

APPENDIX C
SAMPLING AND ANALYSIS PLAN

LOCKHEED
WEST SEATTLE SUPERFUND SITE

**SITE CHARACTERIZATION
SAMPLING AND ANALYSIS PLAN**

Revised Draft

Prepared for



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1. INTRODUCTION

This Site Characterization Sampling and Analysis Plan (SC SAP) is a component of the Remedial Investigation/Feasibility Study Work Plan for the Lockheed West Seattle Superfund Site. This SC SAP is submitted on behalf of Lockheed Martin Corporation (LMC). This SC SAP describes a sampling and analysis plan approach for the Lockheed West Site and has been prepared as a stand-alone document to expedite collection of site data. EPA comments on the draft site investigation approach have been incorporated in to the study design in this SC SAP. As agreed with EPA, collection of additional site data early in the site cleanup process will better inform decision making and determination of appropriate cleanup measures.

Risk assessments underway on the Lower Duwamish River Superfund Site have concluded that the cleanup levels mandated under the Washington State Sediment Management Standards (SMS;WAC 173-204) may not meet EPA risk tolerances for certain contaminants when site-specific input assumptions are used. Given this finding, no-action and natural recovery remediation alternatives are infeasible for meeting risk-based cleanup levels and that more active remediation alternatives would be required throughout the extent of contaminated sediments on the Lockheed West site. At the minimum, remediation of the site would consist of placing caps over all contaminated sediments. Other remediation approaches, such as dredging, may also be implemented if site conditions warrant their use. The purpose of performing the site characterization sampling is to support the streamlined RI/FS in light of remedial plans for the site. Specifically, the purpose of the investigation is to:

- Collect a comprehensive sediment quality data set to determine the nature and extent of sediment contamination resulting from historical releases at the Former Lockheed Shipyard No. 2 (Lockheed West) in support of developing risk-based cleanup goals and determining an appropriate remediation alternative for the site.
- Collect data representative of both the surface and subsurface sediment quality condition.
- Refine site conceptual model based on new sampling and analysis results,
- Identify and characterize (based on sampling and analysis of sediment quality samples) representative Range Finding for Background locations in and about the Elliott Bay system in support of developing appropriate potential cleanup goals for the site,

- Delineate cleanup boundary for the site,
- Identify areas within the cleanup boundary that are suitable for sediment capping and or dredging considering chemical concentrations, physical environment and future site use considerations, and
- Perform supplemental tests and analyses where appropriate to determine effectiveness of capping and dredging using collected data.

The focus of this SC field sampling is the field data collection that will be used to characterize the nature and extent of potential sediment contamination during Winter 2007. The field data collection for the intertidal areas will be conducted during daylight low tides (Spring 2007). In addition, the spring sampling effort may be used to fulfill data gaps identified during the initial data collection.

2. SAMPLING AND ANALYSIS

2.1 OVERVIEW OF SEDIMENT SAMPLING AND ANALYSIS

The rationale for the proposed sampling approach is based on the assessment of existing data and identification of data gaps (see Section 4.7 of the Work Plan). EPA's seven step Data Quality Objectives (DQOs) process was followed to develop all the data collection efforts (e.g., Guidance on Systematic Planning using the Data Quality Objectives Process (QA/G-4), EPA 240/B-06/001 Feb 2006), and provides the technical and decision-making basis for the collection of all proposed data.

Field data collection will be to characterize the nature and extent of the contamination. The sampling effort includes collection and analysis of subtidal subsurface samples, subtidal subsurface samples, intertidal surface samples, range finding for background samples, and a topographic survey to tie the banks in with the multibeam bathymetry data. Field samples collected will be analyzed for contaminants of interest (COIs) listed in Table 2-1. As part of the subtidal subsurface sampling, duplicate cores will be collected for potential contaminant mobility testing and duplicate cores for evaluation of disposal options for dredged material. The analysis of contaminant mobility samples will follow the receipt and evaluation of the data from the initial sampling.

A synopsis of the SC field program is provided below. Samples are located beyond the property boundary to assess the extent of the nature and extent of the contamination from the former shipyard to support the proposed remedial alternatives. Samples are not located beyond the adjacent Puget Sound Resources (PSR) Superfund site boundary (Figure 2-1) because remedial actions (sediment capping) have been recently completed in this area of the site. The PSR site boundary presented is based on the cap boundary shown in the Final Design Submittal, Pacific Sound Resources Superfund Site Marine Sediment Unit, Seattle, Washington dated 2/3/2003. The boundary of the PSR cap (as depicted in the drawings) is evident in the recent hydrographic survey of the LW site. Surface data collected for the SC will be used to define remediation areas. Subsurface data will be used to define the maximum potential dredging depth.

2.2 IDENTIFY EXTENT OF SEDIMENT CONTAMINATION EXCEEDING PRGS

Sediment sampling and analysis will be performed in accordance with the SOW for the purpose of identifying the nature and extent of chemical contamination in sediment at the site.

Sediment sampling will be performed in the general vicinity of the Lockheed West property boundaries. Sample locations are extended beyond the property boundary to assess the nature and extent of contamination from the former shipyard.

Sediment samples will include surface (0 to 10 cm) grab samples and subsurface core samples. All sampling, handling, and analyses will be performed in general accordance with EPA-recommended methodology and PSEP protocols as outlined in the standard operating procedures included in Attachment 1. The proposed sampling program includes evaluation of intertidal and subtidal surface and subsurface samples for the COPCs. Sediment sampling will be performed at 51 locations throughout the Site as shown on Figure 2-1. Subsurface and co-located surface sediment sampling will be performed at 35 locations, surface sediment sampling only will be performed at 7 locations, and up to nine discrete intertidal bank surface samples will be collected along the shoreline. The sample locations and rationale are included in Table 2-1.

2.2.1 Surface Sediment Samples

Sample locations have been selected to be representative of the range of surface sediment conditions at the Site and to provide adequate spatial coverage based on the historical site uses. Surface samples will be used for bulk chemical analysis and to assist in evaluation of remedial alternatives.

Surface sediment samples will be collected to determine the horizontal extent of COIs. COIs consist of the parameters listed in Table 2-1, including bulk sediment TBT and supporting conventional parameters.

The proposed surface sediment samples are comprised of the top 0 to 10 cm at two types of locations:

- Forty-two surface samples collected from the subtidal areas of Lockheed West; and
- Up to nine representative samples will be collected from the intertidal bank areas of Lockheed West and analyzed for COIs.

Background samples (locations were determined in conjunction with EPA) will be collected in and around Elliot Bay.

Subtidal Sediment Samples. A total of 42 surface samples, representative of the upper 10 cm of sediment, will be collected at 42 locations in the subtidal area for the purposes of determining surface sediment quality and establishing the locations of chemical “hot spots.”

