCs (SVOCs, wood resin, and metals) for characterization of area (wood debris). PBT (chlorinated pesticides and PCBs) for HHRA/ERA assessment. Potential bioassay to assess sediment toxicity on benthic organisms.

**Table 4-2 (continued). Rationale for samples to be collected from Oakland Bay.**

Sample ID <sup>a</sup>	Description <sup>b</sup>	Sample Justification
OB-23-WS-00	Wood Waste	Historic log rafting area north of Shelton Harbor. Potential COPCs (SVOCs, wood resin, metals, and TPH) for characterization of area (wood debris). PBT (chlorinated pesticides, PCBs, and dioxin/furans) for HHRA/ERA assessment. Bioassay to assess sediment toxicity on benthic organisms.
OB-23-WC-12	Wood Waste	Historic log rafting area north of Shelton Harbor. Potential COPCs (SVOCs, wood resin, and metals) for characterization of area (wood debris). PBT (chlorinated pesticides and PCBs) for HHRA/ERA assessment.
OB-23-WC-XX	Subsurface	Historic log rafting area north of Shelton Harbor. Potential COPCs (SVOCs, wood resin, and metals) for characterization of area (wood debris). PBT (chlorinated pesticides and PCBs) for HHRA/ERA assessment. Potential bioassay to assess sediment toxicity on benthic organisms.
Background		
BG-01-SS-00	Surface	Located in northeast Oakland Bay near Bayshore Point. Background comparison of COPCs, PBTs, and toxicity analyses.
BG-01-SC-12	Subsurface	Located in northeast Oakland Bay near Bayshore Point. Background comparison of COPCs, PBTs, and toxicity analyses.
BG-01-TS-00	Tissue	Located in northeast Oakland Bay near Bayshore Point. Background comparison of COPCs, PBTs, and toxicity analyses.

<sup>a</sup> Example of sample ID: OB-13-RI-04 = Oakland Bay, Station 13, Radioisotope, 0-4 foot interval. Additional identifiers: SC = sediment core; SS = surface sediment; TS = tissue; WC = wood waste core; WS = wood waste surface. XX = depth to be determined in the field. See Section 6.1.1.

<sup>b</sup> Description of matrix: surface or subsurface sediment, wood waste, or tissue.