FINAL SAMPLING AND ANALYSIS PLAN

Oakland Bay Sediment Characterization Study, Mason County, Washington

Prepared for

Washington Department of Ecology
Toxics Cleanup Program
Southwest Regional Office

September 2008

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Toxics Cleanup Program
Southwest Regional Office
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Abbreviations and Acronyms

CFR	Code of Federal Regulations
cm	centimeter
COC	chain-of-custody
COPC	Constituents of Potential Concern
CRI	color rendering index
CSL	cleanup screening level
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DGPS	Differential Global Positioning System
DMMP	Dredged Material Management Program
dpm	disintegrations per minute
DQO	data quality objective
EDD	electronic data deliverable
E & E	Ecology and Environment, Inc.
Ecology	Washington State Department of Ecology
ft	feet (foot)
g	gram
GC/MS	gas chromatography/mass spectroscopy
HCID	hydrocarbon identification
Herrera	Herrera Environmental Consultants, Inc.
HPAH	high molecular weight polycyclic aromatic hydrocarbons
HRGS	Human reporter gene system
in	inch
kg	kilogram
L	liter
LCS	laboratory control sample
LPAH	low molecular weight polycyclic aromatic hydrocarbon
m	meter
MDL	method detection limit
µg	microgram
mg	milligram
MLLW	mean lower low water
MSDS	material safety data sheet
MSMP	Marine Sediment Monitoring Program
MS/MSD	matrix spike / matrix spike duplicate
NAD 83	North American Datum of 1983
nm	nanometer
NWTPH	northwest total petroleum hydrocarbon
OC	organic carbon
oz	ounce
PAH	polycyclic aromatic hydrocarbon

PARCC	precision, accuracy, representativeness, completeness, comparability
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PE	performance evaluation
ppb	parts per billion
PPE	personal protective equipment
ppt	parts per trillion
PQL	practical quantitation limit
PSDDA	Puget Sound Dredged Disposal Analysis
PSEP	Puget Sound Estuary Program
QA/QC	quality assurance / quality control
RI	Remedial Investigation
RL	reporting limit
RPD	relative percent difference
SAP	Sampling and Analysis Plan
SBP	Sub-Bottom Profiler
SIR	Sediment Investigation Report
SMS	Sediment Management Standards
SOPs	standard operating procedures
SQS	Sediment Quality Standard
SSAPA	Sediment Sampling and Analysis Plan Appendix
ft^2	square feet (foot)
m^2	square meter
SVOC	semi-volatile organic compound
TBT	tributyltin
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TDL	target detection limit
TEF	toxic equivalent factor
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TVS	total volatile solids
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet
WAAS	Wide Area Augmentation System
WAC	Washington Administrative Code
WDOH	Washington Department of Health
WHO	World Health Organization
WWTP	wastewater treatment plant

1.0 Introduction

Oakland Bay is one of seven bays identified as a priority for environmental cleanup by the Washington State Department of Ecology (Ecology) as part of the Toxics Cleanup Program's Puget Sound Initiative. Ecology has identified Oakland Bay for focused sediment investigation related to source control, sediment cleanup and restoration. Ecology initiated this sediment investigation because previous environmental investigations throughout the bay, including the Shelton Harbor area, have documented contamination from historical and current industrial and commercial activities around the bay. Previous sediment quality investigations indicated that contaminant concentrations exceeded Chapter 173-204 Washington Administrative Code (WAC) Sediment Management Standards (SMS). Ecology is directing a sediment characterization investigation and a geophysical survey of the bay that will include assessment of potential contamination across the entire bay and assessment of the marine sediment environment associated with terrestrial and aquatic contaminant sources. Herrera Environmental Consultants, Inc. (Herrera) developed this Sampling and Analysis Plan (SAP) as a subcontractor to Ecology and Environment, Inc. (E & E) under Ecology's contract number C0700036 for the purpose of characterizing marine sediment throughout Oakland Bay to support the prioritization of cleanup and restoration actions under the Puget Sound Initiative.

In 2007, the Puget Sound Partnership was established to oversee and coordinate the Puget Sound Initiative into the future. The following objectives for a Puget Sound 2020 Action Agenda were then developed:

- Protect existing habitat and prevent further losses
- Restore habitat functions and values
- Significantly reduce toxics entering Puget Sound fresh and marine waters
- Significantly reduce nutrients and pathogens entering Puget Sound fresh and marine waters
- Improve water quality and habitat by managing storm water runoff
- Provide water for people, fish and wildlife, and the environment
- Protect ecosystem biodiversity and recover imperiled species
- Build and sustain the capacity for action.

To address elements of the first three objectives listed above, efforts will focus on cleaning up toxic sites and preventing new ones. A leading source of pollution to the Sound is contaminated sites around its shorelines. Ecology's Toxics Cleanup Program is in the process of identifying contaminated sites within one-half mile of the Sound and has targeted efforts to clean up and restore contaminated sites within seven priority bays, including Oakland Bay. The baywide approach, rather than a site-specific approach, has been developed to prioritize cleanup of numerous sites within a geographic area.

The Toxics Cleanup Program relies on the MTCA regulations (Chapter 173-304 WAC) that set strict cleanup standards to ensure that the quality of cleanup and protection of human health and the environment are not compromised. The regulations establish protocols for determining whether to formally establish a site of concern based on a series of assessments performed either by Ecology or potentially liable parties. The Sediment Management Standards (SMS) are a set of regulations (Chapter 173-204 WAC) established, in part under the authority of MTCA, to reduce adverse effects on biological resources and significant health threats to humans from surface sediment contamination. This is accomplished by establishing sediment quality standards, applying the standards as the basis for management and reduction of pollutant discharges, and providing a management and decision process for the cleanup of contaminated sediments (173-204-100 WAC).

Within the context of the programs and regulations cited above, the overall goals for the Puget Sound Initiative baywide studies include:

- Determine boundaries where SMS criteria are exceeded
- Allow relative prioritization of areas for cleanup
- Provide sufficient physical, chemical, and biological data to identify a range of remedial alternatives that can be considered.

This study focuses on marine sediment characterization across Oakland Bay, with an emphasis on locations associated with specific upland inputs to the Bay, with locations associated with wood deposition, and with the distribution of contaminants moving across the bay from Shelton Harbor, as well as an overall assessment of bay. This plan describes the objectives and procedures for data collection efforts to characterize the sediment quality of Oakland Bay. The results of the sediment characterization will be used to assist Ecology in determining whether source control, cleanup, or further characterization or analysis is warranted to minimize actual or potential adverse impacts to people and/or the biotic community. This plan includes the following primary sections:

- Introduction
- Site Background and Objectives
- Organization and Schedule
- Study Design
- Quality Assurance / Quality Control
- Field Procedures
- Laboratory Analytical Methods
- Data Analysis and Reporting.

The SAP addresses the major components of Ecology's *Sediment Sampling and Analysis Appendix, Guidance on the Development of Sediment Sampling and Analysis Plans Meeting the Requirements of the Sediment Management Standards* (Chapter 173-204) (2008) and Ecology's *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies* (2004a), and meets the requirements of Puget Sound Estuary Program (PSEP) guidelines (1996).

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2.0 Site Background and Objectives

Oakland Bay is a shallow estuary located in South Puget Sound, with the City of Shelton and its industrial waterfront and harbor located at the southwest corner of the bay (Figures 2-1 and 2-2). Water depth of the bay generally ranges between 10 and 35 ft, with shallow and broad intertidal zones exposed during low tides at the north end of the bay and in Shelton Harbor. Due to the restrictive nature of Hammersley Inlet, a long narrow waterway linking the bay to the Puget Sound Basin, the water in Oakland Bay has high refluxing, low flushing, and high retention rates (Ecology 2004b). Eight major freshwater creeks discharge into the bay: Deer, Cranberry, Malaney, Uncle John, Campbell, Johns, Shelton, and Goldsborough. The waters of Shelton Harbor and the northern portions of Oakland Bay are currently listed as impaired by the State of Washington under Section 303(d) of the Clean Water Act because of fecal coliform bacteria levels (Ecology 2004c).

The Shelton waterfront and harbor have been historically and are currently used by a number of timber and wood product manufacturing industries, including saw mills and plywood manufacturing, pulp and paper production, and insulation board and fiber board manufacturing. Over the years, process chemicals and wastewater from wood-product manufacturing processes have either been discharged through onsite industrial stormwater systems or were released due to accidental spills and leaks to the harbor, to Shelton and Goldsborough Creeks, or across upland portions of the waterfront. Discharges and spills of process chemicals and wastewater have included:

- Release of sulfite waste liquor generated from the former Rayonier pulp mill during outgoing tides from the mid-1920s through the early 1930s. It was believed that the release of the liquor to the bay may have been an important factor in declining commercial oyster production in Oakland Bay by the mid-1940s. Anecdotal evidence indicates that this waste material, at times, had been seen floating on the water surface in the northern portion of Oakland Bay (Ragan 2008). Tidal flushing into northern Oakland Bay occurs during seasonal cycles of the Bay.

- Release of air emission particulates from wood-fired power plants and associated emission stacks operated without air emissions control from Simpson and Rayonier mills along the south shore of Shelton Harbor between the mid-1920s and the late 1950s. Although power plants for the Rayonier pulp mill and burn plant were shut down by 1957, Simpson's main power plant and its associated stacks continued operating without emission control until 1976, when baghouses were installed.

- Residues from both baghouses were mixed into slurries and discharged to both the former wastewater treatment plant (WWTP) on Pine Street (1976 to 1979) and to the existing plant at Eagle Point (1979 to 1984). WWTP effluent was discharged at two locations immediately beyond the harbor limits. Solids that settled out at each WWTP were disposed of at two public landfills (the Shelton "C Street" Landfill and the Mason County Landfill) and at the Dayton wood waste landfill owned by Simpson. After 1984, all residues generated at the Simpson plant were disposed of at their Dayton wood waste landfill.

- Various chemicals used at a former ITT Rayonier Research Laboratory specializing in cellulose chemistry and silvichemicals produced from wood pulp were discharged to the harbor through the laboratory's industrial stormwater discharge system from the mid-1930s to the mid-1990s.

- A wood preservative dip tank (location unknown) was referred to in a 1981 Ecology file. A letter stated that approximately 9,400 gallons of dilute Permatox 200 wood preservative was removed and disposed of by spraying it across the Simpson Dayton dry log sort yard. According to a material safety data sheet (MSDS), the preservative contained chlorinated phenols and pentachlorophenol (PCP).

- Residual Bunker C fuel oil releases to soil and groundwater from leaking aboveground storage tanks previously located between Sawmill #3 and Goldsborough Creek were identified in 1991. Limited removal of contaminated soil was conducted; however, residual contamination was left in place along Goldsborough Creek, the railroad tracks, and a metal frame tower.

- Numerous spill incidents reportedly occurred between 1980 and 2004. Most of the reported spills were petroleum products, including hydraulic oil, soluble or biodegradable lube oil, gear oil, and diesel. Other reported spills included polychlorinated biphenyl (PCB)-contaminated oil next to the railroad roundhouse in 1984; resin and veneer wastewater discharged to Shelton Creek in 1987 and 1988; and waste oil contaminated with PCBs adjacent to the plywood plant near Shelton Creek in 1990.

Numerous pilings have been installed in the harbor since the mid-1920s to support over-water railroad spurs used for unloading logs from trains directly into the water, for stabilizing log rafts, and for shoreline bulkheads.

Barges loaded with wood chips used by the pulp mill for processing into pulp, have historically moored in the harbor adjacent to the pulp mill. Logs used in lumber, plywood, and fiber board manufacturing were rafted and stored in the water prior to processing at sawmills and plywood plants from the late 1800s through the late 1960s. By the early 1970s, Simpson shifted its log handling practices from over-water log storage operations to a dry log sort yard located 3 miles west and inland from Shelton. Some log rafting activities have continued in the harbor since the

Figure 2-1. **Vicinity map of Oakland Bay in Mason County, Washington.**

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Figure 2-2. Site map of Shelton Harbor, Shelton, Washington.

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mid-1970s, including the Simpson log truck unloading facility at the north end of the harbor next to the vessel haul-out and marine railway facility, and along the south shore of the harbor adjacent to the Manke log sorting yard. Wood waste is a concern because it can impact aquatic life and sediment quality. Excessive wood waste can lead to anaerobic sediment conditions, leach compounds toxic to aquatic life (e.g., phenols, benzoic acid, and benzyl alcohol), and may not provide an appropriate substrate for benthic organisms.

From the early 1900s to late 2005, a bulk fuel storage marine facility operated at the north end of Shelton Harbor (also known as the former Evergreen Fuel site; Figure 2-2). In addition to Evergreen Fuel, three bulk fuel storage marine facilities operated about a half mile northeast of Shelton along the west shore of Oakland Bay (Union Oil, Shell, and ARCO) from the early 1930s to the mid-1980s. No site assessments have been conducted to determine whether petroleum releases have occurred at any of the three bulk fuel facilities.

Tributyltins (TBT), used as an anti-fouling agent on boat bottoms, have been found in sediments collected adjacent to the former Simpson marine railway. The presence of TBT in sediment is likely due to historical and current activities, such as sandblasting, cleaning, and painting of log boom boat bottoms and other boats, conducted in the vicinity of the Shelton Marina.

Shelton Harbor has also received discharges from the city's former and existing WWTP outfalls; septic systems; timber industries, commercial businesses, and residential communities; and non-point source runoff from stormwater since the early 1900s. The harbor also receives direct surface water discharge from two freshwater creeks, Shelton and Goldsborough Creeks, both of which flow through and have received industrial stormwater runoff from the Simpson waterfront plant since the early 1940s.

Other sites identified as potential sources of contamination located at a distance from Shelton Harbor and near Oakland Bay or adjacent to creeks that drain into the bay (see Figure 2-1) include:

- Two gasoline service stations operating since the early 1970s, including one station located along SR 3 adjacent to Johns Creek (Bayshore Union 76 gas station) and the other approximately 2,300 ft northeast of the Oakland Bay shoreline (Deer Creek store). Gasoline contamination in soil and groundwater was identified at the Deer Creek station.

- A concrete dip tank that previously contained wood preservatives for treating fence posts was identified at the Calvin J. Moran property adjacent to the bay. The concrete tank has reportedly overflowed during periods of heavy rainfall since last used in 1960.

Shellfish harvesting has historically been an important commercial and subsistence activity in Oakland Bay. Commercial shellfish harvesting became an important aquaculture industry starting in the late 1800s. Pollution associated with sulfite waste liquor discharged by the Rayonier pulp mill is believed to have led to declining commercial oyster production by the mid-

1940s. Re-populating with oysters and other shellfish in the northern portions of Oakland Bay, including Chapman Cove, and developing a second-generation of shellfish production began in the late 1960s.

Over the last 40 years, water quality impacts to Oakland Bay appear to have shifted from industrial effluent to non-point source pollution. Fecal coliform contamination has contributed to recent closures of shellfish harvesting in portions of the bay. Fecal coliform contamination is being investigated by other stakeholders and thus is not part of this investigation.

During early development of commercial shellfish industry in Oakland Bay, growers constructed 1-foot (ft) high concrete berms across tidelands, creating numerous shallow enclosures to retard ebbing tidewater. Plank floors covered over with gravel were placed in the base of many enclosures to provide a substrate for controlled shellfish growing conditions. These bermed structures reportedly still exist across most of the tidelands owned by Taylor Shellfish Company, including Chapman Cove and north and south of Bayshore Point (Ragan 2008). It is unknown whether these structures exist across other privately owned tidelands in Oakland Bay.