Table 2-1. Sample Locations, Analysis, and Rationale

Location	Type	Proposed Easting ¹	Proposed Northing ¹	Mudline Elevation (MLLW)	Sample Depth (Feet) ²	Target Elevation (MLLW)	Conventional ³ metals	SVOC	PCB	Pesticides	TBT bulk	Archive for PCB/Dioxin	Porewater ⁴	Geotechnical ⁵	Contaminant Mobility ⁶	PSDDA Cores	Work Area	Rationale
1	Core and Grab	1263235.3	216012.3	-8.3	16	-24.3	x	x	x	x	x	x				1	Future POS Terminal (1a)	On slope to assess the area south of the CSO. Expected future POS slope is 1:1.75 side cut on slopes. Collect duplicate core to evaluate for PSDDA suitability.
2	Core and Grab	1263355.3	216056.9	-40.4	12.6	-53.0	x	x	x	x	x	x				1	Future POS Terminal (1a)	Off shore to assess the outer limits of CSO and surface sediment quality. Collect duplicate core to evaluate for PSDDA suitability.
3	Core and Grab	1263351.9	216274.6	-24.8	28.2	-53.0	x	x	x	x	x	x	x			1	Future POS Terminal (1a)	Off shore to assess the outer limits of CSO and surface sediment quality. Collect duplicate core to evaluate for PSDDA suitability.
4	Core and Grab	1263249.0	216267.8	0.0	20	-20.0	x	x	x	x	x	x				1	Future POS Terminal (1a)	On slope to assess the CSO and surface sediment quality. Expected future POS slope is 1:1.75 side cut on slopes. Collect duplicate core to evaluate for PSDDA suitability.
27	Core and Grab	1263334.8	216515.7	-14.9	38.1	-53.0	x									1	Future POS Terminal (1a)	On slope to assess the surface sediment quality. Collect duplicate core to evaluate for PSDDA suitability.
28	Grab	1263421.0	215964.3	-51.9	10 cm grab	--	x	x	x	x	x	x					Future POS Terminal (1a)	Surface grabs added to bound surface contamination in West Waterway.
29	Core and Grab	1263446.7	216397.7	-41.4	11.6	-53.0	x	x	x	x	x	x					Future POS Terminal (1a)	Added to bound extent of contamination in West Waterway.
5	Core and Grab	1263211.3	216573.8	-3.3	6.1	-9.4	x	x	x	x	x	x				1	Eastern Drydock; Future POS Terminal (1b)	On slope to assess the surface sediment quality. Expected future POS slope is 1:1.75 side cut on slopes. Collect sediment to evaluate for PSDDA suitability
6	Core and Grab	1263339.9	216644.1	-41.5	11.5	-53.0	x	x	x	x	x	x			1	Eastern Drydock; Future POS Terminal (1b)	Assess Eastern Drydock area	
7	Core and Grab	1263202.7	216848.1	-6.4	5	NA	x	x	x	x	x	x					Eastern Drydock; Future POS Terminal (1b)	On slope to assess the surface sediment quality. Expected future POS slope is 1:1.75 side cut on slopes.
8	Core and Grab	1263398.2	216875.6	-40.1	12.9	-53.0	x	x	x	x	x	x			1	Eastern Drydock; Future POS Terminal (1b)	Assess Eastern Drydock area	
30	Core and Grab	1263479.5	216815.7	-51.4	1.6	-53.0	x	x	x	x	x	x					Eastern Drydock; Future POS Terminal (1b)	Added to bound spatial contamination in West Waterway.
9	Core and Grab	1263319.7	217126.0	-41.1	11.9	-53.0	x	x	x	x	x	x	x		1	Eastern Drydock; Future POS Terminal (2a)	Near the 3 cores SB-1, D5, and M1 because of the inconsistencies of previous sample results.	
31	Core and Grab	1263489.1	217144.2	-50.4	2.6	-53.0	x	x	x	x	x	x					Eastern Drydock; Future POS Terminal (2a)	Added to bound extent of contamination in West Waterway.
10	Core and Grab	1263358.7	217312.7	-28.7	24.3	-53.0	x	x	x	x	x	x			1	North of Eastern Drydock (2b)	Assess the mound north of the former drydock location.	
11	Core and Grab	1263355.3	217629.9	-40.0	13.0	-53.0	x	x	x	x	x	x			1	North of Eastern Drydock (2b)	collected previously in this vicinity).	
42	Core and Grab	1263524.1	217658.5	-49.9	3.1	-53.0	x	x	x	x	x	x	x				North of Eastern Drydock (2b)	Cores added to bound surface contamination in West Waterway.
32	Core and Grab	1263476.2	217485.2	-42.2	10.8	-53.0	x	x	x	x	x	x					North of Eastern Drydock (2b)	Cores added to bound surface contamination in West Waterway.
33	Core and Grab	1263473.0	217836.1	-46.7	6.3	-53.0	x	x	x	x	x	x					North of Eastern Drydock (2b)	Cores added to bound surface contamination in West Waterway.
12	Core and Grab	1263045.0	217804.8	-41.9	11.1	-53.0	x	x	x	x	x	x			1	Western Former dry dock (3)	Beyond the dredge cut on the north end has uncharacterized surface sediments. Cores (12 and 13) added at north end to assess surface sediment quality and vertical contamination	
13	Core and Grab	1263226.7	217789.3	-45.2	7.8	-53.0	x	x	x	x	x	x	x		1	Western Former dry dock (3)	Beyond the dredge cut on the north end is a deep collection area (deposition/sink). Cores (12 and 13) added at north end to assess surface and vertical contamination	
15	Core and Grab	1263190.7	217485.9	-45.3	7.7	-53.0	x	x	x	x	x	x	x		1	Western Former dry dock (3)	Assess drydock area and uneven bathymetry looking at an elevation lower than Location 17	
16	Core and Grab	1262974.0	217215.4	-35.7	17.3	-53.0	x	x	x	x	x	x			1	Western Former dry dock (3)	Assess drydock area along western border	
17	Core and Grab	1263173.6	217124.1	-43.8	9.2	-53.0	x	x	x	x	x	x	x		1	Western Former dry dock (3)	Assess drydock area and uneven bathymetry looking at an elevation higher than Location 15	
18	Core and Grab	1263065.6	216957.8	-17.7	10	NA	x	x	x	x	x	x					Western Former dry dock (3)	Close to shore to assess slope
40	Grab	1263275.8	217499.2	-29.2	10 cm grab	--	x	x	x	x	x	x					Western Former dry dock (3)	Two additional surface grabs are proposed along historic pier location; no other grabs proposed, as area is well characterized on the surface by the co-located grab/cores.
41	Grab	1263254.0	217086.8	-31.8	10 cm grab	--	x	x	x	x	x	x					Western Former dry dock (3)	Two additional surface grabs are proposed along historic pier location; no other grabs proposed, as area is well characterized on the surface by the co-located grab/cores.
14	Core and Grab	1262951.6	217517.9	-25.0	28.0	-53.0	x	x	x	x	x	x					Former Mooring Area (4)	Assess historic pier location
19	Core and Grab	1262835.8	216971.6	-17.1	10	NA	x	x	x	x	x	x					Former Mooring Area (4)	Close to shore to assess slope
20	Grab	1262787.8	217299.0	-27.3	10 cm grab	--	x	x	x	x	x	x	x				Former Mooring Area (4)	Confirm results from SA6 core, G8 core, and HC-03-06 surface sample area with metals and PCBs on surface.
21	Grab	1262535.8	217309.3	-33.6	10 cm grab	--	x	x	x	x	x	x					Former Mooring Area (4)	Assess surface sediment
22	Core and Grab	1262909.5	217693.3	-42.2	10.8	-53.0	x	x	x	x	x	x					Former Mooring Area (4)	Located in deeper hole near G9 surface sample, cores HC-03-17 and 30-1-197 to assess vertical and spatial contamination
23	Core and Grab	1262647.2	217737.9	-45.4	7.6	-53.0	x	x	x	x	x	x					Former Mooring Area (4)	Assess vertical contamination. Located in an area without historical sample data.
24	Core and Grab	1262314.6	217455.0	-26.3	10	NA	x	x	x	x	x	x					Shipway (5)	Determine spatial and vertical boundary of PAH and SVOCs
25	Core and Grab	1262285.5	217268.2	-25.9	10	NA	x	x	x	x	x	x	x				Shipway (5)	Assess area in between pier and shipway pilings
26	Core and Grab	1262410.5	217033.0	-28.7	10	NA	x	x	x	x	x	x					Former Mooring Area (5)	Close to shore to assess slope adjacent to pier
34	Core and Grab	1263466.5	218102.6	-51.1	1.9	-53.0	x	x	x	x	x	x					North Boundary (6)	No exceedances at depth. Samples added to bound spatial contamination.
35	Core and Grab	1263141.5	218021.3	-47.7	5.3	-53.0	x	x	x	x	x	x					North Boundary (6)	No exceedances at depth. Samples added to bound spatial contamination.
36	Grab	1262978.6	218051.8	-53.9	10 cm grab	--	x	x	x	x	x	x					North Boundary (6)	No exceedances at depth. Samples added to bound spatial contamination.
37	Core and Grab	1262771.1	217930.3	-39.4	13.6	-53.0	x	x	x	x	x	x					North Boundary (6)	No exceedances at depth. Samples added to bound spatial contamination.
38	Grab	1262637.1	217984.6	-66.9	10 cm grab	--	x	x	x	x	x	x					North Boundary (6)	No exceedances at depth. Samples added to bound spatial contamination.
39	Core and Grab	1262481.9	217819.9	-43.6	9.4	-53.0	x	x	x	x	x	x					North Boundary (6)	No exceedances at depth. Samples added to bound spatial contamination.
IT-1	Intertidal Grab	1263183.4	216096.7	NA	10 cm grab	--	x	x	x	x	x	x					Future POS Terminal	Sandy Seep Area
IT-2	Intertidal Grab	1263188.2	216179.1	NA	10 cm grab	--	x	x	x	x	x	x					Future POS Terminal	Sandy Seep Area
IT-3	Intertidal Grab	1263242.0	216345.1	NA	10 cm grab	--	x	x	x	x	x	x					Future POS Terminal	Sandy area near Florida Street Outfall
IT-4	Intertidal Grab	1263166.8	216686.4	NA	10 cm grab	--	x	x	x	x	x	x					Eastern Drydock; Future POS Terminal	Seep area
IT-5	Intertidal Grab	1262714.3	216934.3	NA	10 cm grab	--	x	x	x	x	x	x					Former Mooring Area	Sandy area under pier (Pier 23)
IT-6	Intertidal Grab	1262330.4	216973.0	NA	10 cm grab	--	x	x	x	x	x	x					Former Mooring Area	Sandy area near pier (pier adjacent to shipway)
IT-7	Intertidal Grab	1262269.1	217020.6	NA	10 cm grab	--	x	x	x	x	x	x					Shipway	Sandy area within shipway
IT-8	Intertidal Grab	1262188.8	217026.5	NA	10 cm grab	--	x	x	x	x	x	x					Shipway	Sandy area within shipway
IT-9	Intertidal Grab	1262149.9	217106.8	NA	10 cm grab	--	x	x	x	x	x	x					PSR interface	Sample to assess surface sediments at edge of PSR capping area

Notes:

- 1 Target locations, actual location will be determined in the field.
- 2 Most cores will be pushed to approximately -53 MLLW or to a maximum of 20 feet. Cores along POS Terminal slope will be pushed to slope cut. Cores located in probable cap area will be pushed to 10 ft.
- 3 Conventional analysis includes total solids, grain size, and TOC.
- 4 Analysis of porewater will be conducted on the surface grab sample.
- 5 Atterberg Limits will be analyzed on samples within the potential dredge prism and should primarily consist of clays, therefore to be determined in the field. Specific gravity will be analyzed on each startigraphy layer of cores located within the dredge prism.
- 6 Contaminant mobility samples will be a composite sample of core increments located within the dredge prism as well as a surface water sample.
- 7 Intertidal Bank Samples (IT-1 through IT-9) will be collected during a daylight low tide in the second phase of field work.

P:\projects_2006\Lockheed\maps\Figure1_GB.mxd

Legend

1998 and Earlier Sampling Locations

- Surface Grab
- Subsurface Core
- PSR RI STNS Points

2003 Sampling Locations

- Surface Grab

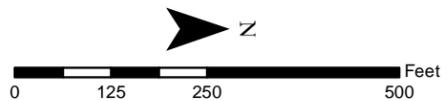
2006 Sampling Locations

- Proposed Surface Grabs
- Proposed Subsurface Cores and Co-located Surface Grabs
- Proposed Intertidal Sampling Location

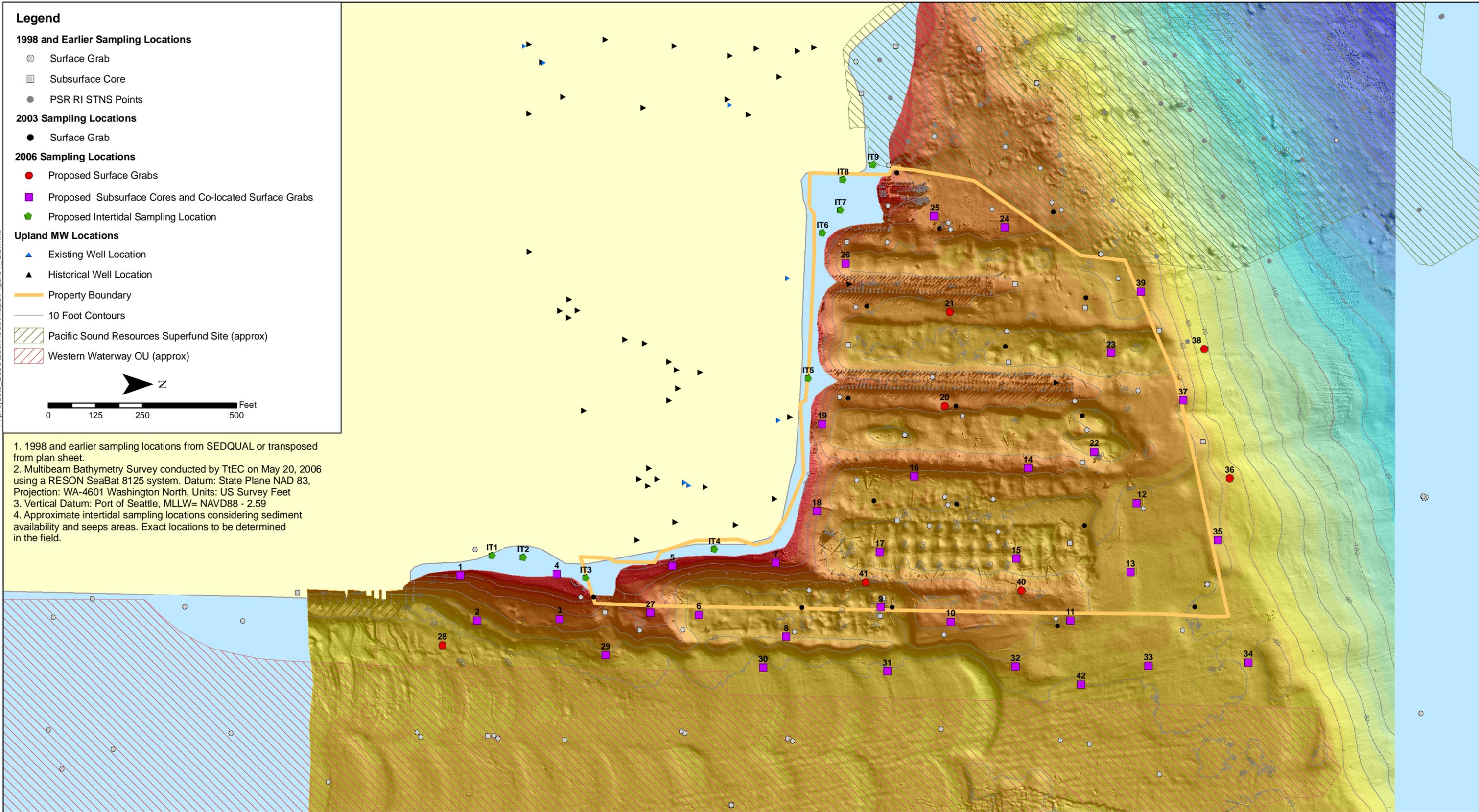
Upland MW Locations

- ▲ Existing Well Location
- ▲ Historical Well Location

- Property Boundary
- 10 Foot Contours
- ▨ Pacific Sound Resources Superfund Site (approx)
- ▨ Western Waterway OU (approx)

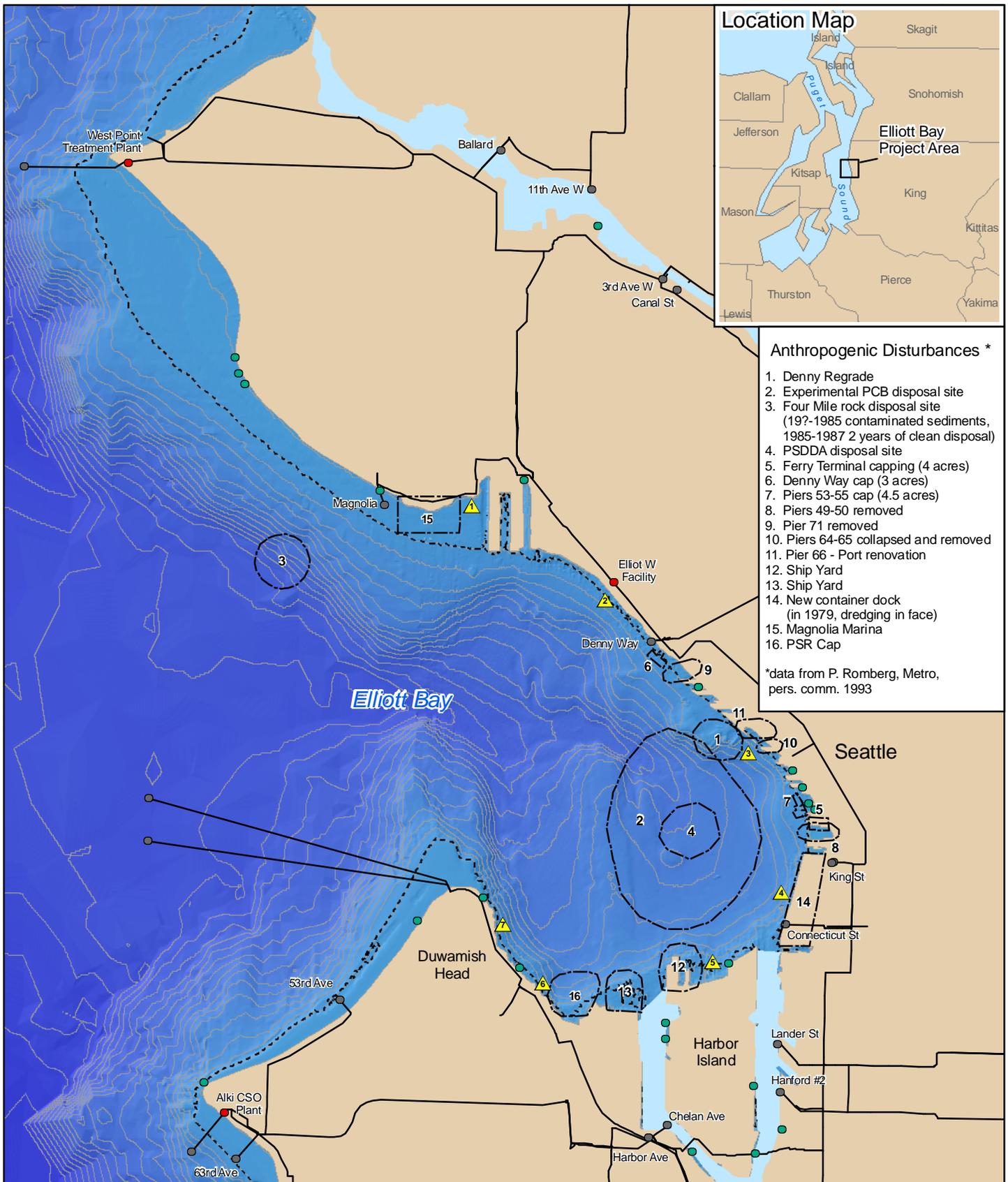


1. 1998 and earlier sampling locations from SEDQUAL or transposed from plan sheet.
2. Multibeam Bathymetry Survey conducted by TtEC on May 20, 2006 using a RESON SeaBat 8125 system. Datum: State Plane NAD 83, Projection: WA-4601 Washington North, Units: US Survey Feet
3. Vertical Datum: Port of Seattle, MLLW= NAVD88 - 2.59
4. Approximate intertidal sampling locations considering sediment availability and seeps areas. Exact locations to be determined in the field.