Current shellfish growing operations involve regular manipulation of sediment beds that includes significant addition of gravel from upland sources and reworking of the top 6 to 8 ft (Bloomfield 2008). Surface sediment in certain portions of the northern bay do not reflect natural depositional conditions.

Previous Investigations

The following sections summarize previous environmental investigations that have been conducted in Shelton Harbor, Oakland Bay, and Hammersley Inlet over the past 20 years. The studies are discussed by general study area (i.e., Shelton Harbor, and Oakland Bay/Hammersley Inlet), then in chronological order based on when the associated sampling activities occurred. Sampling locations from the previous investigations across Shelton Harbor are shown in Figure 2-3; at the Evergreen Fuel, Shelton Yacht Club and Marina, and former Simpson marine railway within Shelton Harbor in Figure 2-4; and in Oakland Bay and Hammersley Inlet in Figure 2-5.

Sediment data generated from these investigations have been evaluated according to the SMS, as will the data generated by the current Oakland Bay Sediment Characterization Study. The SMS 1) establish standards for the quality of surface sediments, 2) establish a process for applying these standards as the basis for management and reduction of pollutant discharges, and 3) provide a management and decision process for the cleanup of contaminated sediments. Sediment chemistry is evaluated based on threshold criteria that determine the need for further evaluation. Sediment quality standard (SQS) criteria correspond to sediment quality that will result in no acute or chronic adverse effects on biological resources and no significant health risk to humans. If any SQS criteria are exceeded, biological testing (bioassay) may be used to confirm that adverse biological effects can be measured in test organisms in site sediments.

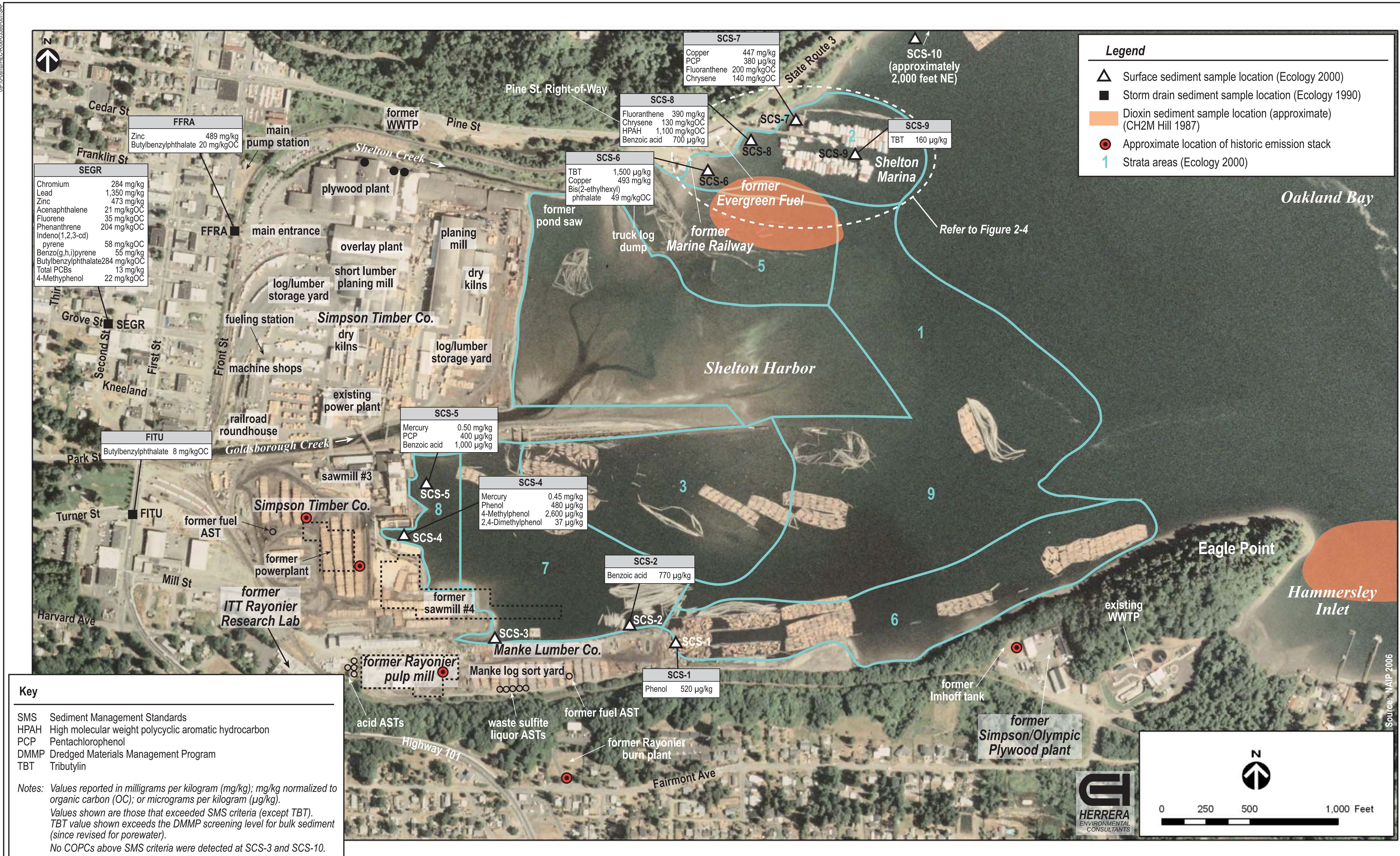

Figure 2-3. **Previous investigation sample locations in Shelton Harbor, Shelton, Washington.**

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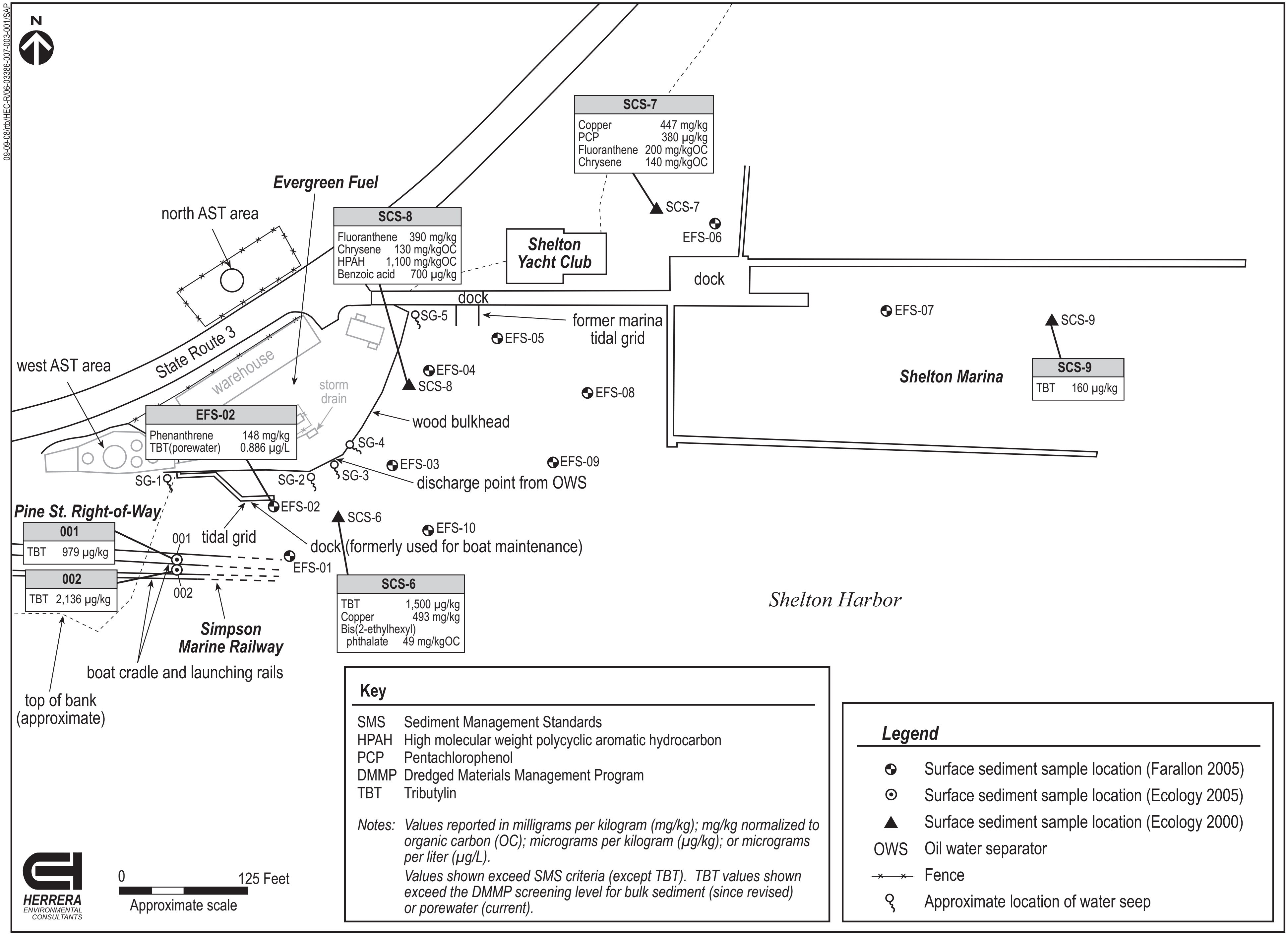

Figure 2-4. **Previous investigation sample locations, former Evergreen Fuel site, Shelton Yacht Club and Marina, and former marine railway, Shelton, Washington.**

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Figure 2-5 Previous investigation sample locations in Oakland Bay and Hammersley Inlet.

Biological testing can also be performed concurrently with, prior to, or instead of sediment chemistry analyses, particularly when other toxic, radioactive, biological or deleterious substances are present. Cleanup screening level (CSL) criteria establish minor adverse effects as the level above which station clusters of potential concern are defined, and at or below which station clusters of low concern are defined. CSL criteria are used to direct sediment cleanup and aid in sediment management decision making.

2.1.1 Shelton Harbor

2.1.1.1 1984-1988 USEPA National Dioxin Study

Between 1984 and 1988, the USEPA conducted a National Dioxin Study to determine the extent of dioxin contamination in the United States and the associated risk to humans and the environment. Simpson volunteered to have their wood-fired power plant tested as part of this study (CH2M Hill 1987). The Simpson power plant was the only wood-fired boiler plant in the area operating at that time. Other wood-fired power plants and associated stacks that previously operated along the south shore of the harbor included the former Rayonier pulp and paper mill; the former Rayonier burn plant above the pulp mill, and the former Simpson/Olympic Plywood plant (Figure 2-3).

In 1986, composite sediment samples composed of five aliquots were collected both from an early former WWTP outfall next to the Evergreen Fuel site and from the existing WWTP outfall east of Eagle Point (Figure 2-3). Samples contained none of the more toxic tetra- through hexa-substituted isomers of chlorinated dioxins or furans, although total dioxins and furans were present and quantified at sub-part per billion levels (CH2M HILL 1987).

2.1.1.2 1989 City of Shelton Storm Drain Sediment Study

A storm drain sediment study was conducted to establish a stormwater priority pollutant concentration baseline in 1989 (Ecology 1990). Fine-grained sediment was collected at six locations in the city. Samples were analyzed for total organic carbon (TOC), percent solids, grain size, semi-volatile organic compound (SVOCs) (USEPA method 8270), pesticides and PCBs (USEPA method 8080), and metals (USEPA method 200 series). Because storm drains were cleaned each summer, data reflected accumulations of less than 1 year.

Three of the six samples collected had contaminant concentrations above SMS SQS criteria. One of the three samples collected from a storm drain at the intersection of Second and Grove Streets (designated as SEGR) had SQS exceedances for chromium, lead, zinc, acenaphthene, fluorene, phenanthrene, indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene, butylbenzylphthalate, total PCBs, and 4-methylphenol. The two remaining storm drain samples, including one located at the intersection of Front Street and Railroad Avenue (designated as FFRA) and the other located just north of the intersection of First and Turner Streets (designated as FITU), had SQS exceedances of butylbenzylphthalate in both samples and zinc in FFRA only) (Figure 2-3).

2.1.1.3 2000 Ecology Reconnaissance Survey of Inner Shelton Harbor Sediments

The objectives of this screening survey of Shelton Harbor sediment focused on evaluating metals and organic contaminant levels near 10 potential sources and estimating the distribution of wood waste in subtidal sediments. Results of sediment screening samples collected at 10 locations near discharge points identified along the Shelton waterfront indicated the following (Figure 2-3; SCS-1 through SCS-10):

- Three surface sediment samples addressing potential contaminant source inputs to the harbor were collected adjacent to Manke log sorting yard and former Rayonier pulp mill along the south shore (SCS-1 through SCS-3). A CSL exceedance for benzoic acid and a SQS exceedance for phenol were identified in two of the three samples; both constituents may be associated with wood waste. No SMS exceedances were identified at SCS-3.

- Two sediment samples addressing potential contaminant source inputs to the harbor were collected adjacent to Simpson operations south of Goldsborough Creek (SCS-4 and SCS-5). CSL exceedances for benzoic acid, phenol, 4-methylphenol, and 2,4-dimethylphenol were identified, all of which may be associated with wood waste. Both samples exhibited mercury levels exceeding the SQS criterion; phenol exceeded the SQS at SCS-4; PCP exceeded the SQS criterion at SCS-5.

- Four surface sediment samples were collected in the vicinity of the Evergreen Fuel/former Simpson marine railway/Shelton Marina area (SCS-6 through SCS-9). Results indicated copper exceeded the CSL criterion at SCS-6 and SCS-7 and benzoic acid exceeded the CSL criterion east of Evergreen Fuel (SCS-8). Other SQS exceedances were identified for bis(2-ethyl hexyl)phthalate, fluoranthene, chrysene, PCP, and high molecular weight polycyclic aromatic hydrocarbons (HPAH). Butyltin concentrations were generally low, except for one sample collected near the base of the launching rails at the vessel haul-out area (SCS-6). Individual concentrations of mono-(1,300 µg/kg), di-(4,100 µg/kg), and tri-(1,500 µg/kg) butyltin chloride all exceeded the PSDDA interim screening level of 73 µgTBT(ion)/kg for butyltin in sediments. Elevated butyltin levels (160 ug/kg) were also found at SCS-9 within the Shelton Marina.

- No SMS exceedances were identified at SCS-10, located approximately 2,000 ft northeast of the harbor.

The harbor was divided into nine strata (Figure 2-3) from which 37 composite surface sediment samples were collected and evaluated for the presence of wood waste. Strata were defined based on log handling practices (e.g., rafting, storing, dumping) and water depth. Results indicated that mean wood content in the nine strata ranged from 5.1 to 18.5 percent on a weight basis. Wood waste was most predominant across the southern half of the harbor, with the highest concentrations near the Simpson and Manke property shorelines. Chemicals associated with wood waste that exceeded SMS were found in four samples from the south harbor and one sample near the marina; and included benzoic acid, phenol, 2,4-dimethylphenol and 4-methylphenol.