**Lockheed West
Shipyard No. 2
Seattle, WA**

**Figure 2-1
Existing and Proposed
Sediment Sampling Locations**

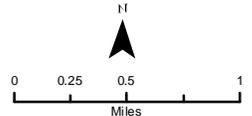


- ### Anthropogenic Disturbances *
1. Denny Regrade
 2. Experimental PCB disposal site
 3. Four Mile rock disposal site (197-1985 contaminated sediments, 1985-1987 2 years of clean disposal)
 4. PSDDA disposal site
 5. Ferry Terminal capping (4 acres)
 6. Denny Way cap (3 acres)
 7. Piers 53-55 cap (4.5 acres)
 8. Piers 49-50 removed
 9. Pier 71 removed
 10. Piers 64-65 collapsed and removed
 11. Pier 66 - Port renovation
 12. Ship Yard
 13. Ship Yard
 14. New container dock (in 1979, dredging in face)
 15. Magnolia Marina
 16. PSR Cap
- *data from P. Romberg, Metro, pers. comm. 1993

Legend

- | | |
|---------------------------------|------------------------|
| — Sewer Line | ● City of Seattle CSO |
| — Contours (40 ft. interval) | ● King County CSO |
| - - - -40 foot Contour | ● Treatment Plant |
| ⬜ 11 Anthropogenic Disturbances | ▲ Proposed Sample Site |

Figure 2-2 Range Finding Background Locations



Samples collected from the subtidal portion of the Site will be collected using a van Veen grab sampler deployed from a work vessel.

Surface samples have been placed outside of the property boundary to the north and east to evaluate and bound the spatial extent of contamination.

Surface sampling will be conducted during the early part of the field effort to ensure that the surface sediments are undisturbed and not impacted by the other RI field activities.

Intertidal Bank Samples. Waterway bank areas are representative of nearshore surface sediments that may be impacted by eroding banks, historical and current outfalls, seeps, or surface runoff. These areas are also subject to deposition of suspended particulate material that may be resuspended during storm events, from vessel wakes, or during dredging within the waterway. No data exist on the condition of the banks. Intertidal samples will be collected for the purpose of determining the sediment chemical concentrations and extent of sandblast grit, defining the location of chemical “hot spots,” and determining the intertidal sediment physical characteristics. These data will also provide data that will define the upper (shoreward) boundary of the sediments in Lockheed West.

Based on a visual survey of the Lockheed West bank areas, several sampling areas have been identified where discrete intertidal bank samples will be collected (Figure 2-1). Intertidal bank samples will be collected with bowls and spoons during a daytime low tide to allow field personnel to assess the slope and substrate for optimal sampling locations.

To characterize the upper portion of the slope (intertidal zone), up to nine discrete samples are proposed along the Site shoreline bank (locations IT-1 through IT-9). Each sample will be analyzed for COIs. The samples will be collected from the top 10 cm of silt and/or sand, either at the sediment/riprap interface at the top of the slope or along the exposed bank slope if no riprap is present. The proposed bank locations are shown on Figure 2-1. The rationale for each location is included in Table 2-1. The actual sampling locations will be determined in the field, based on the results of the low tide habitat and structure survey. Areas that will be avoided are rip rap and areas with little sediments. In the event that a suspected source material is identified, the location will be documented, a discrete sample will be collected, and EPA will be notified. A sufficient volume of sediment will be collected for the COIs. The location of each discrete sample, tidal elevation, material description, and identification of suspected source material will be documented and presented in the RI Data Collection Report.

2.2.2 Subsurface Sediment Sampling and Analysis

Subsurface Sampling. Subsurface sampling will be performed primarily using a vibrocore system. The coring system will be operated from a work vessel

Data gathered from the subsurface cores will be used for characterization of the subsurface material, sediment chemical characterization, and optional dredgability and contaminant mobility testing. Sample locations have been selected systematically to provide adequate spatial coverage of the Site based on historical site uses and previous sediment core results.

Most subsurface cores will be advanced beyond the deepest extent of PRG exceedances indicated by the existing data or to native material, expected to be an approximate elevation of -45 feet MLLW, which is the historical dredging depth to a maximum of 20 feet in length. Several cores will be advanced to -53 MLLW, the maximum depth potentially required for navigation. The primary objective will be to determine the vertical extent of sediment potentially requiring remediation. No cores will be longer than 20 feet, as the depth of contamination from shipyard activities is not expected to be buried 20 feet below the existing surface.

Collection of duplicate cores in the area south of the property boundary along the West Waterway may also be used to support a preliminary evaluation to assess potential Port of Seattle development options. These locations include Stations 1 through 5 and 27 (Table 1). The Port of Seattle may expand Terminal 5 into this area. The duplicate cores can provide information about preliminary disposal options. If this preliminary evaluation indicates that the potential dredge material may be disposed of at an open water disposal site, LMC will discuss the need for a full PSDDA characterization with EPA.

Collection of duplicate cores in areas where removal may be a feasible remedial option will allow for the formation of a sediment composite representative of the potential dredge prism to be analyzed for contaminant mobility.

Chemistry Sample Collection. Subsurface sediment cores will be collected at 37 co-located surface sample locations to determine the vertical extent of chemical concentrations in subsurface sediment exceeding the SQS or CSL chemical criteria and to determine volumes of sediment that may require remediation (Table 2-1). The primary objective will be to determine the vertical extent of sediment requiring remediation down to native material or a maximum elevation of -53 MLLW. This is the deepest elevation that would be required for navigation. Therefore, based on site bathymetry and proposed locations, cores will range from approximately 7.5 to 20 feet in length. Each subsurface core will be logged and subsampled in the field. A certified geologist will conduct the visual classification of the

sediment cores. The core logging will include the description of grain size, sediment consistency, and location of native sediments (if possible) to aid in the evaluation of dredging suitability.

Sample intervals will be identified first based on sediment stratigraphy then by 1-foot intervals with consideration of required volumes for chemical analyses. Therefore, a 20-ft long core may be divided up into 20 samples. A minimum of two sample intervals will be analyzed from each core with the remaining samples archived. Selection of samples to be submitted for chemical analyses will be representative of the various subsurface sediment types observed based on the visual observations and core logs. A relatively uniform subsurface sediment stratigraphy is expected within the Lockheed West site; therefore, an estimated two to three sediment sample intervals from each core will likely be submitted for chemical analysis. As co-located surface sediment samples (0 to 10 cm) will be collected at each core location, an estimate of four samples (three core intervals and one surface) may be submitted for analysis at each location. The remaining core intervals will be collected and archived and held under chain of custody for determination as to which additional samples may need to be submitted for analysis.

Contaminant Mobility Sample Collection. Duplicate subtidal cores from the potential dredge area will be archived pending review of sediment chemistry results (Table 2-1). One to two sediment composite samples representative of the potential dredge prism will be created from the duplicate archived cores to support sediment contaminant mobility testing. Based on a review of sediment stratigraphy, sediment chemistry results, and dredging plan specifics, a volume weighted sediment composite sample (e.g., equal volume of sediment for each depth interval that may require removal) will be created that is representative of sediments that may require removal from the subtidal area. Multiple cores may be necessary at any one location to collect adequate volumes for the planned analyses. The sediment composite sample will be submitted for analysis. Contaminant mobility testing performed on the sediment composite includes a Column Settling Test (CST) and a Dredging Elutriate Test (DRET) to provide an assessment of contaminant mobility testing during dredging and aquatic confinement and disposal (i.e., thick capping, capped aquatic disposal, or upland disposal).

2.2.3 Background

Proposed cleanup actions at the Lockheed West site requires characterization of background sediment quality conditions. Background sediment quality concentrations for the Lockheed West chemicals of concern will be used as site cleanup objectives if risk-based cleanup

numbers derived from the site-specific human health and ecological risk assessments are calculated to be below the background. Sampling and analysis of the proposed locations will be performed in conjunction with the surface sediment sampling effort.

Objective for selection of urban background sediment quality sampling locations:

- Sample areas that are representative of the overall ambient sediment quality condition
- Sample in areas that do not have a potential to be biased by known or suspected contaminant sources
- Sample at depth ranges comparable to those of Lockheed West Site (i.e., < 45 feet MLLW)
- Sample sediments that are comparable to those of Lockheed West Site (e.g., %TOC, grain size)

Locations and Rationale:

Proposed Elliott Bay background sediment concentration sampling locations are presented on Figure 2-2. Rationale for selection of the proposed locations is presented below.

- Sampling Location 1 is representative of northern Elliott Bay and is the same as the LDW background site 2. This site is situated near the Magnolia marina and Terminals 90 and 91 and will be located at depths that are comparable to those of Lockheed West. This location is not in the immediate vicinity of known outfalls or industrial use areas that may provide point sources of contamination.
- Sampling Location 2 is representative of northern Elliott Bay and is the same as the PSR background location “BK02”. This location is situated along a municipal park and is at depths that are comparable to those at Lockheed West. This location is not in the immediate vicinity of known outfalls or industrial use areas that may provide point sources of contamination. The location is not situated within an area to have been subject to anthropogenic disturbances. The nearest industrial use is the Port of Seattle bulk grain loading facility.
- Sampling Location 3 is representative of the eastern portion of Elliott Bay. This location is situated along the central waterfront of Downtown Seattle. This location is not in the immediate vicinity of known outfalls or industrial use areas that may provide point sources of contamination. The location is not situated within an area to have been subject to anthropogenic disturbances. Uses of areas near the sampling location are primarily commercial and maritime transportation.

- Sampling Location 4 is representative of the southeastern portion of Elliott Bay. This location is situated along the large container dock south of the central waterfront of Downtown Seattle. This location is not in the immediate vicinity of known outfalls or industrial use areas that may provide point sources of contamination. The location is situated within an area that was last dredged in 1979. Uses of areas near the sampling location are primarily commercial and maritime transportation.
- Sampling location 5 is representative of the southern portion of Elliott Bay. This location is situated along the north shore of Harbor Island. The location is not in the immediate vicinity of known outfalls. The nearshore and onshore areas located near the site are used for maritime commerce purposes such as tug boat storage and shipbuilding. The location is not situated within an area to have been subject to anthropogenic disturbances. Sediment cleanup has been completed at the shipyard facility to the west of the proposed sampling location.
- Sampling location 6 is representative of southwestern Elliott Bay. This location is situated along the west shore Harbor Avenue. This location is not in the immediate vicinity of known outfalls or industrial use areas that may provide point sources of contamination. Uses of areas near the sampling location are primarily public access, municipal parks, and commercial businesses. The location is not situated within an area to have been subject to anthropogenic disturbances. Sediment cleanup has been completed at the PSR facility to the east of the proposed sampling location.
- Sampling Location 7 is representative of western Elliott Bay. This location is situated along the west shore Harbor Avenue. This location is not in the immediate vicinity of known outfalls or industrial use areas that may provide point sources of contamination. Uses of areas near the sampling location are primarily public access, municipal parks, and commercial businesses. The location is not situated within an area to have been subject to anthropogenic disturbances.

Sampling Approach

Surface sediment samples (0 to 10 cm) will be collected from the proposed locations using a grab- type sampling device deployed from a work vessel. On collection, sediment samples will be observed to ensure that the sampling objectives (described above) are met.

Acceptable samples will be submitted to the analytical laboratory for chemical analysis. In the event a given sample location does not yield a sample meeting the above objectives, a second attempt will be made at an alternative location in the vicinity of the proposed location. In the event the second sample location does not yield a sample meeting the above objectives,

a third attempt will be made at an alternative location in the vicinity of the proposed location. In the event the third offset sample is found to be unacceptable then the proposed location will not be sampled.

2.2.4 Physical Testing

Characterization of the physical properties of the Lockheed West sediments will be accomplished to provide the information necessary for an evaluation of remedial options. Physical properties analysis of the sediments will be conducted on selected samples to identify and estimate the dredge and disposal characteristics of sediments likely requiring removal and confinement. Physical characterization testing will include the following:

- PSEP grain size, percent solids, and TOC will be determined at all surface and subsurface locations (conventional analyses).
- In addition, selected samples from the subsurface cores will be submitted for:
 - Atterberg limit determinations by American Society for Testing and Materials (ASTM) Method D4318-84; and
 - Sediment specific gravity determination by ASTM Method D854.

Test results will be used to characterize the sediments and assess the feasibility of removing and/or capping impacted sediments. Specifically, these tests will be used to estimate the dredgability, water generation during dredging, and bulking of sediments subjected to different types of removal techniques.

2.2.5 Water Quality

Surface water samples will be collected from representative locations as supply water for the column settling and elutriate tests. The water will be collected below the water surface but above the bottom using a peristaltic pump with weighted Teflon-lined tubing. Water for the column settling test will be stored in pre-cleaned polyethylene containers. Water for chemical and elutriate testing will be collected and stored in 1-liter amber glass bottles. The bottles will be shipped to the lab and analyzed for the chemical parameters (elutriate tests and baseline chemical testing of surface water). Representative surface water collected and used in the elutriate testing will be analyzed in duplicate for both dissolved and total contaminants of concern.

2.2.6 Topographic Survey

The purpose of the topographic survey is to document the current upland elevations to tie in the current bathymetry survey. This survey will provide additional data that will be used during the FS and design. A survey firm licensed in Washington will conduct a full-coverage topographic survey of the upland area adjacent to Lockheed West site. The survey area will extend from the shoreline bank (to the water's edge) up to 200 feet away on Port of Seattle property. Horizontal positioning will be based on North American Datum (NAD) 1983 and vertical positioning will be tied in to the bathymetry survey which is based on the Port of Seattle MLLW datum for Elliott Bay.

3. LABORATORY ANALYSIS

A detailed description of the laboratory analyses to be conducted is presented in the Quality Assurance Project Plan (QAPP), Appendix D of the Work Plan). This section includes an overview.

3.1 SEDIMENT CHEMISTRY

Sediment samples will be analyzed for COPCs listed in Table 3-1. Analytical methods are listed below for each parameter. Consistent with risk-based low-level detection limits of the Lower Duwamish project, the preferred methods and low-level detection limits are provided in Table 3-2. Additionally, sediment porewater will be analyzed at selected stations for analysis of the COIs in Table 3-1.

Table 3-1. COIs for the Site Characterization

Parameters	Analysis	Sediment Target Detection Limit ^a
Grain Size	PSEP 1986	0.1 % retained
Total Organic Carbon	ASTM 4129/Plumb 19819060	500 mg/kg
TBT	Krone et al. 1989	1-5 µg/kg
Metals	SW846 6020, 6010B	0.03 – 1 mg/kg
Mercury	SW846 7471A	0.003 µg/kg
PCB Aroclors ^b	SW846 8082	0.4 µg/kg
Pesticides	SW846 8081A	0.024- 3 µg/kg
Semivolatiles	SW846 8270C-low level	0.006 – 0.1 mg/kg
PAHs	SW846 8270C-low level	0.001 – 0.05 µg/kg
PCB Congeners ^c	SW846 1668A	0.35 – 0.95 ng/kg
Dioxin/Furans ^c	Method 1613B	0.059 – 0.518 ng/kg

(a) Detection limits are on wet weight basis. Detection limits on dry weight basis are dependent on total solids content.

(b) PCB Aroclors to be analyzed include 1016, 1221, 1232, 1242, 1248, 1254, 1260. Detected Aroclors will be summed to find total PCBs.

(c) Sediment will be archived for potential analysis of PCB Congeners and Dioxin/Furans.

Notes: Samples with high moisture contents or matrix interference may have detection limits higher than those listed.

EPA test methods are found in SW-846. Test methods for the evaluation of solid waste physical/chemical methods.

Table 3-2. Laboratory Method Detection Limits and Reporting Limits

METHOD AND ANALYTE	RL ^a (mg/kg dw)	MDL ^a (mg/kg dw)	SEDIMENT ACG ^b (mg/kg dw)
EPA Method 8270C -low level			
<i>PAHs</i>			
Acenaphthylene	0.02	0.00909	0.33
Benzo(a)anthracene	0.02	0.00834	0.0052
Benzo(a)pyrene	0.02	0.00731	0.00076
Benzo(b)fluoranthene	0.02	0.00734	0.0047
Benzo(k)fluoranthene	0.02	0.0104	0.047
Total benzofluoranthenes ^c	0.02	0.0104	1.2
Benzo(g,h,i)perylene	0.02	0.00804	0.16
Chrysene	0.02	0.00809	0.48
Dibenzo(a,h)anthracene	0.02	0.00835	0.06
Fluoranthene	0.02	0.00849	0.80
Indeno(1,2,3-cd)pyrene	0.02	0.00854	0.0029
Phenanthrene	0.02	0.00863	0.50
Pyrene	0.02	0.00872	5.0
Acenaphthene	0.02	0.00936	0.08
Anthracene	0.02	0.00869	1.1
Fluorene	0.02	0.00917	0.12
Naphthalene	0.02	0.00753	0.50
2-Methylnaphthalene	0.02	0.00721	0.19
Dibenzofuran	0.02	0.00795	0.075
Total LPAHs ^d	0.02	0.00936	1.9
Total HPAHs ^e	0.02	0.0104	4.8
Total PAHs ^f	0.02	0.0104	1,410
<i>Other SVOCs</i>			
1-Methylnaphthalene ¹	0.02	0.00691	na
1,2,4-Trichlorobenzene	0.02	0.00588	0.0041
1,2-Dichlorobenzene	0.02	0.00876	0.012
1,3-Dichlorobenzene	0.02	0.00755	0.17
1,4-Dichlorobenzene	0.02	0.00816	0.016
2-Methylnaphthalene ¹	0.02	0.0183	na
2-Methyl-4,6-dinitrophenol (4,6-dinitro-o-cresol) ¹	0.2	0.11	na
2-Nitroaniline ¹	0.1	0.0542	na
2-Nitrophenol ¹	0.1	0.00878	na
2,4,5-Trichlorophenol	0.10	0.00834	610
2,4,6-Trichlorophenol	0.10	0.010	0.61
2,4-Dichlorophenol	0.10	0.00773	18
2,4-Dimethylphenol	0.02	0.01052	0.029
2,4-Dinitrophenol	0.20	0.1042	12
2,4-Dinitrotoluene	0.10	0.00897	12
2,6-Dinitrotoluene	0.10	0.01073	6.1
2-Chloronaphthalene	0.02	0.00832	490
2-Chlorophenol	0.20	0.00948	6.3
2-Methylphenol	0.02	0.0138	0.063
3,3'-Dichlorobenzidine	0.10	0.0617	1.1
3-Nitroaniline ¹	0.1	0.0532	na
4-Bromophenyl phenyl ether ¹	0.02	0.0129	na
4-Chloro-3-methylphenol ¹	0.1	0.0101	na
4-Chlorophenyl phenyl ether ¹	0.02	0.012	na