2.1.1.4 2005 Remedial Investigation of the Evergreen Fuel Site

Sampling was performed in both upland and sediment areas across the former Evergreen Fuel Site; sampling location map is provided in Figure 2-4 (Farallon 2005). Ten surface sediment samples were collected for chemical analysis from the following locations:

- EFS-01 – Within the intertidal zone near the base of the launching rails of the former Simpson marine railway facility
- EFS-02 – East of the Pine Street right-of-way, within the intertidal zone near a former tidal boat grid and vessel haul-out area
- EFS-03 – Within the intertidal zone near an oil/water separator discharge pipe
- EFS-04 – Within the intertidal zone east of the Evergreen Fuel office and warehouse
- EFS-05 – Within the intertidal zone in the vicinity of the marina's remnant tidal boat grid
- EFS-06 – Within the intertidal zone north of the marina dock
- EFS-07 – In the subtidal zone within the marina to characterize former fuel loading
- EFS-08 and EFS-09 – Approximately 200 ft east and offshore the Evergreen Fuel site within the marina
- EFS-10 – Approximately 130 ft east and offshore from the Pine Street right-of-way near Ecology (2000) sediment sample location SCS-6.

Results of these sediment samples indicated the following:

- Phenanthrene concentration exceeded the SQS criterion at EFS-02 collected within the Pine Street right-of-way.

- Concentrations of diesel- and/or lube oil-range hydrocarbons were detected in nine of the 10 sediment samples collected (no hydrocarbons were detected in EFS-09). Further evaluation of chromatograms from each of the nine samples indicated that apparent total petroleum hydrocarbon (TPH) concentrations consisted entirely of polycyclic aromatic hydrocarbons (PAHs) that elute as TPH in the analyses (Farallon 2005). The PAH concentrations in all nine sediment samples (with the exception of phenanthrene in EFS-02) were below SMS criteria; the PAHs in these samples were interpreted by Ecology as likely associated with residual creosote from nearby treated timbers of the bulkheads and docks.

- No PCBs were detected above practical quantitation limits (PQLs) in either soil or groundwater samples collected during the RI from the upland portion of the site. However, total PCBs were detected in all ten sediment samples ranging from 0.84 to 4.77 mg/kg organic carbon (OC); all concentrations were below SMS criteria.

- TBT in interstitial water was detected in two of the sediment samples: 0.888 µg/L at EFS-02 and 0.0326 µg/L at EFS-03. The Puget Sound Dredge Disposal Analysis Porewater Screening Level of 0.15 µg/L was used as a screening level of concern for the site; therefore, EFS-02 did fail the screening level for TBT.

- Two samples (EFS-08 and EFS-09) exceeded SQS criterion for silver because the laboratory reporting limit was slightly above the criterion. However, silver was not detected at the method detection limit of 0.114 mg/kg, well below the SQS criterion of 6.1 mg/kg. All ten samples exhibited concentrations of arsenic, chromium, copper, lead, mercury, and zinc below their respective SMS criteria. Concentrations of cadmium below the SMS criterion were detected in nine of the ten samples (no cadmium was detected in EFS-01).

Ecology determined that photo-activated PAH compounds were present in sediment at three locations at concentrations warranting bioassay testing. In January 2005, Ecology conducted bioassay tests on sediment sample EFS-03 (split sample) using both the standard method and the ultraviolet (UV) exposure method (Ecology 2008). The guidance for the UV exposure method cites several studies that suggest that photo-activation of certain PAH compounds can result in increased toxicity to organisms. Results indicated no substantial differences between the standard method and the UV exposure method in the 10-day and 20-day tests. In the 48-hour test, the mean individual growth rate for mussels using the UV method was substantially lower than that of the standard method. No further documentation regarding the bioassay data was found in the site file.

In addition to sediment samples, water samples at five seep locations in the intertidal area of the Evergreen Fuel site were sampled (Figure 2-4; SG-1 through SG-5). Based on specific conductance and other geochemical measures taken at three of the seeps, it appeared that fresh water (groundwater) was discharging at seep SG-1 and salt water (marine water) was discharging at SG-2 and SG-4 (Mercuri 2005). No COPCs associated with the Evergreen Fuel site investigation were found at concentrations above regulatory cleanup criteria in samples SG-3 through SG-5. Results for samples SG-1 and SG-2 indicated the following:

- Reddish-brown stained soil was observed above the mean higher high water line near the discharge point for seep location SG-1, southeast and adjacent to the west AST area. Ecology expressed concern that the stained soil may be associated with petroleum product.

- The seep sample collected at SG-2 near the bulkhead indicated the presence of PAHs that may be attributed to contact with creosote-treated pilings.

2.1.1.5 2005 Ecology Initial Investigation of the Simpson Marine Railway

Ecology conducted further investigation of the marine railway to follow-up on TBT found in sediment in the Evergreen Fuel Remedial Investigation (Ecology 2005). Two surface sediment samples were collected and analyzed for the presence of TBT, metals, total organic carbon (TOC), SVOCs, and diesel- and lube oil-range hydrocarbons (001 and 002, Figure 2-4). Both samples contained mono- (180 and 580 µg/kg), di- (510 and 1,800 µg/kg), and tri- (1,100 and 2,400 µg/kg) butyltin chloride. To compare tributyltin chloride results to the PSDDA screening level, the chloride results were multiplied by 0.89 (Michelsen et al. 1996), resulting in 979 and 2,136 µg/kg as TBT for the two samples; both exceeding the PSDDA screening level of 73 µg/kg. No information was available concerning other analytes of concern.

2.1.2 Oakland Bay and Hammersley Inlet

2.1.2.1 1989-1999 Sediment Studies in Oakland Bay

Three sediment quality studies conducted in Oakland Bay were identified in the Ecology Environmental Information Management (EIM) database. The locations of sediment samples collected from these studies are shown in Figure 2-5; the name of the study conducted and samples collected in Oakland Bay include the following:

- 1997-1999 PSAMPNOAA (Puget Sound Assessment and Monitoring Program and the NOAA National Status and Trends Program) – Six sediment samples were collected in Oakland Bay near Shelton Harbor. The samples include PSAMP/NOAA-227, PSAMP/NOAA-228, PSAMP/NOAA-229, PSAMP/NOAA-230, PSAMP/NOAA-231, and PSAMP/NOAA-232.

- 1989-1995 PSAMP HP (Puget Sound Assessment and Monitoring Program's historical sediment monitoring) – This program was part of the

Puget Sound Ambient Monitoring Program; the sediment component of this program was implemented in 1989 by Ecology. Four sediment samples were collected in Oakland Bay as part of this study, including two samples collected outside of Shelton Harbor and one sample near Chapman Cove (same area was sampled twice). The samples include PSAMP HP-50 (in 1989), PSAMP HP-70 (in 1992), and PSAMP HP-101R (in 1990 and 1993).

- 1992 DNRREC92 (Washington DNR Aquatic Lands Sediment Quality Reconnaissance) – Two sediment samples were collected in Shelton Harbor, including DNREC92SHLT01XX and DNREC92SHLT02XX.

Analyses conducted on the sediment samples collected in the three studies included grain size, TOC, SVOCs, metals, PCBs, and pesticides (DNR samples were not analyzed for PCBs or pesticides). No samples exceeded SMS criteria.

In addition to chemical and physical analyses, bioassay toxicity testing was conducted on sediment samples collected during the joint 1997-1999 Ecology/NOAA survey (1997-1999 PSAMPNOAA Programs). The six samples listed in the first bullet above were tested using the following bioassay test methods:

- Amphipod survival in solid-phase sediments
- Sea urchin fertilization success in pore waters
- Microbial bioluminescence activity in organic solvent extracts (Microtox™)
- Cytochrome P450 HRGS (human reporter gene system) induction in organic solvent extracts.

The results indicated significant cytochrome P450 HRGS responses in all six samples collected in Oakland Bay near Shelton Harbor (Long et al. 2003). No toxicity was observed on these samples tested by the three remaining bioassay tests.

Benthic faunal index summaries for all six samples showed reduced total abundance and/or species richness (lower quartile <= 25%). Three stations in Shelton Harbor showed intermediate/degraded sediments based on chemistry, toxicity and benthic fauna.

2.1.2.2 2004/2005 Fecal Coliform Bacteria TMDL Studies

Several agencies have collected fecal coliform data in the Oakland Bay/Hammersley Inlet watershed over the years including the Washington Department of Health (WDOH), the Squaxin Island Tribe, Mason County, and Ecology. In the late 1980s, during extensive reconstruction of Shelton's sewer systems, fecal pollution significantly dropped. In response, WDOH upgraded portions of Oakland Bay from Restricted to Conditionally Approved, allowing shellfish harvesting to take place except during predictable pollution events, such as following significant rainfall (current shellfish harvest restricted areas are depicted on Figure 2-1). Fecal coliform pollution in Oakland Bay has increased slightly in recent years (WDOH 2007).

In September 2004, the shorelines of Oakland Bay and Hammersley Inlet were surveyed for small drainages and/or discharge points in addition to the major tributaries that may contribute pollution to the marine water bodies (Figure 2-5). The 279 identified locations included storm water culverts, unnamed tributaries, and direct runoff points from agricultural activities (Ecology 2004c). In February 2005, out of the 142 drainage points sampled (those conveying water), only 10 had fecal coliform concentrations greater than the water quality standard of 100 colony forming units (cfu)/100 milliliters (ml). Two sites were located in the upper portion of Oakland Bay (one on the northwest shore and one near the mouth of Deer Creek), one site was located just south of Chapman Cove, and the remaining sites were located on the southern shoreline of Shelton Harbor and the southern shoreline of Hammersley Inlet (Ecology 2004c).

Because Oakland Bay is classified as a shellfish growing area, fecal coliform pollution continues to be investigated by several agencies.

2.2 Study Objectives

The scope of this study is limited geographically to the marine areas of Oakland Bay, including northeast Oakland Bay, Shelton Harbor, and the west end of Hammersley Inlet (i.e., to Miller Point).

The general objective of the study is to conduct a multi-faceted, tiered sediment characterization of Oakland Bay to define the baywide nature and extent of potential sediment contamination and wood waste. Water quality conditions, and specifically fecal coliform contamination, are not part of this investigation. The specific objectives of the sediment characterization include the following:

- In Shelton Harbor, conduct a sampling and analysis effort based on previous investigations and existing data gaps to further characterize and prioritize areas for potential cleanup. This will be conducted through:
    - Determination of contaminant concentration trends across the Harbor
    - Sampling near known and suspected sources of contaminants
    - Evaluation of the distribution of wood waste through cores and chemical analysis

    - Determination of the biological effects through toxicity testing in surface sample locations.

- In Oakland Bay, conduct a sampling and analysis effort to assess presence of contaminants and wood waste. Chemical analysis of sediments, wood waste characterization through coring and chemical analysis, and toxicity testing to evaluate biological effects will be performed.

- Evaluate potential for transport of contaminated sediments and wood waste out of Shelton Harbor into and across Oakland Bay and Hammersley Inlet.

- Conduct a geophysical survey to determine the distribution of wood waste across Shelton Harbor and Oakland Bay for mapping and determining volume estimates (core samples will be used to compare visual evidence of wood waste presence to that indicated by the broader geophysical survey).

- Characterize horizontal and vertical extent of contamination in sediment across Shelton Harbor for effects from known and suspected sources, and characterize potential transport into Oakland Bay. Characterize Oakland Bay sediment for effects from tidal flushing, creek inputs, and potential near-shore use of hazardous substances.

- Characterize wood waste using chemical and toxicity testing. In Shelton Harbor, sample locations are associated with a range of wood waste and quantities. In Oakland Bay, sample locations are associated with areas of known rafting and wood waste accumulations.

- Estimate sedimentation rates in Oakland Bay and Shelton Harbor using radioisotope dating and geophysical survey data.

- Conduct bioassays to determine extent of acute and chronic toxicity of sediment at all surface locations in Shelton Harbor and Oakland Bay.

- Conduct a screening-level "fingerprinting" evaluation of TPH, PAHs, and dioxin/furan sediment data to provide a preliminary indication of the usefulness of the analytical data to differentiate between sources of contaminants.

- Provide chemical and toxicity testing comparisons through analysis of sediments from a reference location.

Data generated from site characterization efforts can be used in the future to complete human health and ecological risk assessments; Ecology will determine the need for risk assessments after the sediment and bioassay data have been evaluated. Collection and analysis of tissue samples may be conducted at a later time based on evaluation of data collected during this study.

3.0 Organization and Schedule

Herrera, as a subconsultant to E & E, will manage technical work conducted for the project, including background information gathering, plan preparation, field coordination and sampling, reporting, and performing a geophysical survey. In addition, the expertise of Teresa Michelsen of Avocet Consulting will be utilized for study design and data evaluation support, and for senior review of key deliverables.

Key staff to be assigned to this work assignment includes:

- Andy Hafferty (E & E), Principal in Charge, Senior Chemist and Oceanographer
- Peter Jowise (Herrera), Project Manager
- Gina Catarra (Herrera), Assistant Project Manager and Field Team Leader
- Rob Zisette (Herrera), QC Manager
- Teresa Michelsen Ph.D. (Avocet Consulting), Study Design/Data Evaluation Advisor
- Jennifer Goldsmith (Herrera), Fluvial Geomorphologist
- Jeff Parsons Ph.D. (Herrera), Coastal Geomorphologist.

In addition to the key staff identified above, the project team will include staff level scientists from E & E and Herrera for SAP development, field work implementation, laboratory coordination, and report production.

E & E solicited competitive bids for laboratory analytical services and for independent validation of laboratory data and database development for the Port Angeles Harbor Sediment Study, and given the high degree of nearly identical activities anticipated in the Oakland Bay Study, the same laboratories will be utilized for the Oakland Bay Study. Herrera will subcontract the following laboratories to ensure a high level of data comparability for this work assignment:

- Axys Analytical Services, Ltd. for dioxin/furan analyses
- Test America for TPH, metals, pesticides, PCBs, and sediment core dating analyses
- Analytical Resources, Inc. for grain size, TOC, SVOCs, sulfide, ammonia, TBTs, total volatile solids (TVS) and wood resins analyses

- New Fields Northwest, LLC for bioassay tests
- Global Geophysics for marine geophysics survey
- Research Support Services (RSS) and Bio-Marine Enterprises for sampling vessels.

The major deliverables and associated deadlines for this work assignment are presented in Section 3-1.

3.1 Schedule and Deliverables

The major deliverables and associated deadlines for this work assignment are listed below.

Deliverable	Schedule Deadline
Final Existing Information and Data Gaps Memorandum	April 22, 2008
Public Review Draft SAP/HSP/RA Work Plan	May 8, 2008
Geophysical Study	June, 2008
Public Comment Period	June 2 – August 11, 2008
Public Meeting	June 16, 2008
Stakeholder Meeting	July 29, 2008
Technical Meeting	August 6, 2008
Stakeholder Meeting	August 11, 2008
Ecology technical memo about SAP changes to stakeholders	August 18, 2008
Final SAP Work Plan and Responsiveness Summary	September 25, 2008
Commence Field Work	September 29, 2008
Progress reports to stakeholders (via attendance at Clean Water District Advisory Meetings) and email)	October 2008 to June 2009
** Presentation to stakeholders of preliminary study results	by May 2009
** Public Review Draft Sediment Investigation Report (SIR) for 30 day comment period (7 to 10 days after presenting to stakeholders)	July 2009
** Final SIR	September2009

** Dates are approximate

4.0 Study Design

This section describes the study design for each data type to be collected for the Oakland Bay Sediment Characterization Study. The study follows methods and guidance developed under State sediment management programs (Sediment Management Standards (173-204 WAC) and Sediment Sampling and Analysis Plan Appendix (Ecology 2008), Puget Sound Estuary Program and the Dredge Materials Management Program), input from citizens and stakeholders, and from public meetings. A summary of sampling areas within Oakland Bay is presented in Table 4-1.

Table 4-1. Summary description of sampling areas.