Table 3-2. Laboratory Method Detection Limits and Reporting Limits

METHOD AND ANALYTE	RL ^a (mg/kg dw)	MDL ^a (mg/kg dw)	SEDIMENT ACG ^b (mg/kg dw)
4-Nitroaniline ^l	0.1	0.0255	na
4-Nitrophenol ^l	0.1	0.037	na
4-Chloroaniline	0.10	0.0257	24
4-Methylphenol	0.10	0.0135	0.67
Aniline	0.02	0.00912	85
Benzoic acid	0.20	0.105	0.65
Benzyl alcohol	0.40	0.041	0.057
Bis(2-chloroethoxy)methane ^l	0.02	0.0123	na
Bis(2-chloroethyl)ether	0.02	0.00993	0.21
Bis(2-ethylhexyl)phthalate	0.02	0.0108	0.24
Bis-chloroisopropyl ether	0.02	0.00996	2.9
Butyl benzyl phthalate	0.02	0.0103	0.025
Di-ethyl phthalate	0.02	0.135	0.31
Dimethyl phthalate	0.02	0.0120	0.27
Di-n-butyl phthalate	0.02	0.0135	1.1
Di-n-octyl phthalate	0.02	0.0113	0.29
Hexachlorobenzene ⁱ	0.02	0.00928	0.0019
Hexachlorobutadiene ⁱ	0.02	0.00828	0.02
Hexachlorocyclopentadiene ^l	0.10	0.0445	na
Hexachloroethane	0.02	0.00798	0.12
Isophorone	0.02	0.00738	510
Nitrobenzene	0.02	0.0159	2.0
N-Nitrosodimethylamine	0.10	0.00912	0.0095
N-Nitrosodi-n-propylamine	0.10	0.0102	0.069
N-Nitrosodiphenylamine	0.02	0.0107	0.055
Pentachlorophenol	0.10	0.0371	0.36
Phenol	0.02	0.00947	0.42
EPA Method 8082			
Aroclor 1016	0.02	0.00098	0.0061
Aroclor 1221	0.02	0.00098	0.00021
Aroclor 1232	0.02	0.00098	0.00021
Aroclor 1242	0.02	0.00098	0.00021
Aroclor 1248	0.02	0.00098	0.00021
Aroclor 1254	0.02	0.00098	0.00021
Aroclor 1260	0.02	0.00098	0.00021
Total PCBs ^g	0.02	0.00098	0.00021
EPA Method 6020 (except as noted)			
Antimony	0.20	0.005	3.1
Arsenic	0.20	0.02	0.006
Cadmium	0.20	0.02	0.003
Chromium (EPA 6010B)	0.50	0.09	100
Cobalt	0.30	0.03	900
Copper (EPA 6010B)	0.20	0.04	1.3
Lead	2.00	0.12	40
Molybdenum	0.50	0.06	39
Nickel	1.00	0.38	140
Selenium	5.00	0.3	14.9
Silver	0.30	0.03	6.1
Thallium	0.20	0.003	0.52
Vanadium (EPA 6010B)	0.30	0.03	55
Zinc (EPA 6010B)	0.60	0.29	16

Table 3-2. Laboratory Method Detection Limits and Reporting Limits

METHOD AND ANALYTE	RL^a (mg/kg dw)	MDL^a (mg/kg dw)	SEDIMENT ACG^b (mg/kg dw)
EPA Method 7471A			
Mercury	0.05	0.003	0.016
TBT Method - Krone 1989			
Di-n-butyltin ^l	0.006	0.00479	na
n-Butyltin ^l	0.006	0.00451	na
Tri-n-butyltin	0.006	0.00284	0.00028
EPA Method 8081A			
4,4'-DDD	0.002	0.000320	0.0083
4,4'-DDE	0.002	0.000166	0.0026
4,4'-DDT	0.001	0.000284	0.00092
2,4'-DDD	0.002	0.0011	0.0083
2,4'-DDE	0.002	0.000894	0.0026
2,4'-DDT	0.002	0.000870	0.00092
Total DDT ^j	0.002	0.0011	0.00092
Aldrin	0.001	0.000054	0.000063
alpha-BHC	0.001	0.000214	0.09
beta-BHC	0.001	0.000045	0.00063
delta-BHC ^l	0.001	0.00002	na
alpha-Chlordane	0.001	0.000144	0.01
gamma-Chlordane ^l	0.001	0.00012	na
Total chlordane ^k	0.001	0.000964	0.0017
Dieldrin	0.001	0.000049	0.000033
Endosulfan	0.001	0.000129	0.50
Endrin	0.002	0.00024	0.027
gamma-BHC (Lindane)	0.001	0.000141	0.00083
Heptachlor	0.001	0.000027	0.00025
Heptachlor epoxide	0.001	0.000122	0.053
Hexachlorobenzene	0.001	0.000034	0.0019
Oxy-chlordane ^l	0.002	0.00012	na
trans-Nonachlor ^l	0.002	0.000024	na
cis-Nonachlor ^l	0.002	0.000055	na
Methoxychlor	0.010	0.000402	0.44
Mirex	0.002	0.00122	0.27
Toxaphene	0.100	0.0297	0.44
EPA Method 1668			
PCB-77 ^h	2.0E-6	3.9E-7	3.5E-3
PCB-81 ^h	2.0E-6	3.9E-7	3.5E-3
PCB-105 ^h	2.0E-6	4.4E-7	3.5E-3
PCB-114 ^h	2.0E-6	4.6E-7	7.0E-4
PCB-118 ^h	2.0E-6	3.7E-7	3.5E-3
PCB-123 ^h	2.0E-6	9.5E-7	3.5E-3
PCB-126 ^h	2.0E-6	2.1E-7	3.5E-6
PCB-156 ^h	2.0E-6	6.6E-7	7.0E-4
PCB-157 ^h	2.0E-6	6.6E-7	7.0E-4
PCB-167 ^h	2.0E-6	3.5E-7	3.5E-2
PCB-169 ^h	2.0E-6	4.4E-7	3.5E-2
PCB-189 ^h	2.0E-6	3.4E-7	3.5E-3

Table 3-2. Laboratory Method Detection Limits and Reporting Limits

METHOD AND ANALYTE	RL ^a (mg/kg dw)	MDL ^a (mg/kg dw)	SEDIMENT ACG ^b (mg/kg dw)
EPA Method 1613B			
2,3,7,8-TCDD	1.0E-6	5.9E-8	3.5E-07
1,2,3,7,8-PeCDD ^h	5.0E-6	1.53E-7	3.5E-07
1,2,3,4,7,8-HxCDD ^h	5.0E-6	1.72E-7	7.0E-07
1,2,3,6,7,8-HxCDD ^h	5.0E-6	1.18E-7	3.5E-06
1,2,3,7,8,9-HxCDD ^h	5.0E-6	1.72E-7	3.5E-06
1,2,3,4,6,7,8-HpCDD ^h	5.0E-6	1.69E-7	3.5E-06
OCDD ^h	1.0E-5	5.18E-7	3.5E-06
2,3,7,8-TCDF ^h	1.0E-6	7.7E-8	3.5E-06
1,2,3,7,8-PeCDF ^h	5.0E-6	1.32E-7	3.5E-06
2,3,4,7,8-PeCDF ^h	5.0E-6	1.43E-7	3.5E-06
1,2,3,4,7,8-HxCDF ^h	5.0E-6	1.48E-7	3.5E-06
1,2,3,6,7,8-HxCDF ^h	5.0E-6	1.54E-7	7.0E-06
1,2,3,7,8,9-HxCDF ^h	5.0E-6	1.48E-7	3.5E-05
2,3,4,6,7,8-HxCDF ^h	5.0E-6	9E-8	3.5E-05
1,2,3,4,6,7,8-HpCDF ^h	5.0E-6	1.83E-7	3.5E-05
1,2,3,4,7,8,9-HpCDF ^h	5.0E-6	8.1E-8	0.0035
OCDF ^h	1.0E-5	3.81E-7	0.0035

Footnotes**RL** reporting limit**MDL** method detection limit**ACG** analytical concentration goal**mg/kg dw** milligrams per kilogram dry weight**na** not available

RLs or MDLs in BOLD are greater than at least one of their respective ACGs. All of the ACGs that are lower than RLs or MDLs are based on human health RBCs, with the exception of the following four chemicals, which are based on benthic invertebrate RBCs: 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, and hexachlorobenzene.

^a RLs, MDLs, and ACGs from LDWG Surface QAPP (LDWG 2005)

^b ACG for sediment is the lowest of the RBCs for benthic invertebrates, spotted sandpipers, and humans.

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

^d Total LPAHs is the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. RL and MDL are the highest RL and MDL for the LPAHs.

2-methyl naphthalene is not included in the LPAH definition under the SMS and under the DMMP.

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

^f Total PAHs is the sum of the LPAHs and the HPAHs. RL and MDL are the highest RL and MDL for either the LPAHs or HPAHs.

^g Total PCBs is the sum of the Aroclors. RL and MDL are the highest RL and MDL for the individual Aroclors.

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

ⁱ Hexachlorobenzene and Hexachlorobutadiene are also analyzed with 8081A to obtain lower DLs

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

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

^l RLs and MDLs from LDWG Subsurface QAPP (LDWG 2006)

3.2 GEOTECHNICAL AND CONTAMINANT MOBILITY TESTING

A suite of physical tests are used to evaluate dredging and capping methods, dredged material transport and placement, dredge material behavior in the disposal site, potential short-term impacts at the dredge and disposal sites, and capacity of existing sediments to provide foundation support for capping material. The following tests will be completed for selected samples collected in the cores (Table 3-3).

Table 3-3. Geotechnical and Contaminant Mobility Methodology

Parameters	Method
Grain Size	PSEP 1986
Atterburg Limits	ASTM D 4318-95
Specific Gravity	ASTM D 854-92
Column Settling Test	EPA/USACE 1998
Dredge Elutriate Test	DiGiano et al. 1995

ASTM = American Society for Testing and Materials
PSEP = Puget Sound Estuary Program

Grain size will be analyzed by the pipette and sieve method following PSEP and will provide information on site geologic character and engineering properties of sediment proposed for remediation.

Atterberg Limit analysis will be analyzed on selected samples of fine-grained sediment in accordance with ASTM D-4318-95 (includes organic determination). Atterberg limits, which include the liquid limit, plastic limit, and the plasticity index, are used to define plasticity characteristics of clays and other cohesive sediments.

Specific gravity will be measured on selected samples analyzed for engineering properties in accordance with ASTM D-854-92. The specific gravity of sediment samples is used to determine sediment dredgeability, the dispersal and settling characteristics of the dredged material after placement, and the bed consolidation after capping.

The dredging elutriate test (DRET) will be performed on a composite of representative material to be dredged to provide an assessment of contaminant mobility. The DRET method is particularly effective for examining the short-term contaminant release at the point of dredging. The test will be performed in accordance with WES-recommended procedures (DiGiano, et al., 1995) using a solids concentration of 10 g/L and a settling time of one hour. Representative sediment from areas yet undetermined for dredging in the Site will be collected for elutriate testing. Approximately 4 liters of sediment representative of the dredge prism are required. In addition, approximately 10 to 15 liters of site water will be collected

from the waterway for the testing. The elutriate will be analyzed for those constituents that have marine acute and chronic water quality criteria.

The CST is used to model the settling behavior of sediments that may be dredged (EPA/USACE 1998). The objective is to predict the gravity settling rate and behavior of dredged material discharged as a slurry of water and sediment into a containment area. Results of the testing identify the characteristics of the sediment settling and consolidation which are used to select an appropriate dredging/placement method, predict potential water quality effects, and to design the disposal site/containment area. The test is conducted by placing a known quantity of sediment slurry in a settling column and observing the amount of time necessary to settle different size fractions of the sample. The CST will be conducted in general accordance with WES-recommended procedures (USACE 1993) using a solids concentration of 150 g/L. Approximately 40 liters of sediment representing a composite sample and 60 liters of site water are required for the test.

4. REPORTING AND SCHEDULE

4.1 REPORTING

Reporting for this project includes laboratory reports, quality assurance reports, and the final report.

4.1.1 Laboratory Reports

Final written laboratory reports will be required for both chemical and physical analyses. Key elements of these reports are described below. It is expected that these reports, or summaries of these reports (as appropriate), will be appended to the final report.

4.1.2 Chemistry Reports

Final written laboratory reports and data deliverables will contain the following:

- Case narrative
- Identification of all protocols
- Summary results of initial and continuing calibrations
- Method and instrument blanks
- All field sample and field QA/QC sample results
- Surrogate recoveries (organic analyses)
- Matrix spikes (organics, batch specific)
- Matrix spike duplicates (organics only, batch specific)
- Supporting raw data and spectra
- Supporting sample tracking information (e.g. shipping forms, chain-of-custody forms)
- Supporting documentation on any corrective actions

Initial calibration information must include concentrations of each standard analyzed, response factors for each analyte at each standard concentration, relative standard deviation (RSD) (or correlation coefficient for metals analytes) over all standards for individual analytes. The RSD control limit range must also be indicated in the initial calibration summary data.

Continuing calibration information must include the response factor (organic analytes) for each analyte, and the calculated percent difference as compared to initial calibration (organic analytes). Control limits for each analyte must also be indicated on each continuing calibration summary data sheet.

Method blank and field sample data pages must indicate the method reporting limit and the dilution factor. Surrogate reporting forms must list control limits for surrogate recovery. Spike reporting forms (blank and matrix spikes) must indicate spike percent recovery and relative percent difference control limits (if spikes are analyzed in duplicate).

Documentation of detection limits (detection limit studies) and results of performance evaluation samples (supplied by regulatory agencies or purchased from certified vendors) are not required for the data deliverable. However, these records must be supplied upon request. Total measurement error determination for field duplicate samples will be calculated.

Electronic data deliverables will also be required.

4.1.3 Geotechnical Testing and Contaminant Mobility Laboratory Report

Final written laboratory reports and data deliverables will include the following:

- A short write-up on laboratory methods, sample identifications, and problems encountered during testing
- A full data report of all chemistry data for elutriate testing
- Graphs and tables for the column settling test including total suspended solids (TSS) and turbidity versus time, interface height versus time, TSS versus turbidity, percent initial concentration (TSS versus time versus height), average TSS versus time, and initial test parameters with associated test description
- Grainsize data and Atterberg limits presented on graphs
- Volumes and weights of sample used in column settling and elutriate tests
- A copy of the chain-of-custody forms

4.1.4 Data Validation Report

The project QA representative will prepare a report based upon a review of the laboratory analytical data. An internal data validation or third party data validation will be completed. The laboratory quality assurance/quality control (QA/QC) reports and any data package validation reports will be incorporated by reference. This report will identify any laboratory

activities that deviated from the approved referenced protocols and will make a statement regarding the overall validity of the data collected. The data validation report will be incorporated into the final report.

4.1.5 Final Data Report

A final written report will be prepared documenting all activities associated with collection, compositing, and transportation of samples. At a minimum, the following will be included in the data report:

- Brief description of the project and its objectives
- Type of sampling equipment used
- Identification and description of protocols used during sampling and testing and an explanation of any deviations from the sampling plan protocols
- Description or summary of sampling and compositing procedures
- Descriptions of each sample and the sediments (i.e., core logs and sample logs)
- Summary of methods used to locate the sampling positions, and a discussion of the position accuracy
- Locations where the sediment samples were collected. Locations will be reported in NAD 83 State Plane Coordinates
- A plan view of the project showing the actual sampling locations
- Sample results

In addition to the items listed above, the final report will include an electronic file of sample location information (i.e., sample ID, sample type, coordinates, sample data, water depth, and sample depth) and sample results.

Data will be reported according to the data management discussed in the QAPP. Only appropriate laboratory replicates will be reported to two significant figures, both original and field duplicate results will be reported, only the appropriate result for one analyte by two different methods will be reported, and totals will be calculated according to Sediment Management Standards Chapter 173-204 WAC.

4.2 SCHEDULE

The overall schedule for the field effort is shown in Table 4-1. This schedule will be revised, as appropriate, as details of the program are developed.

Table 4-1. Project Schedule

Milestone	Target Timeline/Date
EPA-approval of Site Characterization SAP	November 22, 2006
Project planning, scheduling, and mobilization	30 days
Subtidal field collection effort	January 2007
Draft Data Report	May 2007
EPA Review	45 days
Intertidal field collection effort	April 2007
Addenda to Draft Data Report	July 2007
Final Data Report	January 2008

5. REFERENCES

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- EPA (Environmental Protection Agency). 2006a. Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA QA/G-4. United States Environmental Protection Agency. Office of Environmental Information. EPA/240/B-06/001. Washington D.C. 100pp.
- EPA/USACE. 1998. Evaluation of Dredged Material Proposed For Discharges in Waters of the U.S. – Testing Manual (Inland Testing Manual). EPA-823-B-98. USEPA Office of Water, Office of Science and Technology, Washington, D.C., and Department of the Army, U.S. Army Corps of Engineers, Operations, Construction, and Readiness Division, Washington, D.C. February 1998.
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- LDWG. 2005. Quality Assurance Project Plan: Surface Sediment Sampling for Chemical Analyses and Toxicity Testing of the Lower Duwamish Waterway. Prepared for EPA and Ecology dated January 14, 2005. Prepared by Windward Environmental for Lower Duwamish Work Group, Seattle, WA.
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ATTACHMENT 1

STANDARD OPERATING PROCEDURES

- SOP 1: Sampling Equipment Decontamination
- SOP 2: Decontamination of Hand Sampling Equipment
- SOP 3: Sample Packing and Shipment
- SOP 4: Vibracore Sampling
- SOP 5: Documentation

STANDARD OPERATING PROCEDURE 1

SAMPLING EQUIPMENT DECONTAMINATION

Required Equipment

Source-approved potable tap water
ASTM Type II, or equivalent, reagent deionized (DI) water
Laboratory-grade detergent (i.e., Alconox[®] or equivalent)
5-gallon buckets
Scrub brushes
Plastic garbage can
Plastic sheeting
Sprayers (i.e., garden or hand)
Pressure washer (provided by subcontractors).