Areas of Concern	Location	Potential Sources of Interest
Oakland Bay	Northeast and central Oakland Bay	Six creeks, three bulk fuel facilities, two gas stations, a wood preservative site, log rafts
Shelton Harbor	West of Oakland Bay and Hammersley Inlet	Two creeks, numerous stormwater and industrial waste pipe discharges, overland flow from industrial operations, fuel spills, groundwater, historic wood treating, log rafting, wood chip loading
Hammersley Inlet	Southeast portion of Oakland Bay and Hammersley inlet to Miller Point	WWTP effluent discharges, log rafts, sediment redistribution from Shelton Harbor
Reference Samples	Carr Inlet	Reference sediment for toxicity testing

Sediment samples will be collected across Shelton Harbor, Oakland Bay, and Hammersley Inlet to identify the presence of contaminants of potential concern (COPCs), to estimate the abundance of wood waste, and to evaluate sedimentation rates. Samples will be collected from stations associated with historical discharges to the marine environment along the shorelines and from areas across each water body where either wood waste has been directly deposited, where aerial deposition has or is likely to have occurred, or contaminants may have been redistributed by fluvial forces. Some sampling locations are referred to as sediment sample locations and others are described as wood waste sample locations. The distinction has been made to identify specific locations either known or suspected to have been impacted by the release of wood waste into the native sediment; these locations are the wood waste sampling stations. Sediment sampling locations are in areas where the sediment is not expected to have been significantly impacted by wood waste. Samples will be collected from the sediment surface (0 to 10 cm) and from 4-ft (sediment locations) or 12-ft (wood waste locations) cores. Core depths will be impacted by sediment composition and the degree to which sample collection equipment can penetrate the wood waste or sediment.

Industrial COPCs include SVOCs, organochlorine pesticides, PCBs as Aroclors, heavy metals, dioxins/furans, petroleum hydrocarbons, and TBTs. TOC and grain size analyses will be conducted to supplement the COPC data. Wood waste COPCs include sulfide, ammonia, and fatty acid resins; the wood waste component will be determined through analysis of total volatile solids on a percentage basis. Wood waste "sediments" are expected to be composed of wood waste materials mixed with sediment. Field personnel will remove larger, obvious wood waste materials (e.g., large pieces of bark or solid wood chips) from each sample prior to submitting aliquots for analysis. No attempt will be made to remove wood waste fines from the samples. A visual estimate of gross wood content encountered in the field will be made during sampling and recorded in notebooks. A summary of total sample numbers and analyses required is provided in Section 6.0.

The Summary of Existing Conditions and Data Gaps report (Herrera 2008) identified seven major issues of concern that will be addressed in this SAP, including:

- The spatial extent and contaminant concentration of wood waste debris associated with pulp, paper, and lumber mill activities, including log rafting.
- Petroleum contamination in areas associated with petroleum-based industry, machinery and vehicles associated with timber processing, boating, and stormwater runoff from roads.
- COPC concentrations in sediment near industrial discharge points along the Shelton Harbor shoreline.
- COPC concentrations in sediment near creek discharge points.
- TBT contamination in sediment and biota near the marina and marine railway.
- SVOC concentrations associated with dense areas of intact, degrading, and/or submerged creosote pilings.
- Sediment contaminant concentrations where significant intertidal and shallow subtidal beaches are present, and where contact with or consumption of bivalves by biota and human populations is increased.

To address these data gaps, first geophysical surveys will be conducted across Oakland Bay, Shelton Harbor, and Hammersley Inlet and then sediment and wood waste sediment samples will be collected.

4.1 Geophysical Surveys

Two different, but complementary, data-collection methods will be used to provide information to meet the diverse objectives of the Oakland Bay study. The geophysical study will provide additional information regarding sedimentation within Oakland Bay.

4.1.1 Geophysical Mapping

Shallow acoustic tomography (imaging) of the seabed will be performed across each of the primary geomorphic units throughout greater Oakland Bay, including the Goldsborough Creek delta, Shelton Creek delta, Deer Creek delta, Campbell Creek delta (Chapman Cove) and the main basins of Oakland Bay, Shelton Harbor, and Hammersley Inlet (Figure 4-1). Acoustic imaging will used to estimate the changes in the composition of the uppermost layers of the seabed. The onset of development in the area (i.e., deforestation and other changes to the local hydrology) had a strong impact on sedimentation and thus produced changes in the composition of the seabed. It is expected that these changes will record the amount of sediment deposited since the onset of development 150 years ago. In conjunction with core-dating mentioned below and known geologic markers determined from the background analysis (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. This information will provide a detailed picture of the geomorphic processes active in greater Oakland Bay.

The strength of the reflections observed in the acoustic imaging also will provide an estimate of the absolute composition of the seabed. The presence of different types of wood waste (bark, sawdust) has a strong impact on the reflectivity of the uppermost portion of the seabed, such that acoustic energy is either attenuated or reflected. The reflectivity measurements will then be correlated to the observations made of the sediment cores and used to extrapolate the core observations throughout the Bay.

Electrical resistivity mapping of marine sediments is also capable of resolving wood waste horizons and estimating wood waste thicknesses. Resistivity mapping in areas of known wood waste (inner Shelton Harbor) will help identify the thickness of wood waste, as well as its interaction with ongoing sedimentological processes (Figure 4-1). The survey will be performed along several lines oriented north-to-south across the inner harbor; the exact locations will be determined in the field to provide adequate coverage and ability of the technique to resolve the presence of wood waste.

Finally, side-scan sonar will be used to identify anomalous large material lying on the seabed. It is expected that large logs and other refuse/debris will be observed in the side-scan data.

4.1.2 Sediment Core Dating

The goal of the sediment core dating (radioisotopic sediment survey) is to determine the historical patterns (within the last 100 years) of sedimentation and accumulation in Oakland Bay and Shelton Harbor. Although studies have been performed on the circulation of Oakland Bay, this work was not specifically targeted to understand the dynamics of the sediment transport, in particular the mobility of contaminated sediment and wood waste. The lead-210 results should enable a sediment budget of the Bay, which would determine the extent of removal of contamination from erosion and the areas ultimately most affected by the accumulation of contaminated sediment and wood waste.

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-3 and OB-5 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. The technique works by examining the change in the relative presence of lead-210. Lead-210 ceases to be reformed once it is buried. The remaining lead-210 decays at a known rate. Therefore by measuring the amount of lead-210 in sediment it can be determined how long it has been since that particular sediment was buried. Sedimentation rate can be estimated by examining the trend in the reduction of lead-210 with depth below the seabed.

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 were identified at locations chosen to help assess the presence of chemical contaminants and wood waste, to identify potential sources of hazardous substances, and to evaluate contaminant transport and sediment depositional rates. Sampling station locations were selected based on guidance for initial investigation of sediment contamination in the *Sediment Sampling and Analysis Plan Appendix* (Ecology 2008) and review of previous studies in Oakland Bay (Herrera 2008). Sampling locations within Oakland Bay are presented on Figure 4-2.

Sediment chemistry analyses, wood waste sediment chemistry analyses, and bioassay toxicity analyses will be completed concurrently. A surface (0-10 cm) sediment sample will be collected at each sediment sampling station and submitted for analyses. In addition, a 4-ft core will be collected at each sediment sampling station. A surface (0-10 cm) wood waste sediment sample will be collected at each wood waste station. A subsurface core will be advanced a minimum of 4 ft or to the bottom of the wood waste encountered (to a maximum depth of 12 ft) at each wood waste station. Core samples will be collected by sectioning each core into 1-ft intervals (for example; 0-1 ft, 1-2 ft, and so on to the maximum depth of the core) and containerizing sediment from each interval. Each surface and core sample will be visually evaluated for gross wood content to allow estimates of wood waste thickness, type (bark, chips, sawdust), and abundance.

The analyses to be conducted on individual samples are based on *Sediment Sampling and Analysis Plan Appendix* (Ecology 2008) guidance and review of previous studies (Herrera 2008).

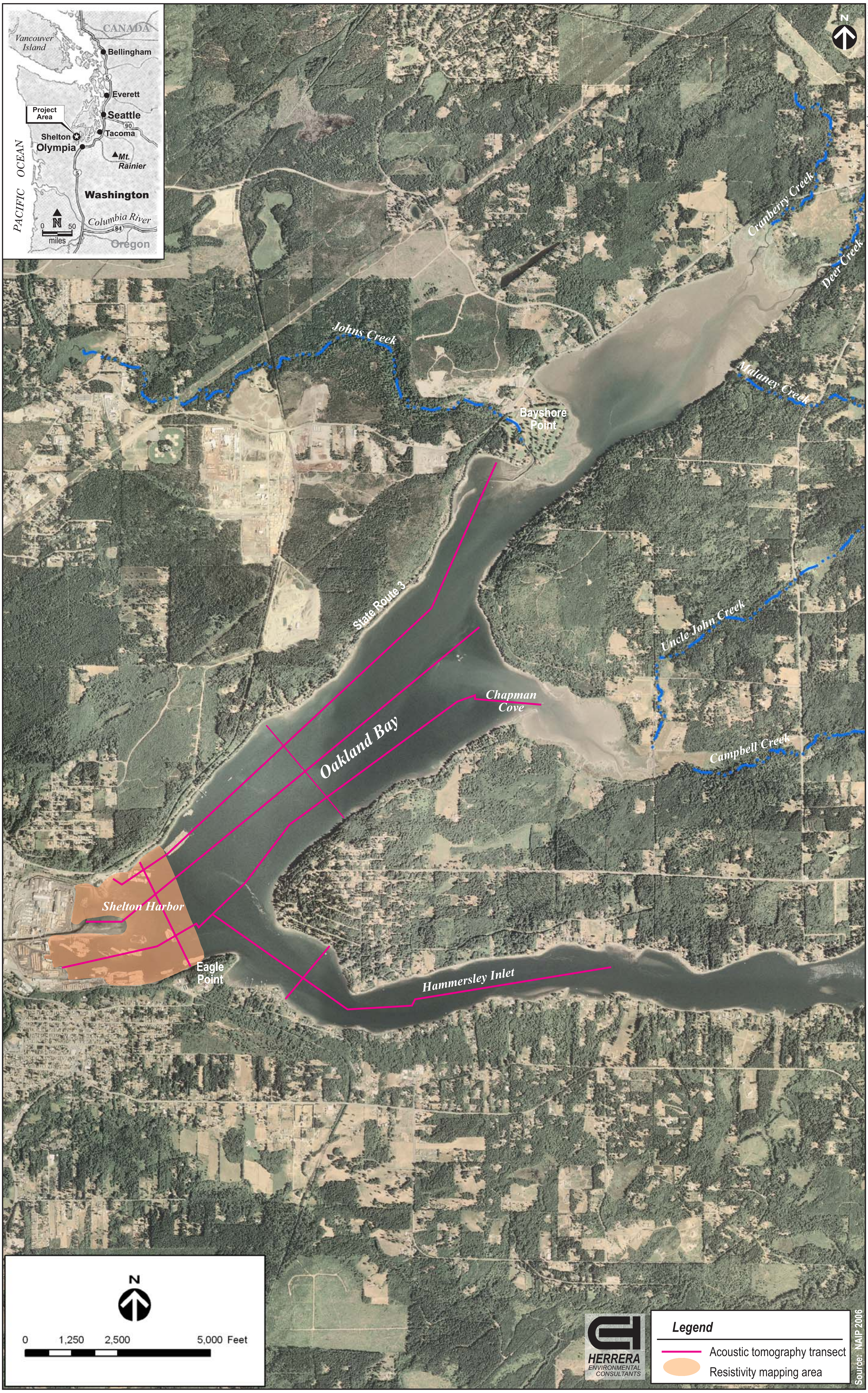

Figure 4-1. Geophysical mapping locations across Oakland Bay in Mason County, Washington.

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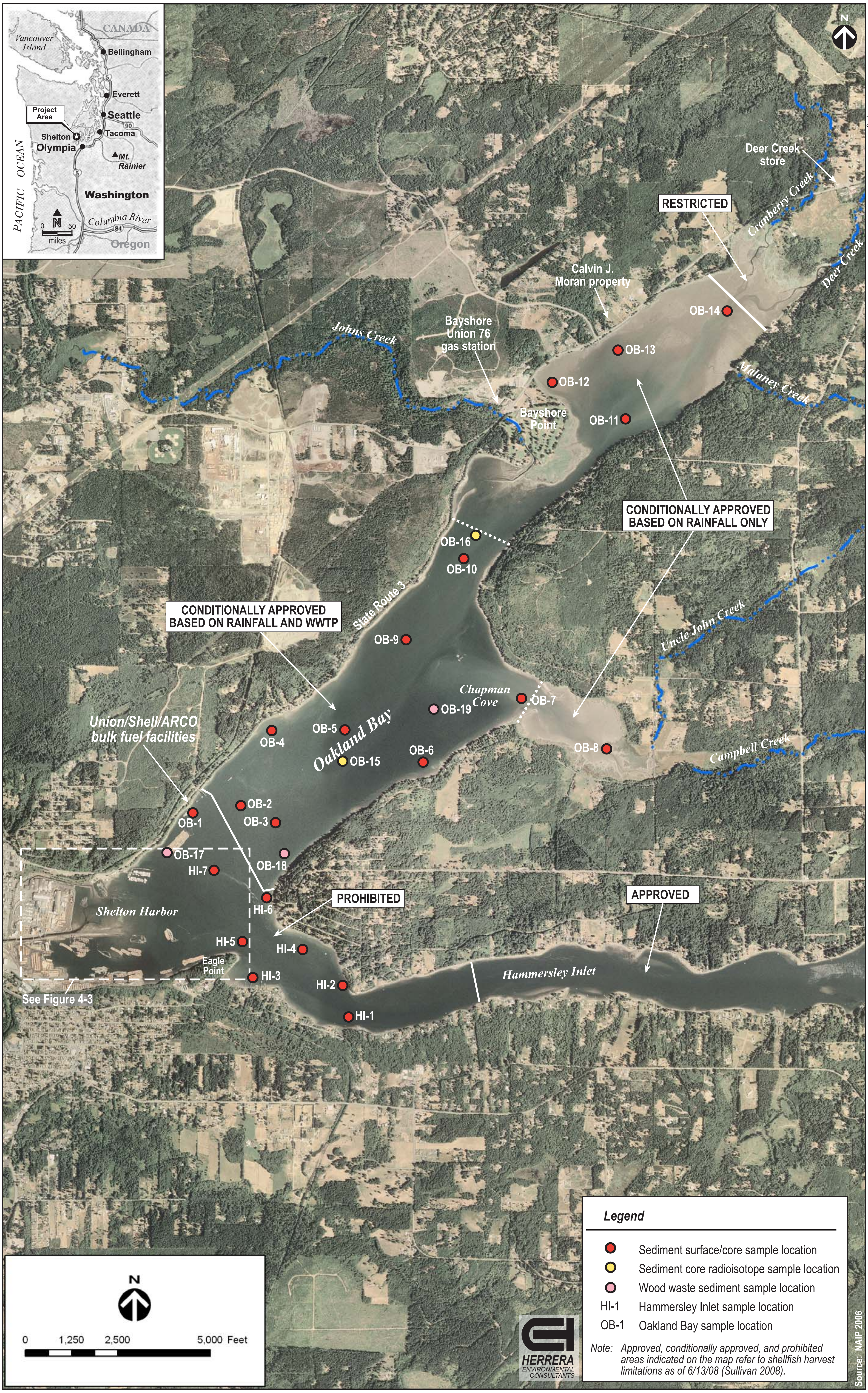

Figure 4-2. Sediment and wood waste sample locations (to be collected) in Oakland Bay and Hammersley Inlet in Mason County, Washington.