Typical Procedures

Preparation:

1. Set up decontamination area on plastic sheeting.
2. Set up “clean” area upwind of decontamination area for air drying of equipment.
3. Fill one 5-gallon “wash” bucket with detergent and potable tap water.
4. Fill spray bottles with DI water and methanol.

Decontamination of Sampling Equipment:

1. Clean all sampling equipment to remove gross contamination.
2. Wash equipment in detergent.
3. Rinse with potable tap water (bucket).
4. Rinse with DI water (sprayer).
5. Air dry.
6. Place disposable items (sampling gloves, paper towels, etc.) in garbage can.
7. Document activities in the field and site logbooks.

Note: In adverse weather conditions, air drying may not be possible. In this case, a methanol rinse will be added.

STANDARD OPERATING PROCEDURE 2

DECONTAMINATION OF HAND SAMPLING EQUIPMENT

Required Equipment

Source approved potable tap water
ASTM Type II, or equivalent, reagent deionized (DI) water
Laboratory-grade detergent (i.e., Liquinox, Alconox, or equivalent)
5-gallon buckets
Scrub brushes
Plastic sheeting
Garden and hand sprayers (plastic).

Typical Procedures

Preparation:

Set up decontamination area—buckets, plastic sheeting, scrub brushes, sprayers.
Set up “clean” area upwind of decontamination area for air drying of equipment.
Fill one 5-gallon bucket with detergent and potable tap water.
Fill a second 5-gallon bucket with potable tap water only.
Fill new/clean spray bottles with DI water (garden sprayer).

Decontamination of Sampling Equipment:

Scrub all sampling equipment to remove gross contamination.
Wash equipment in detergent.
Rinse with potable tap water.
Rinse with DI water.

Note: If sticky or oily residues are observed during sampling, an acid/solvent rinse sequence (i.e., nitric acid [0.1 percent] and isopropanol) will be added prior to the final DI water rinse.

Air dry.

Cover sampling surfaces with aluminum foil.

Place disposable items (sampling gloves, paper towels, etc.) in garbage can, garbage bag, or 5-gallon bucket with lid.

Document activities in the field and site logbooks.

Note: All decontamination fluids will be contained in a tub or bucket for proper disposal.

STANDARD OPERATING PROCEDURE 3

SAMPLE PACKING AND SHIPMENT

Required Equipment

Sampling and Analysis Plan

Indelible, black ink pens

Field logbook

Ziploc[®] bags

Coolers

Blue Ice[®]

Strapping tape or duct tape

Vermiculite

Sample logs

Sample labels

Chain of custody forms

Custody seals.

Typical Procedures

Before packing, all samples will be individually labeled and noted in the field logbook by the Sample Coordinator or designee. Labels will be completed with all required information. The samples will be assigned individual numbers. The sample numbers will be used to complete the chain of custody forms.

Samples to be hand-delivered to the laboratory:

1. Attach sampling label and custody seals (if necessary) on each sample jar.
2. Place each sample in a plastic Ziploc[®] bag and align the label so it can be easily read. Seal the bag.
3. Place individual samples into the cooler so that each container is safely secured.
4. Include sufficient ice or Blue Ice[®] packs to cool samples to 4°C.

5. Complete a chain of custody form for the containers and seal in a Ziploc[®] bag. Place the chain of custody form in the cooler. Always transport the cooler together with its accompanying chain of custody form.

Samples to be shipped to the laboratory:

1. Attach custody seal on each sample jar.
2. Place each sample in a plastic Ziploc[®] bag and align the label so it can be easily read. Seal the bag.
3. Spread a layer of vermiculite or foam peanuts at least 1-inch deep in the bottom of a cooler.
4. Place individual samples into the cooler so each container has at least 1 inch of clearance on all sides.
5. Fill the void spaces with vermiculite, foam peanuts, or other cushioning material. When the level of the cushioning material is even with the jar tops, jiggle the cooler vigorously to settle the cushioning material, then add enough additional material to cover the containers with at least 2 inches.
6. Cover the head space inside the cooler with frozen Blue Ice[®] packs and cover with more packing material.
7. Place the chain of custody form in a sealed Ziploc[®] bag and attach to inside cover of the cooler.
8. Close and latch the cooler. Wrap the cooler and lid with at least two turns of strapping or duct tape. Affix signed custody seals over the edge of the lid and the top of the cooler body at front and rear.
9. Label coolers with up arrows and information to comply with U.S. Department of Transportation requirements.

The Lead Sampler will notify the laboratory approximately when and how many samples will arrive. The samples must be kept refrigerated (or packed with Blue Ice[®]) between sampling and analysis processing. The sample containers will be checked on arrival at the laboratory for breakage.

STANDARD OPERATING PROCEDURE 4

VIBRACORE SAMPLING

Required Equipment

Sampling and Analysis Plan (SAP), Site logbook, Sample logs, Sample labels

Indelible black ink pens

Camera

End caps for Vibracore sleeves

Electrical tape, duct tape, aluminum foil

Vibracore apparatus

Sample shipping containers

Ice

H₂S monitor

Tape measure

Operating Procedures

1. The support frame is maneuvered over the approximate position for the core and the water depth and bottom slope determined. The Vibracore Sampler (VCS) base will be adjusted to the bottom slope, if required.
2. The corer is suspended from the support frame and lowered to the bottom.
3. After successful deployment, the penetration recording system and vibratory head are engaged and the desired penetration is obtained. Penetration versus time is recorded.
4. The core is extracted from the sediment and the VCS is recovered and stowed.
5. The core, with contained sediment, is removed from the driving head and transferred to a processing rack. (Note: Check H₂S in the work space prior to proceeding)
6. Core Measuring: The distance from the top of the core to the end of the core tube is physically measured and the top of the core is marked on the outside of the tube using black indelible ink (large Sharpie[®], etc.).
7. The tube is positioned in the rack to allow cutting at/near the top of the core and the tube is securely clamped to the rack.

8. The excess core tube is cut off using a tube cutter. Two personnel are required—one to operate the tube cutter and a second to hold onto the segment being removed.
9. The core is marked for cutting into desired segments, positioned in the core rack, and cut. As segments are removed, they are sealed, labeled, and stowed in a core storage box. This box is insulated and can be covered if segment length is less than 4 feet. Ice may be used for cooling.
10. The core holding area is then washed down using the deck pump/hose system.
11. Equipment is secured and the support frame is moved to the next sampling site.

Core Acceptance Criteria

A continuous core sample will be collected to the designated coring depth or until refusal.

The depth of core penetration will be measured and recorded.

The core sample will be evaluated at the visible ends of the core tube to ensure that retrieved sediment core reached the required penetration depth. Sample recovery will be inspected relative to the following acceptance criteria:

1. Overlying water is present and the surface is intact;
2. Calculated compaction is not greater than 25 percent; and
3. The core tube appears intact without obstruction or blocking.

STANDARD OPERATING PROCEDURE 5 DOCUMENTATION

Required Equipment

Sampling and Analysis Plan
Indelible black-ink pens
Site logbook (bound and ruled)
Camera

Typical Procedures

Photo Documentation:

1. Record sample location in site logbook.
2. Obtain a sufficient amount of photographs of all material before sampling to ensure accurate documentation of the site and sampled materials

Site Logbook:

Note: One site logbook will be used for all tasks. The sampling coordinator is responsible for documenting all site activities.

1. Label front cover of site logbook in indelible black ink with project name and number, client name, contact number, and start and end dates of field investigation. If multiple logbooks are used, they must be numbered sequentially.
2. Enter the date and page number on the top of each page.
3. Enter the day; date; time of arrival on site; weather conditions; and names, titles, and organizations of personnel present on site.
4. List instrument calibration information including serial number, model number, calibration fluid, readings, adjustments, red line (if applicable), battery level, and person performing the calibration.
5. Record name, title, and organization of all visitors to the site.
6. Describe all site activities performed for each day.
7. Describe any field tests that were performed.
8. Describe any samples collected, their sample numbers, and whether splits, duplicates, or blanks were prepared.
9. List all chain of custody details, including air bills, sample identification numbers, and analytical laboratory.
10. If applicable, list any equipment failures encountered during the day, and how repairs were made.
11. Describe any field changes that occur which deviate from the Sampling and Analysis Plan.
12. Record all telephone calls relating to the field activities.

13. The sampling coordinator or designee must sign the bottom of each page.
14. Label front cover of site logbook in indelible black ink with project name and number, client name, contact number, and start and end dates of field investigation. If multiple logbooks are used, they must be numbered sequentially.
15. Enter the date and page number on the top of each page.
16. Enter the day; date; time of arrival on site; weather conditions; and names, titles, and organizations of personnel present on site.
17. List instrument calibration information including serial number, model number, calibration fluid, readings, adjustments, red line (if applicable), battery level, and person performing the calibration.
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