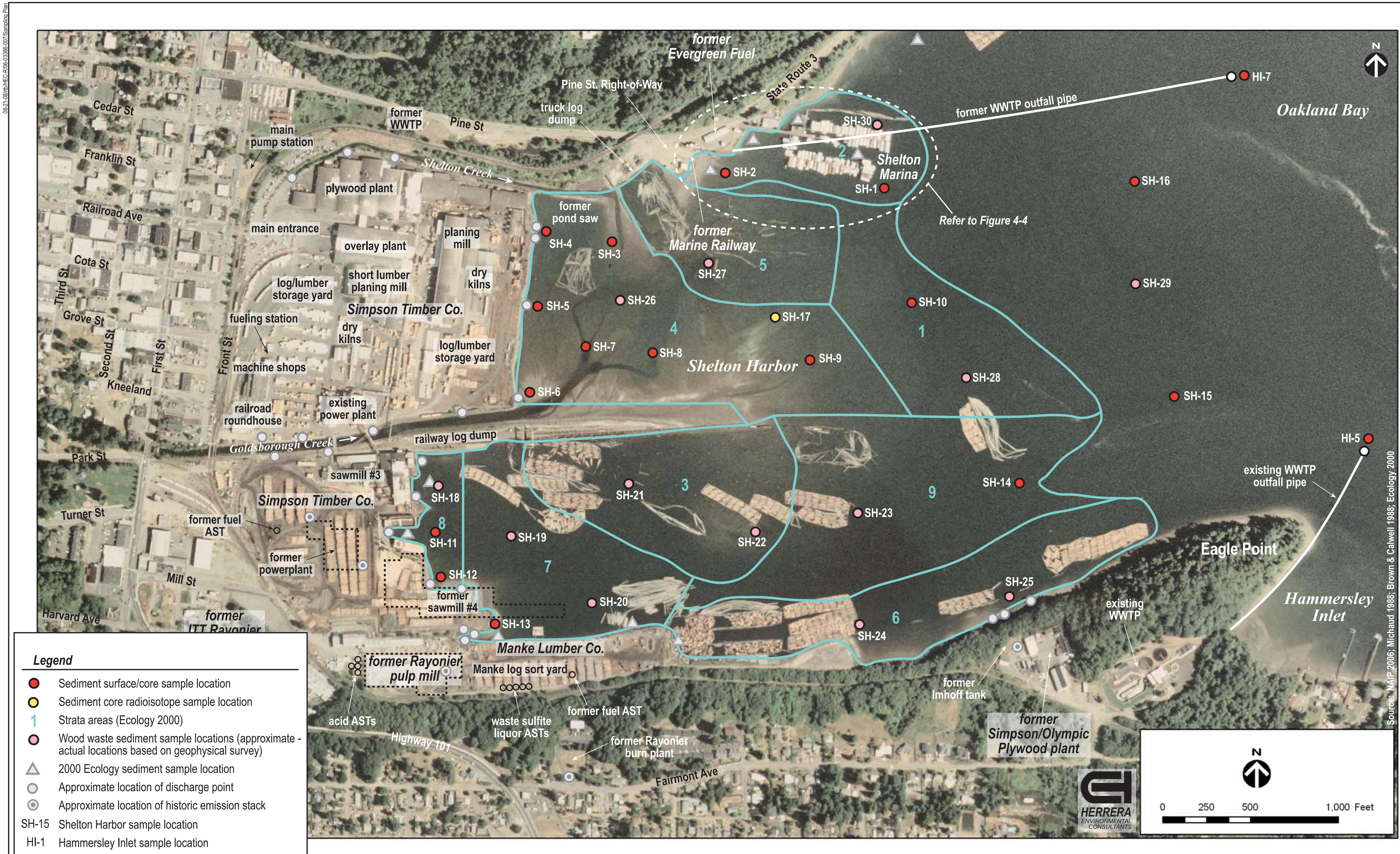

Figure 4-3. Sediment and wood waste sample locations (to be collected) in Shelton Harbor, Shelton, Washington.

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4.2.1 Sediment

Sampling stations have been established in general transects across the bay, at locations to characterize bay boundaries, and at locations to represent depositional sediments. 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 and bioassay toxicity.

4.2.1.1 Surface Sediment Samples

Representative surface sediment (0 to 10 cm) samples will be collected at 14 locations within Oakland Bay (Figure 4-2). An aliquot from each location will be homogenized and submitted for chemical and bioassay analysis. Sample aliquots for ammonia and sulfide will be collected prior to sample homogenization to minimize losses due to volatilization. Refer to Section 6 for recommended holding times for analyses. As shown in Tables 4-2 and 4-3, samples from all locations will be analyzed for the broad spectrum of industrial discharge COPCs. Surface sediment samples will also be analyzed for dioxins/furans and bioassay toxicity. A few samples near potential on-shore petroleum sources will be analyzed for TPH. 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. Core sampling locations will be co-located at the 14 surface sediment locations (Figure 4-2). Cores will be advanced to 4+ ft below the surface using a Vibracore sampler. If significant wood waste is encountered, based on visual observations, cores will be advanced to to the bottom of the wood waste, to a maximum of 12 ft. Cores will be archived as sample aliquots in 1-ft increments beginning at the sediment surface and may be submitted for chemical analysis at a later time. The 1-2 ft segment from each core will be divided into multiple aliquots. Each other 1-ft increment will be homogenized and archived (identified in Table 4-3).

Sample aliquots for ammonia and sulfide will be collected from the 1-2 ft increment prior to sample homogenization. The remaining 1-2 ft core sample material will be homogenized and sample aliquots for grain size and TOC will then be collected. Because archiving (freezing and deferring analyses until a later date) of sediments may affect results for some analyses (total sulfides, ammonia, total organic carbon, and grain size), 1-2 ft increment samples will be initially analyzed for these parameters only. The remaining material will be placed in the applicable sample containers as if they were to be analyzed immediately (these samples are marked with a “P” in Table 4-3 to indicate that they are ready for potential additional analyses). As with the archived samples, these containerized samples will be stored frozen. Each other 1-ft increment will be homogenized and placed in large sample jars for archiving. 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.

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

Sample ID [a]	Description [b]	Sample Justification
OB-01-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-01-SC-12	Subsurface	Former bulk fuel storage along shoreline. Analyze for COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-02-SS-00	Surface	Characterization of lower-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 lower-Oakland Bay. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-03-SS-00	Surface	Characterization of lower-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 lower-Oakland Bay. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-04-SS-00	Surface	Characterization of mid-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 mid-Oakland Bay. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-05-SS-00	Surface	Characterization of mid-Oakland Bay. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-05-SC-12	Subsurface	Characterization of mid-Oakland Bay. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-06-SS-00	Surface	Characterization of mid-Oakland Bay. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-06-SC-12	Subsurface	Characterization of mid-Oakland Bay. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-07-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.

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

Sample ID [a]	Description [b]	Sample Justification
OB-07-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-08-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-08-SC-12	Subsurface	Uncle John and Campbell Creeks – 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	Characterization of upper mid-Oakland Bay. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-09-SC-12	Subsurface	Characterization of upper mid-Oakland Bay. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-10-SS-00	Surface	Characterization of upper mid-Oakland Bay . COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-10-SC-12	Subsurface	Characterization of upper mid-Oakland Bay. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-11-SS-00	Surface	Characterization of upper-Oakland Bay (topographic low). COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-11-SC-12	Subsurface	Characterization of upper-Oakland Bay (topographic low). COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-12-SS-00	Surface	Characterization of upper-Oakland Bay (public access). COPCs (SVOCs, pesticides, PCB, TPH, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-12-SC-12	Subsurface	Characterization of upper-Oakland Bay (public access). COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
OB-13-SS-00	Surface	Concrete tank with wood preservative along shoreline – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, TPH, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-13-SC-12	Subsurface	Concrete tank with wood preservative along shoreline – potential point source to Oakland Bay. Analyze for COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.

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

Sample ID [a]	Description [b]	Sample Justification
OB-14-SS-00	Surface	Deer Creek and 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-14-SC-12	Subsurface	Deer Creek and 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-15-RI-04	Sediment Core	Sediment core dating. Collect from deepest area in central portion of Oakland Bay.
OB-16-RI-04	Sediment Core	Sediment core dating. Collect along edge of Johns Creek alluvial fan.
OB-17-WS-00	Wood Waste	Historic log rafting area north of Shelton Harbor. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-17-WC-12	Wood Waste	Historic log rafting area north of Shelton Harbor. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).
OB-18-WS-00	Wood Waste	Historic log rafting area north of Munson Point. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
OB-18-WC-12	Wood Waste	Historic log rafting area north of Munson Point. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).
OB-19-WS-00	Wood Waste	Historic log rafting area near Chapman Cove. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms
OB-19-WC-12	Wood Waste	Historic log rafting area near Chapman Cove. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).

[a] Example of sample ID: OB-15-RI-04 = Oakland Bay, Station 15, Radioisotope, 0-4 ft interval. Additional identifiers: SC = sediment core; SS = surface sediment; WC = wood waste sediment core; WS = wood waste surface sediment. See Section 6.1.1.
[b] Description of matrix: surface or subsurface sediment, or wood waste sediment.

Table 4-3. Summary of samples to be collected from Oakland Bay.

Sample ID [a]	Description	TOC/ GS	SVOC	Resin	Pest	PCB [b]	Dioxin/ Furan	TPH	TBT	Metal	S2 NH3	TVS	Pb210	Cs137	Bioassay
OB-01-SS-00	Surface	X	X		X	X	X	X		X	X				X
OB-01-SC-12	Subsurface	X	P		P	P				P	X				
OB-02-SS-00	Surface	X	X		X	X	X			X	X				X
OB-02-SC-12	Subsurface	X	P		P	P				P	X				
OB-03-SS-00	Surface	X	X		X	X	X			X	X				X
OB-03-SC-12	Subsurface	X	P		P	P				P	X				
OB-04-SS-00	Surface	X	X		X	X	X			X	X				X
OB-04-SC-12	Subsurface	X	P		P	P				P	X				
OB-05-SS-00	Surface	X	X		X	X	X			X	X				X
OB-05-SC-12	Subsurface	X	P		P	P				P	X				
OB-06-SS-00	Surface	X	X		X	X	X			X	X				X
OB-06-SC-12	Subsurface	X	P		P	P				P	X				
OB-07-SS-00	Surface	X	X		X	X	X			X	X				X
OB-07-SC-12	Subsurface	X	P		P	P				P	X				
OB-08-SS-00	Surface	X	X		X	X	X			X	X				X
OB-08-SC-12	Subsurface	X	P		P	P				P	X				
OB-09-SS-00	Surface	X	X		X	X	X			X	X				X
OB-09-SC-12	Subsurface	X	P		P	P				P	X				
OB-10-SS-00	Surface	X	X		X	X	X			X	X				X
OB-10-SC-12	Subsurface	X	P		P	P				P	X				
OB-11-SS-00	Surface	X	X		X	X	X			X	X				X
OB-11-SC-12	Subsurface	X	P		P	P				P	X				
OB-12-SS-00	Surface	X	X		X	X	X	X		X	X				X
OB-12-SC-12	Subsurface	X	P		P	P				P	X				
OB-13-SS-00	Surface	X	X		X	X	X	X		X	X				X

Table 4-3 (continued). Summary of samples to be collected from Oakland Bay.

Sample ID [a]	Description	TOC/ GS	SVOC	Resin	Pest	PCB [b]	Dioxin/ Furan	TPH	TBT	Metal	S2 NH3	TVS	Pb210	Cs137	Bioassay
OB-13-SC-12	Subsurface	X	P		P	P				P	X				
OB-14-SS-00	Surface	X	X		X	X	X			X	X				X
OB-14-SC-12	Subsurface	X	P		P	P				P	X				
OB-15-RI-04	Sediment Core												X	X	
OB-16-RI-04	Sediment Core												X	X	
OB-17-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X
OB-17-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
OB-18-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X
OB-18-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
OB-19-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X
OB-19-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
Archived Samples															
OB-01-SC-01	Subsurface														
OB-01-SC-23	Subsurface														
OB-01-SC-34	Subsurface														
OB-02-SC-01	Subsurface														
OB-02-SC-23	Subsurface														
OB-02-SC-34	Subsurface														
OB-03-SC-01	Subsurface														
OB-03-SC-23	Subsurface														
OB-03-SC-34	Subsurface														
OB-04-SC-01	Subsurface														
OB-04-SC-23	Subsurface														
OB-04-SC-34	Subsurface														
OB-05-SC-01	Subsurface														

Table 4-3 (continued). Summary of samples to be collected from Oakland Bay.

Sample ID [a]	Description	TOC/ GS	SVOC	Resin	Pest	PCB [b]	Dioxin/ Furan	TPH	TBT	Metal	S2 NH3	TVS	Pb210	Cs137	Bioassay
OB-05-SC-23	Subsurface														
OB-05-SC-34	Subsurface														
OB-06-SC-01	Subsurface														
OB-06-SC-23	Subsurface														
OB-06-SC-34	Subsurface														
OB-07-SC-01	Subsurface														
OB-07-SC-23	Subsurface														
OB-07-SC-34	Subsurface														
OB-08-SC-01	Subsurface														
OB-08-SC-23	Subsurface														
OB-08-SC-34	Subsurface														
OB-09-SC-01	Subsurface														
OB-09-SC-23	Subsurface														
OB-09-SC-34	Subsurface														
OB-10-SC-01	Subsurface														
OB-10-SC-23	Subsurface														
OB-10-SC-34	Subsurface														
OB-11-SC-01	Subsurface														
OB-11-SC-23	Subsurface														
OB-11-SC-34	Subsurface														
OB-12-SC-01	Subsurface														
OB-12-SC-23	Subsurface														
OB-12-SC-34	Subsurface														
OB-13-SC-01	Subsurface														
OB-13-SC-23	Subsurface														

Table 4-3 (continued). Summary of samples to be collected from Oakland Bay.

Sample ID [a]	Description	TOC/ GS	SVOC	Resin	Pest	PCB [b]	Dioxin/ Furan	TPH	TBT	Metal	S2 NH3	TVS	Pb210	Cs137	Bioassay
OB-13-SC-34	Subsurface														
OB-14-SC-01	Subsurface														
OB-14-SC-23	Subsurface														
OB-14-SC-34	Subsurface														
OB-17-WC-01	Wood Waste														
OB-17-WC-23	Wood Waste														
OB-17-WC-34	Wood Waste														
OB-18-WC-01	Wood Waste														
OB-18-WC-23	Wood Waste														
OB-18-WC-34	Wood Waste														
OB-19-WC-01	Wood Waste														
OB-19-WC-23	Wood Waste														
OB-19-WC-34	Wood Waste														

[a] Example of sample ID: OB-15-RI-04 = Oakland Bay, Station 15, Radioisotope, 0-4 ft interval. Additional identifiers: SC = sediment core; SS = surface sediment; WC = wood waste sediment core; WS = wood waste surface sediment. See Section 6.1.1.
[b] PCBs analyzed as Aroclors for sediment and wood waste sediment samples.
Bioassay = Sediment Management Standards acute and chronic tests
Ce137 = Cesium-137
Dioxin/furan = 2,3,7,8-substituted isomers and congeners
Metals = Antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc
P = For sediment cores, 1-2 ft interval samples analyzed pending surface sample results.
Pb210 = Lead-210
PCB = Polychlorinated biphenyls
Resin = Wood waste indicator compounds, e.g., guaiacols and fatty acids
Pest = Chlorinated pesticides
SVOC = Semi-volatile organic compounds
TBT = Tributyltin
TOC = Total organic carbon
TPH = Total petroleum hydrocarbons as NWTPH-HCID (hydrocarbon identification)
TVS = Total volatile solids
X = Samples submitted for laboratory analysis.

Based on surface sediment analytical results, additional analysis of the 1-2 ft interval may be conducted on archived sediment core samples. The SMS provides criteria used to identify surface sediment that have no adverse acute or chronic effects on biological resources and no significant risk to humans, which will be used to help determine additional analyses. Specifically, surface sediment with SQS exceedances, bioassay toxicity, or exceedances of other criteria not having an SQS value (see Section 8.1) may trigger subsurface analysis. Additional analyses may be conducted on archived sediment core samples collected over other depth intervals based on this initial data.

4.2.2 Wood Waste

Historical wood rafting operations have been identified, along the shoreline north of the Shelton Marina (station OB-17), across Hammersley Inlet east of Shelton Harbor (station OB-18), and at Chapman Cove (station OB-19).

4.2.2.1 Surface Wood Waste Sediment Samples

Representative surface wood waste sediment (0 to 10 cm) samples will be collected at each of these three locations within Oakland Bay (Figure 4-2). Sediment from each location will be homogenized and submitted for chemical and bioassay analysis. Sample aliquots for ammonia and sulfide will be separated out prior to sample homogenization to minimize losses due to volatilization. Refer to Section 6 for recommended holding times for analyses. 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 wood waste sediment samples will also be analyzed for TVS and other wood waste indicators (resins and guaiacols), dioxins/furans, and bioassay toxicity. The chemical analyte list, analytical methods, TDLs, and comparative criteria are discussed in Section 7.1.

4.2.2.2 Subsurface Wood Waste Sediment Cores

Wood waste sediment cores will be collected to determine the vertical extent of potential contamination. Core sampling locations will be co-located at the three surface wood waste sediment stations (Figure 4-2). Cores will be advanced to 4+ ft below the surface using a Vibracore sampler. If significant wood waste is encountered, based on visual observations, cores will be advanced to to the bottom of the wood waste, to a maximum of 12 ft. Core samples will be collected by sectioning each core into 1-ft intervals and then containerizing sediment from each interval.

Sample aliquots for ammonia and sulfide will be separated from the 1-2 ft increment prior to sample homogenization. The remaining 1-2 ft core sample material will be homogenized and sample aliquots for all other analyses containerized. As shown in Tables 4-2 and 4-3, 1-2 ft interval samples from these locations will be analyzed for the broad spectrum of industrial discharge COPCs, TVS, and other wood waste indicators (resins and guaiacols). The chemical analyte list, analytical methods, TDLs, and comparative criteria are discussed in Section 7.1.

Each other 1-ft increment will be homogenized and placed in large sample jars for archiving and stored frozen (identified in Table 4-3). Core collection and evaluation will include a physical description of the stratigraphy.

The SMS provides criteria used to identify surface sediment that have no adverse acute or chronic effects on biological resources and no significant risk to humans, which will be used to help determine additional analyses. Specifically, surface sediment with SQS exceedances, bioassay toxicity, or exceedances of other criteria not having an SQS value (see Section 8.1) may trigger subsurface analysis. Additional analyses may be conducted on archived sediment core samples collected over other depth intervals based on this initial data.

4.2.3 Bioassays

Bioassays will be conducted to determine the extent of acute and chronic toxicity of sensitive test organisms to contaminants found in Oakland Bay sediments. The 14 surface sediment samples collected across Oakland Bay will be submitted for toxicity testing. In addition, surface wood waste sediment collected from the three wood waste sample locations will be submitted for toxicity testing. Toxicity tests to be conducted on Oakland Bay sediments include amphipod mortality, juvenile polychaete growth, bivalve larvae development, and Microtox® (porewater) bioluminescence. Details on toxicity testing methodology are provided in Section 7.2.

4.3 Shelton Harbor

The study consists of a non-random design that utilizes a tiered analysis approach to spatially characterize sediment conditions across the harbor. Sampling stations are placed at locations with potential and/or known point and non-point sources, to characterize current wood waste distribution, to evaluate movement/concentration trends of contaminants out from the Harbor, and to characterize deposition rates. Station locations were based on guidance for investigation of sediment contamination in the *Sediment Sampling and Analysis Plan Appendix* (Ecology 2008) and review of data from previous investigations in Shelton Harbor (Herrera 2008). Sampling locations within Shelton Harbor are presented on Figures 4-3 and 4-4.

Sediment chemistry analyses, wood waste sediment chemistry analyses, and bioassay toxicity analyses will be completed concurrently. A surface (0-10 cm) sediment sample will be collected at each sediment sampling station and submitted for analyses. In addition, a 4-ft core will be collected at each sediment sampling station. A surface (0-10 cm) wood waste sediment sample will be collected at each wood waste station. A subsurface core will be advanced a minimum of 4 ft or to the bottom of the wood waste encountered (to a maximum depth of 12 ft) at each wood waste station. Core samples will be collected by sectioning each core into 1-ft intervals (for example; 0-1 ft, 1-2 ft, and so on to the maximum depth of the core) and containerizing sediment from each interval. Each surface and core sample will be visually evaluated for gross wood content to allow estimates of wood waste thickness, type (bark, chips, sawdust), and abundance.

The analyses to be conducted on individual samples are based on *Sediment Sampling and Analysis Plan Appendix* (Ecology 2008) guidance and review of previous studies (Herrera 2008).

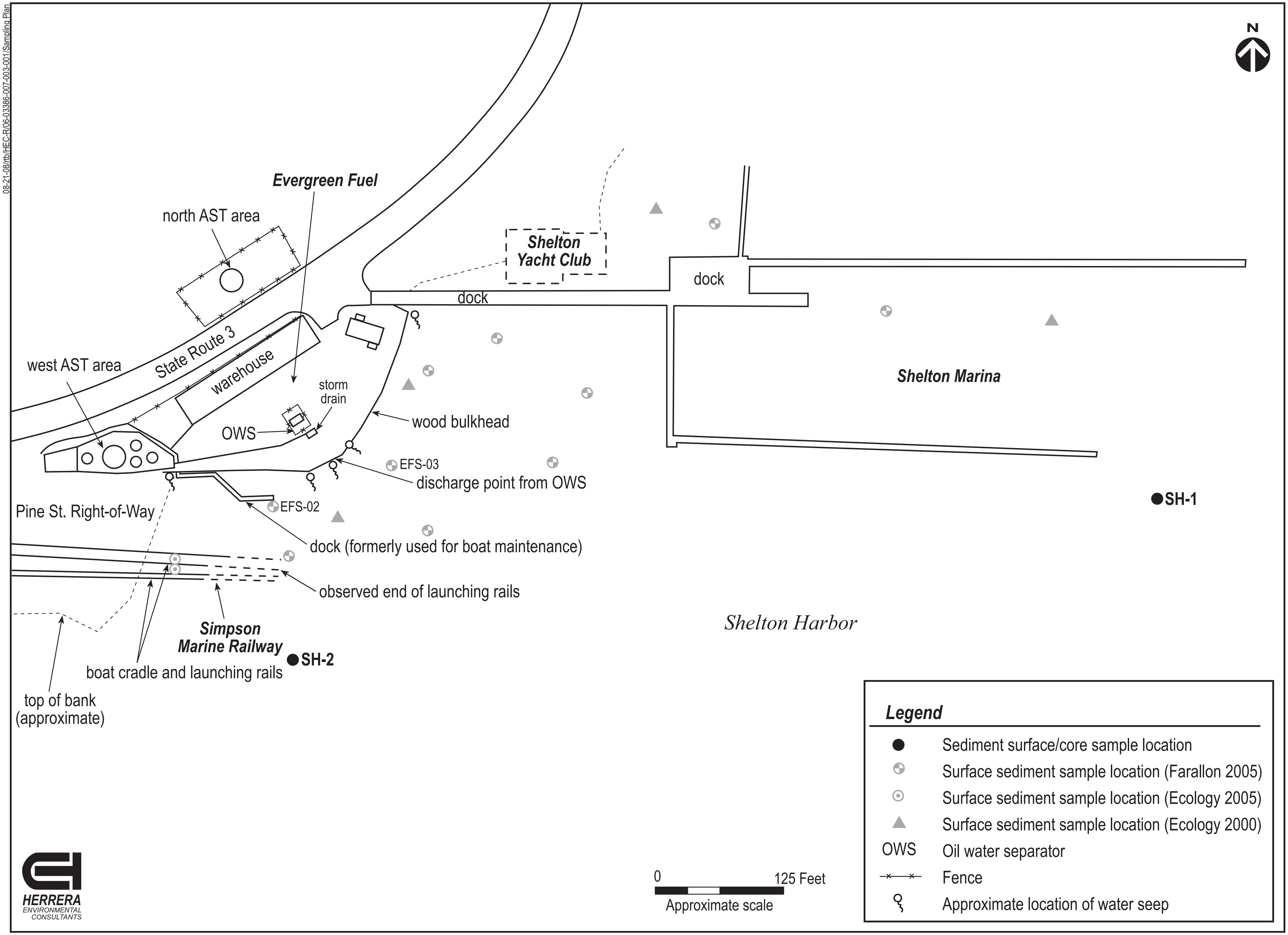

Figure 4-4. **Sediment sample locations (to be collected) at the former Evergreen Fuel site, Shelton, Washington.**

4.3.1 Sediment

The Data Gaps report identified 26 pipe discharge locations in and around Shelton Harbor that have conveyed stormwater or industrial waste into the harbor, with 15 locations situated along the harbor shoreline. This study will focus on seven shoreline discharge locations (stations, SH-4, SH-5, SH-6, SH-11, SH-12, SH-13, and SH-25) based on previous sampling performed and the clustering of mapped discharge points. Four sample stations (stations SH-3, SH-7, SH-8, and SH-9) will be used to address Goldsborough and Shelton Creek discharges into the north and central portions of the harbor. Four additional sample stations (SH10 and SH-14 to SH-16) will be used to characterize the harbor as it transitions to Hammersley Inlet and Oakland Bay.

4.3.1.1 Surface Sediment Samples

Representative surface sediment (0 to 10 cm) samples will be collected at 16 locations within Shelton Harbor (Figures 4-3 and 4-4). An aliquot from each location will be homogenized and submitted for chemical and bioassay analysis. Sample aliquots for ammonia and sulfide will be collected prior to sample homogenization to minimize losses due to volatilization. Refer to Section 6 for recommended holding times for analyses. As shown in Tables 4-4 and 4-5, samples from all locations will be analyzed for the broad spectrum of industrial discharge COPCs. Surface sediment samples will also be analyzed for dioxins/furans and bioassay toxicity. A few samples near potential on-shore petroleum sources will be analyzed for TPH. Samples in areas suspected to be impacted by boating and marina activities will be analyzed for tributyltin (TBT). The chemical analyte list, analytical methods, TDLs, and comparative criteria are discussed in Section 7.1.

4.3.1.2 Subsurface Sediment Cores

Sediment cores will be collected to determine the vertical extent of potential contamination. Core sampling locations will be co-located at the 16 surface sediment locations (Figures 4-3 and 4-4). Cores will be advanced to 4+ ft below the surface using a Vibracore sampler. If significant wood waste is encountered, based on visual observations, cores will be advanced to to the bottom of the wood waste, to a maximum of 12 ft. Cores will be archived as sample aliquots in 1-ft increments beginning at the sediment surface and may be submitted for chemical analysis at a later time.

Sample aliquots for ammonia and sulfide will be collected from the 1-2 ft increment prior to sample homogenization. The remaining sample material will be homogenized. Sample aliquots for all other analyses will then be collected. As shown in Tables 4-4 and 4-5, 1-2 ft interval samples from these locations will be analyzed for the broad spectrum of industrial discharge COPCs. The chemical analyte list, analytical methods, TDLs, and comparative criteria are discussed in Section 7.1.

All other 1-ft increments will be homogenized and placed in large sample jars for archiving and stored frozen. Table 4-5 identifies the archive samples. Core collection and evaluation will include a physical description of the stratigraphy.

Table 4-4. Rationale for samples to be collected in Shelton Harbor.

Sample ID [a]	Description [b]	Sample Justification
SH-01-SS-00	Surface	Located near Shelton Marina. COPCs (SVOCs, pesticides, PCB, TPH, metals, and dioxin/furans) and butyltins. Bioassay to assess sediment toxicity on benthic organisms.
SH-01-SC-12	Subsurface	Located near Shelton Marina. COPCs (SVOCs, pesticides, PCB, TPH, and metals) and butyltins.
SH-02-SS-00	Surface	Located near marine railway. COPCs (SVOCs, pesticides, PCB, TPH, metals, and dioxin/furans) and butyltins. Bioassay to assess sediment toxicity on benthic organisms.
SH-02-SC-12	Subsurface	Located near marine railway. COPCs (SVOCs, pesticides, PCB, TPH, and metals) and butyltins.
SH-03-SS-00	Surface	Shelton Creek – potential point source to Shelton Harbor. Analyze for COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-03-SC-12	Subsurface	Shelton Creek – potential point source to Shelton Harbor. Analyze for COPCs (SVOCs, pesticides, PCB, and metals).
SH-04-SS-00	Surface	Outfall location – pond saw, plywood plant. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-04-SC-12	Subsurface	Outfall location– pond saw, plywood plant COPCs (SVOCs, pesticides, PCB, and metals).
SH-05-SS-00	Surface	Outfall location – east log storage yard. COPCs (SVOCs, pesticides, PCB, TPH, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-05-SC-12	Subsurface	Outfall location – east log storage yard. COPCs (SVOCs, pesticides, PCB, and metals).
SH-06-SS-00	Surface	Outfall location – shops, boiler plant, overlay plant. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-06-SC-12	Subsurface	Outfall location – shops, boiler plant, overlay plant. COPCs (SVOCs, pesticides, PCB, and metals).
SH-07-SS-00	Surface	Goldsborough Creek – potential point source to Shelton Harbor. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-07-SC-12	Subsurface	Goldsborough Creek – potential point source to Shelton Harbor. COPCs (SVOCs, pesticides, PCB, and metals).
SH-08-SS-00	Surface	Goldsborough Creek – potential point source to Shelton Harbor. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-08-SC-12	Subsurface	Goldsborough Creek – potential point source to Shelton Harbor. COPCs (SVOCs, pesticides, PCB, and metals).
SH-09-SS-00	Surface	Shelton and Goldsborough Creeks confluence in Shelton Harbor. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-09-SC-12	Subsurface	Shelton and Goldsborough Creeks confluence in Shelton Harbor. COPCs (SVOCs, pesticides, PCB, and metals).
SH-10-SS-00	Surface	Mid-Shelton Harbor characterization. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.

Table 4-4 (continued). Rationale for samples to be collected in Shelton Harbor.

Sample ID [a]	Description [b]	Sample Justification
SH-10-SC-12	Subsurface	Mid-Shelton Harbor characterization. COPCs (SVOCs, pesticides, PCB, and metals).
SH-11-SS-00	Surface	Outfall location – City stormwater and proximity to reported wood treating area, and to pentachlorophenol exceedance from prior study. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-11-SC-12	Subsurface	Outfall location. – City stormwater and proximity to reported wood treating area, and to pentachlorophenol exceedance from prior study. COPCs (SVOCs, pesticides, PCB, and metals).
SH-12-SS-00	Surface	Outfall location – sawmill stormwater. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-12-SC-12	Subsurface	Outfall location – sawmill stormwater. COPCs (SVOCs, pesticides, PCB, and metals).
SH-13-SS-00	Surface	Outfall location – Rayonier laboratory. COPCs (SVOCs, pesticides, PCB, TPH, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-13-SC-12	Subsurface	Outfall location – Rayonier laboratory. COPCs (SVOCs, pesticides, PCB, and metals).
SH-14-SS-00	Surface	Mid-Shelton Harbor characterization. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-14-SC-12	Subsurface	Mid-Shelton Harbor characterization. COPCs (SVOCs, pesticides, PCB, and metals).
SH-15-SS-00	Surface	Outer-Shelton Harbor characterization. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-15-SC-12	Subsurface	Outer-Shelton Harbor characterization. COPCs (SVOCs, pesticides, PCB, and metals).
SH-16-SS-00	Surface	Outer-Shelton Harbor characterization. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-16-SC-12	Subsurface	Outer-Shelton Harbor characterization. COPCs (SVOCs, pesticides, PCB, and metals).
SH-17-RI-04	Sediment Core	Sediment core dating. Collect from Goldsborough Creek alluvial fan.
SH-18-WS-00	Wood Waste	Stratum 8. COPCs (SVOCs, wood resin, pesticides, PCBs, TPH, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-18-WC-12	Wood Waste	Stratum 8. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).

Table 4-4 (continued). Rationale for samples to be collected in Shelton Harbor.

Sample ID [a]	Description [b]	Sample Justification
SH-19-WS-00	Wood Waste	Stratum 7. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-19-WC-12	Wood Waste	Stratum 7. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).
SH-20-WS-00	Wood Waste	Stratum 7. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-20-WC-12	Wood Waste	Stratum 7. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).
SH-21-WS-00	Wood Waste	Stratum 3. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-21-WC-12	Wood Waste	Stratum 3. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).
SH-22-WS-00	Wood Waste	Stratum 3. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-22-WC-12	Wood Waste	Stratum 3. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).
SH-23-WS-00	Wood Waste	Stratum 9. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-23-WC-12	Wood Waste	Stratum 9. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).
SH-24-WS-00	Wood Waste	Stratum 6. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-24-WC-12	Wood Waste	Stratum 6. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).
SH-25-WS-00	Wood Waste	Stratum 6. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-25-WC-12	Wood Waste	Stratum 6. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).
SH-26-WS-00	Wood Waste	Stratum 4. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-26-WC-12	Wood Waste	Stratum 4. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).

Table 4-4 (continued). Rationale for samples to be collected in Shelton Harbor.

Sample ID [a]	Description [b]	Sample Justification
SH-27-WS-00	Wood Waste	Stratum 5. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms
SH-27-WC-12	Wood Waste	Stratum 5. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).
SH-28-WS-00	Wood Waste	Stratum 1. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-28-WC-12	Wood Waste	Stratum 1. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).
SH-29-WS-00	Wood Waste	Outer Shelton Harbor. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
SH-29-WC-12	Wood Waste	Outer Shelton Harbor. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals).
SH-30-WS-00	Wood Waste	Stratum 2. COPCs (SVOCs, wood resin, pesticides, PCBs, metals, and dioxin/furans) and butyltins. Bioassay to assess sediment toxicity on benthic organisms.
SH-30-WC-12	Wood Waste	Stratum 2. COPCs (SVOCs, wood resin, pesticides, PCBs, and metals) and butyltins.

[a] Example of sample ID: SH-17-RI-04 = Shelton Harbor, Station 17, Radioisotope, 0-4 ft interval. Additional identifiers: SC = sediment core; SS = surface sediment; WC = wood waste sediment core; WS = wood waste surface sediment.

[b] Description of matrix: surface or subsurface sediment, or wood waste sediment.

Table 4-5. Summary of samples to be collected from Shelton Harbor.

Sample ID [a]	Description	TOC/GS	SVOC	Resin	Pest	PCB [b]	Dioxin/ Furan	TPH	TBT	Metal	S2/NH3	TVS	Pb210	Cs137	Bioassay
SH-01-SS-00	Surface	X	X		X	X	X	X	X	X	X				X
SH-01-SC-12	Subsurface	X	X		X	X		X	X	X	X				
SH-02-SS-00	Surface	X	X		X	X	X	X	X	X	X				X
SH-02-SC-12	Subsurface	X	X		X	X		X	X	X	X				
SH-03-SS-00	Surface	X	X		X	X	X			X	X				X
SH-03-SC-12	Subsurface	X	X		X	X				X	X				
SH-04-SS-00	Surface	X	X		X	X	X			X	X				X
SH-04-SC-12	Subsurface	X	X		X	X				X	X				
SH-05-SS-00	Surface	X	X		X	X	X	X		X	X				X
SH-05-SC-12	Subsurface	X	X		X	X				X	X				
SH-06-SS-00	Surface	X	X		X	X	X			X	X				X
SH-06-SC-12	Subsurface	X	X		X	X				X	X				
SH-07-SS-00	Surface	X	X		X	X	X			X	X				X
SH-07-SC-12	Subsurface	X	X		X	X				X	X				
SH-08-SS-00	Surface	X	X		X	X	X			X	X				X
SH-08-SC-12	Subsurface	X	X		X	X				X	X				
SH-09-SS-00	Surface	X	X		X	X	X			X	X				X
SH-09-SC-12	Subsurface	X	X		X	X				X	X				
SH-10-SS-00	Surface	X	X		X	X	X			X	X				X
SH-10-SC-12	Subsurface	X	X		X	X				X	X				
SH-11-SS-00	Surface	X	X		X	X	X			X	X				X
SH-11-SC-12	Subsurface	X	X		X	X				X	X				
SH-12-SS-00	Surface	X	X		X	X	X			X	X				X
SH-12-SC-12	Subsurface	X	X		X	X				X	X				

Table 4-5 (continued). Summary of samples to be collected from Shelton Harbor.

Sample ID [a]	Description	TOC/GS	SVOC	Resin	Pest	PCB [b]	Dioxin/ Furan	TPH	TBT	Metal	S2/NH3	TVS	Pb210	Cs137	Bioassay
SH-13-SS-00	Surface	X	X		X	X	X	X		X	X				X
SH-13-SC-12	Subsurface	X	X		X	X				X	X				
SH-14-SS-00	Surface	X	X		X	X	X			X	X				X
SH-14-SC-12	Subsurface	X	X		X	X				X	X				
SH-15-SS-00	Surface	X	X		X	X	X			X	X				X
SH-15-SC-12	Subsurface	X	X		X	X				X	X				
SH-16-SS-00	Surface	X	X		X	X	X			X	X				X
SH-16-SC-12	Subsurface	X	X		X	X				X	X				
SH-17-RI-04	Sediment Core												X	X	
SH-18-WS-00	Wood Waste	X	X	X	X	X	X	X		X	X	X			X
SH-18-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
SH-19-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X
SH-19-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
SH-20-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X
SH-20-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
SH-21-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X
SH-21-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
SH-22-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X
SH-22-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
SH-23-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X
SH-23-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
SH-24-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X
SH-24-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
SH-25-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X
SH-25-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
SH-26-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X

Table 4-5 (continued). Summary of samples to be collected from Shelton Harbor.

Sample ID [a]	Description	TOC/GS	SVOC	Resin	Pest	PCB [b]	Dioxin/ Furan	TPH	TBT	Metal	S2/NH3	TVS	Pb210	Cs137	Bioassay
SH-26-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
SH-27-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X
SH-27-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
SH-28-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X
SH-28-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
SH-29-WS-00	Wood Waste	X	X	X	X	X	X			X	X	X			X
SH-29-WC-12	Wood Waste	X	X	X	X	X				X	X	X			
SH-30-WS-00	Wood Waste	X	X	X	X	X	X		X	X	X	X			X
SH-30-WC-12	Wood Waste	X	X	X	X	X			X	X	X	X			
Archived Samples															
SH-01-SC-01	Subsurface														
SH-01-SC-23	Subsurface														
SH-01-SC-34	Subsurface														
SH-02-SC-01	Subsurface														
SH-02-SC-23	Subsurface														
SH-02-SC-34	Subsurface														
SH-03-SC-01	Subsurface														
SH-03-SC-34	Subsurface														
SH-04-SC-01	Subsurface														
SH-04-SC-23	Subsurface														
SH-04-SC-34	Subsurface														
SH-05-SC-01	Subsurface														
SH-05-SC-23	Subsurface														
SH-05-SC-34	Subsurface														
SH-06-SC-01	Subsurface														
SH-06-SC-23	Subsurface														
SH-06-SC-34	Subsurface														
SH-07-SC-01	Subsurface														

Table 4-5 (continued). Summary of samples to be collected from Shelton Harbor.

Sample ID [a]	Description	TOC/GS	SVOC	Resin	Pest	PCB [b]	Dioxin/ Furan	TPH	TBT	Metal	S2/NH3	TVS	Pb210	Cs137	Bioassay
SH-07-SC-23	Subsurface														
SH-07-SC-34	Subsurface														
SH-08-SC-01	Subsurface														
SH-08-SC-23	Subsurface														
SH-08-SC-34	Subsurface														
SH-09-SC-01	Subsurface														
SH-09-SC-23	Subsurface														
SH-09-SC-34	Subsurface														
SH-10-SC-01	Subsurface														
SH-10-SC-23	Subsurface														
SH-10-SC-34	Subsurface														
SH-11-SC-01	Subsurface														
SH-11-SC-23	Subsurface														
SH-11-SC-34	Subsurface														
SH-12-SC-01	Subsurface														
SH-12-SC-23	Subsurface														
SH-12-SC-34	Subsurface														
SH-13-SC-01	Subsurface														
SH-13-SC-23	Subsurface														
SH-13-SC-34	Subsurface														
SH-14-SC-01	Subsurface														
SH-14-SC-23	Subsurface														
SH-14-SC-34	Subsurface														
SH-15-SC-01	Subsurface														
SH-15-SC-23	Subsurface														
SH-15-SC-34	Subsurface														
SH-16-SC-01	Subsurface														
SH-16-SC-23	Subsurface														

Table 4-5 (continued). Summary of samples to be collected from Shelton Harbor.

Sample ID [a]	Description	TOC/GS	SVOC	Resin	Pest	PCB [b]	Dioxin/ Furan	TPH	TBT	Metal	S2/NH3	TVS	Pb210	Cs137	Bioassay
SH-16-SC-34	Subsurface														
SH-18-WC-01	Wood Waste														
SH-18-WC-23	Wood Waste														
SH-18-WC-34	Wood Waste														
SH-19-WC-01	Wood Waste														
SH-19-WC-23	Wood Waste														
SH-19-WC-34	Wood Waste														
SH-20-WC-01	Wood Waste														
SH-20-WC-23	Wood Waste														
SH-20-WC-34	Wood Waste														
SH-21-WC-01	Wood Waste														
SH-21-WC-23	Wood Waste														
SH-21-WC-34	Wood Waste														
SH-22-WC-01	Wood Waste														
SH-22-WC-23	Wood Waste														
SH-22-WC-34	Wood Waste														
SH-23-WC-01	Wood Waste														
SH-23-WC-23	Wood Waste														
SH-23-WC-34	Wood Waste														
SH-24-WC-01	Wood Waste														
SH-24-WC-23	Wood Waste														
SH-24-WC-34	Wood Waste														
SH-25-WC-01	Wood Waste														
SH-25-WC-23	Wood Waste														
SH-25-WC-34	Wood Waste														
SH-26-WC-01	Wood Waste														
SH-26-WC-23	Wood Waste														
SH-26-WC-34	Wood Waste														

Table 4-5 (continued). Summary of samples to be collected from Shelton Harbor.

Sample ID [a]	Description	TOC/GS	SVOC	Resin	Pest	PCB [b]	Dioxin/ Furan	TPH	TBT	Metal	S2/NH3	TVS	Pb210	Cs137	Bioassay
SH-27-WC-01	Wood Waste														
SH-27-WC-23	Wood Waste														
SH-27-WC-34	Wood Waste														
SH-28-WC-01	Wood Waste														
SH-28-WC-23	Wood Waste														
SH-28-WC-34	Wood Waste														
SH-29-WC-01	Wood Waste														
SH-29-WC-23	Wood Waste														
SH-29-WC-34	Wood Waste														
SH-30-WC-01	Wood Waste														
SH-30-WC-23	Wood Waste														
SH-30-WC-34	Wood Waste														

[a] Example of sample ID: SH-17-RI-04 = Shelton Harbor, Station 17, Radioisotope, 0-4 ft interval. Additional identifiers: SC = sediment core; SS = surface sediment; WC = wood waste sediment core; WS = wood waste surface sediment. See Section 6.1.1.
[b] PCBs analyzed as Aroclors for sediment and wood waste sediment samples.
Bioassay = Sediment Management Standards acute and chronic tests
Ce137 = Cesium-137
Dioxin/furan = 2,3,7,8-substituted isomers and congeners
Metals = Antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc
Pb210 = Lead-210
PCB = Polychlorinated biphenyls
Resin = Wood waste indicator compounds, e.g., guaiacols and fatty acids
Pest = Chlorinated pesticides
SVOC = Semi-volatile organic compounds
TBT = Tributyltin
TOC = Votal organic carbon
TPH = Total petroleum hydrocarbons as NWTPH-HCID (hydrocarbon identification)
TVS = Total volatile solids
X = Samples submitted for laboratory analysis.

The SMS provides criteria used to identify surface sediment that have no adverse acute or chronic effects on biological resources and no significant risk to humans, which will be used to help determine additional analyses. Specifically, surface sediment with SQS exceedances, bioassay toxicity, or exceedances of other criteria not having an SQS value (see Section 8.1) may trigger subsurface analysis. Additional analyses may be conducted on archived sediment core samples collected over other depth intervals based on this initial data.

4.3.2 Wood Waste

Wood waste cores will be collected and submitted for analysis to help measure the vertical extent of wood waste in areas of historical log rafting and other wood handling activities. Accumulations of wood waste have been identified across the entire harbor, as defined by nine sub-areas (strata) in the Ecology 2000 Reconnaissance Survey. One or two sample stations have been established in each of the nine strata (SH-18 to SH-28, and SH-30) to characterize the extent of wood waste across Shelton Harbor. An additional station (SH-29) was established outside the original reconnaissance survey area to help establish the extent of wood waste leading from Shelton Harbor into Oakland Bay.

4.3.2.1 Surface Wood Waste Sediment Samples

Representative surface wood waste sediment (0 to 10 cm) samples will be collected at each of these 13 locations within Shelton Harbor (Figure 4-3). An aliquot from each location will be homogenized and submitted for chemical and bioassay analysis. Sample aliquots for ammonia and sulfide will be separated out prior to sample homogenization to minimize losses due to volatilization. Refer to Section 6 for recommended holding times for analyses. As shown in Tables 4-4 and 4-5, samples from all of these locations will be analyzed for the broad spectrum of industrial discharge COPCs. Surface wood waste sediment samples will also be analyzed for TVS and other wood waste indicators (resins and guaiacols), dioxins/furans, and bioassay toxicity. The chemical analyte list, analytical methods, TDLs, and comparative criteria are discussed in Section 7.1.

4.3.2.2 Subsurface Wood Waste Sediment Cores

Wood waste sediment cores will be collected to determine the vertical extent of potential contamination. Core sampling locations will be co-located at the 13 surface wood waste sediment stations (Figure 4-3). Cores will be advanced to 4+ ft below the surface using a Vibracore sampler. If significant wood waste is encountered, based on visual observations, cores will be advanced to to the bottom of the wood waste, to a maximum of 12 ft. Core samples will be collected by sectioning each core into 1-ft intervals and then containerizing sediment from each interval.

Sample aliquots for ammonia and sulfide will be separated from the 1-2 ft increment prior to sample homogenization. The remaining 1-2 ft core sample material will be homogenized and sample aliquots for all other analyses will then be containerized in the appropriate sample bottles. As shown in Tables 4-4 and 4-5, 1-2 ft interval samples from these locations will be analyzed for the broad spectrum of industrial discharge COPCs, TVS, and other wood waste indicators (resins and guaiacols). The chemical analyte list, analytical methods, TDLs, and comparative criteria are discussed in Section 7.1.

All other 1-ft increments will be homogenized and placed in large sample jars for archiving and stored frozen (identified in Table 4-5). Core collection and evaluation will include a physical description of the stratigraphy.

The SMS provides criteria used to identify surface sediment that have no adverse acute or chronic effects on biological resources and no significant risk to humans, which will be used to help determine additional analyses. Specifically, surface sediment with SQS exceedances, bioassay toxicity, or exceedances of other criteria not having an SQS value (see Section 8.1) may trigger subsurface analysis. Additional analyses may be conducted on archived sediment core samples collected over other depth intervals based on this initial data.

4.3.3 Bioassays

Bioassays will be conducted to determine the extent of acute and chronic toxicity of sensitive test organisms to contaminants found in Shelton Harbor sediments. The 16 surface sediment samples collected across Shelton Harbor will be submitted for toxicity testing. In addition, sediment collected at the 13 surface wood waste sediment sample locations will be submitted for toxicity testing. Toxicity tests to be conducted on Shelton Harbor sediments and wood waste sediments include amphipod mortality, juvenile polychaete growth, bivalve larvae development, and Microtox® (porewater) bioluminescence. Details on toxicity testing methodology are provided in Section 7.2.

4.4 Hammersley Inlet

The study consists of a non-random design to spatially characterize sediment conditions in the western portion of Hammersley Inlet. Sampling stations are placed at locations with potential for sediment redistribution from Shelton Harbor and Oakland Bay and at locations associated with WWTP outfalls. Station locations were based on guidance for initial investigation of sediment contamination in the *Sediment Sampling and Analysis Plan Appendix* (Ecology 2008) and review of previous studies in and near the inlet (Herrera 2008). Sampling locations within Hammersley Inlet are presented on Figure 4-2.

Sediment chemistry analyses and bioassay toxicity analyses will be completed concurrently. A surface (0-10 cm) sediment sample will be collected at each sediment sampling station and submitted for analyses. In addition, a 4-ft core will be collected at each sediment sampling station. Core samples will be collected by sectioning each core into 1-ft intervals and containerizing sediment from each interval. Each surface and core sample will be visually evaluated for gross wood content to allow estimates of wood waste thickness, type (bark, chips, sawdust), and abundance.

The analyses to be conducted on individual samples are based on *Sediment Sampling and Analysis Plan Appendix* (Ecology 2008) guidance and review of previous studies (Herrera 2008).

4.4.1 Sediment

The Data Gaps report (Herrera 2008) did not identify any creeks discharging to the western portion of the inlet or any sites with documented or potential releases of hazardous substances (including log rafting). Sampling stations have been established at locations with natural sediment accumulation. Five stations will be sampled along the shoreline and study area boundary of the inlet to evaluate conditions resulting from fluvial redistribution processes (stations HI-1 to HI-4, and HI-6). Two additional discharge points associated with the former and existing WWTPs located at the transition area between Shelton Harbor, Oakland Bay, and Hammersley Inlet will also be sampled (stations HI-5 and HI-7). 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 and bioassay toxicity.

4.4.1.1 Surface Sediment Samples

Representative surface sediment (0 to 10 cm) samples will be collected at seven locations within Hammersley Inlet (Figure 4-2). An aliquot from each location will be homogenized and submitted for chemical and bioassay analysis. Sample aliquots for ammonia and sulfide will be collected prior to sample homogenization to minimize losses due to volatilization. Refer to Section 6 for recommended holding times for analyses. As shown in Tables 4-6 and 4-7, samples from all locations will be analyzed for the broad spectrum of industrial discharge COPCs. Surface sediment samples will also be analyzed for dioxins/furans and bioassay toxicity. The chemical analyte list, analytical methods, TDLs, and comparative criteria are discussed in Section 7.1.

4.4.1.2 Subsurface Sediment Cores

Sediment cores will be collected to determine the vertical extent of potential contamination. Core sampling locations will be co-located at the seven surface sediment locations (Figure 4-2). Cores will be advanced to 4+ ft below the surface using a Vibracore sampler. If significant wood waste is encountered, based on visual observations, cores will be advanced to to the bottom of the wood waste, to a maximum of 12 ft. Cores will be archived as sample aliquots in 1-ft increments beginning at the sediment surface and may be submitted for chemical analysis at a later time. The 1-2 ft segment from each core will be divided into multiple aliquots. Each other 1-ft increment will be homogenized and archived (identified in Table 4-7).

Sample aliquots for ammonia and sulfide will be collected from the 1-2 ft increment prior to sample homogenization. The remaining 1-2 ft core sample material will be homogenized and sample aliquots for grain size and TOC will then be collected. Because archiving (freezing and deferring analyses until a later date) of sediments may affect results for some analyses (total sulfides, ammonia, TOC, and grain size), 1-2 ft increment samples will be initially analyzed for these parameters only. The remaining material will be placed in the applicable sample containers as if they were to be analyzed immediately (these samples are marked with a "P" in Table 4-7 to indicate that they are ready for potential additional analyses). As with the archived samples, these containerized samples will be stored frozen. Each other 1-ft increment will be homogenized and placed in large sample jars for archiving. Core collection and evaluation will also include a physical description of the stratigraphy. The chemical analyte list, analytical methods, TDLs, and comparative criteria are discussed in Section 7.1.

Table 4-6. Rationale for samples to be collected from Hammersley Inlet and Carr Inlet (reference site).

Sample ID [a]	Description [b]	Sample Justification
HI-01-SS-00	Surface	Located across inlet from Millers Point – extent of study area. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
HI-01-SC-12	Subsurface	Located across inlet from Millers Point – extent of study area. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
HI-02-SS-00	Surface	Located near Millers Point – extent of study area. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
HI-02-SC-12	Subsurface	Located near Millers Point – extent of study area. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
HI-03-SS-00	Surface	Located near Eagle Point – characterize study area. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
HI-03-SC-12	Subsurface	Located near Eagle Point – characterize of study area. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
HI-04-SS-00	Surface	Located south of Munson Point – characterize study area. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
HI-04-SC-12	Subsurface	Located south of Munson Point – characterize study area. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
HI-05-SS-00	Surface	Current WWTP outfall. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
HI-05-SC-12	Subsurface	Current WWTP outfall. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
HI-06-SS-00	Surface	Located near Munson Point – characterize study area. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
HI-06-SC-12	Subsurface	Located near Munson Point – characterize study area. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.
HI-07-SS-00	Surface	Historic WWTP outfall. COPCs (SVOCs, pesticides, PCB, metals, and dioxin/furans). Bioassay to assess sediment toxicity on benthic organisms.
HI-07-SC-12	Subsurface	Historic WWTP outfall. COPCs (SVOCs, pesticides, PCB, and metals). Samples analyzed based on surface sample sediment results.

Table 4-6 (continued). Rationale for samples to be collected from Hammersley Inlet and Carr Inlet (reference site).

Reference Samples (Carr Inlet)		
RF-01-SS-00	Surface	Quantification of reference surface sediment contaminant concentrations. Bioassay to assess sediment toxicity on benthic organisms.
RF-02-SS-00	Surface	Quantification of reference surface sediment contaminant concentrations. Bioassay to assess sediment toxicity on benthic organisms.
RF-03-SS-00	Surface	Quantification of reference surface sediment contaminant concentrations. Bioassay to assess sediment toxicity on benthic organisms.

[a] Example of sample ID: HI-01-SS-00 = Hammersley Inlet, Station 01, Surface Sediment, 0-10 cm interval. Additional identifiers: SC = sediment core; SS = surface sediment. See Section 6.1.1.
[b] Description of matrix: surface or subsurface sediment

Table 4-7. Summary of samples to be collected from Hammersley Inlet and Carr Inlet (reference site).

Sample ID [a]	Description	TOC/ GS	SVOC	Resin	Pest	PCB [b]	Dioxin/ Furan	TPH	TBT	Metal	S2 NH3	TVS	Pb210	Cs137	Bioassay
HI-01-SS-00	Surface	X	X		X	X	X			X	X				X
HI-01-SC-12	Subsurface	X	P		P	P				P	X				
HI-02-SS-00	Surface	X	X		X	X	X			X	X				X
HI-02-SC-12	Subsurface	X	P		P	P				P	X				
HI-03-SS-00	Surface	X	X		X	X	X			X	X				X
HI-03-SC-12	Subsurface	X	P		P	P				P	X				
HI-04-SS-00	Surface	X	X		X	X	X			X	X				X
HI-04-SC-12	Subsurface	X	P		P	P				P	X				
HI-05-SS-00	Surface	X	X		X	X	X			X	X				X
HI-05-SC-12	Subsurface	X	P		P	P				P	X				
HI-06-SS-00	Surface	X	X		X	X	X			X	X				X
HI-06-SC-12	Subsurface	X	P		P	P				P	X				
HI-07-SS-00	Surface	X	X		X	X	X			X	X				X
HI-07-SC-12	Subsurface	X	P		P	P				P	X				
Reference Samples															
RF-01-SS-00	Surface	X	X	X	X	X	X	X	X	X	X	X			X
RF-02-SS-00	Surface	X	X	X	X	X	X	X	X	X	X	X			X
RF-03-SS-00	Surface	X	X	X	X	X	X	X	X	X	X	X			X
Archived Samples															
HI-01-SC-01	Subsurface														
HI-01-SC-23	Subsurface														
HI-01-SC-34	Subsurface														
HI-02-SC-01	Subsurface														
HI-02-SC-23	Subsurface														
HI-02-SC-34	Subsurface														
HI-03-SC-01	Subsurface														
HI-03-SC-23	Subsurface														

Table 4-7 (continued). Summary of samples to be collected from Hammersley Inlet and Carr Inlet (reference site).

Sample ID [a]	Description	TOC/ GS	SVOC	Resin	Pest	PCB [b]	Dioxin/ Furan	TPH	TBT	Metal	S2 NH3	TVS	Pb210	Cs137	Bioassay
HI-03-SC-34	Subsurface														
HI-04-SC-01	Subsurface														
HI-04-SC-23	Subsurface														
HI-04-SC-34	Subsurface														
HI-05-SC-01	Subsurface														
HI-05-SC-23	Subsurface														
HI-05-SC-34	Subsurface														
HI-06-SC-01	Subsurface														
HI-06-SC-23	Subsurface														
HI-06-SC-34	Subsurface														
HI-07-SC-01	Subsurface														
HI-07-SC-23	Subsurface														
HI-07-SC-34	Subsurface														

[a] Example of sample ID: HI-01-SS-00 = Hammersley Inlet, Station 01, Surface Sediment, 0-10 cm interval. Additional identifiers: SC = sediment core; SS = surface sediment; WC = wood waste sediment core; WS = wood waste surface sediment. See Section 6.1.1.
[b] PCBs analyzed as Aroclors for sediment and wood waste sediment samples.
Bioassay = Sediment Management Standards acute and chronic tests
Ce137 = Cesium-137
Dioxin/furan = 2,3,7,8-substituted isomers and congeners
Metals = Antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc
P = For sediment cores, 1-2 ft interval samples analyzed pending surface sample results.
Pb210 = Lead-210
PCB = Polychlorinated biphenyls
Resin = Wood waste indicator compounds, e.g., guaiacols and fatty acids
Pest = Chlorinated pesticides
SVOC = Semi-volatile organic compounds
TBT = Tributyltin
TOC = Total organic carbon
TPH =Total petroleum hydrocarbons as NWTPH-HCID (hydrocarbon identification)
TVS = Total volatile solids
X =Samples submitted for laboratory analysis.

Based on surface sediment analytical results, additional analysis of the 1-2 ft interval may be conducted on archived sediment core samples. The SMS provides criteria used to identify surface sediment that have no adverse acute or chronic effects on biological resources and no significant risk to humans, which will be used to help determine additional analyses. Specifically, surface sediment with SQS exceedances, bioassay toxicity, or exceedances of other criteria not having an SQS value (see Section 8.1) may trigger subsurface analysis. Additional analyses may be conducted on archived sediment core samples collected over other depth intervals based on this initial data.

4.4.2 Bioassays

Bioassays will be conducted to determine the extent of acute and chronic toxicity of sensitive test organisms to contaminants found in Hammersley Inlet sediments. The seven surface sediment samples collected across Hammersley Inlet will be submitted for toxicity testing. Toxicity tests will include amphipod mortality, juvenile polychaete growth, bivalve larvae development, and Microtox® (porewater) bioluminescence. Details on toxicity testing methodology are provided in Section 7.2.

4.5 Reference Sample Location

The purpose of a reference station is to reflect the natural condition of sediments in the absence of anthropogenic influences. It provides a point of comparison for evaluating the potential biological effects of the site sediments. Washington State Department of Ecology's *Sediment Sampling and Analysis Plan Appendix – Guidance on the Development of Sediment Sampling and Analysis Plans Meeting the Requirements of the Sediment Management Standards (Chapter 172-204 WAC)* dated February 2008 references the Puget Sound Program (PSEP) protocols for bioassay testing. PSEP's *Laboratory Sediment Bioassays – General QA/QC Guidelines* (revised July 1995) specifies the need for reference test samples and identifies several potential Puget Sound reference areas. The primary reference areas identified include: Sequim Bay, Samish Bay, Dabob Bay, and Carr Inlet. Of these options, Carr Inlet has been selected as the most reasonable reference area for Oakland Bay. A summary of sample locations for reference sediment is presented in Table 4-6 and a summary of sample analyses is presented in Table 4-7. Sampling locations within Carr Inlet are presented on Figure 4-5.

Reference sediments, which closely match the grain size characteristics of the test sediments, will be run with each test batch for all three bioassays. Reference sediment should have a percent fine content within 20 percent of the sample sediment content (Ecology 2008). The wet sieving protocol (see Section 6.4.2) will be used in the field to determine the percent fines content of the sample sediment collected.

Reference sediment samples will also be analyzed for all COPCs plus conventional parameters to evaluate whether Oakland Bay results are elevated above what are considered to be Puget Sound background concentrations.

Figure 4-5. Reference sediment sample locations (to be collected) in Carr Inlet, Washington.

4.5.1 Sediment

Representative surface sediment (0 to 10 cm) samples will be collected at three locations within the Carr Inlet reference area (Figure 4-5). An aliquot from each location will be homogenized and submitted to each laboratory for chemical analysis. Sample aliquots for ammonia and sulfide will be collected prior to sample homogenization to minimize losses due to volatilization. Refer to Section 6 for recommended holding times for analyses. As shown in Tables 4-6 and 4-7, samples from all locations will be analyzed for the broad spectrum of industrial discharge COPCs. Surface sediment samples will also be analyzed for TPH, TBT, TVS, resins and guiucols, dioxins/furans, and bioassay toxicity. The chemical analyte list, analytical methods, TDLs, and comparative criteria are discussed in Section 7.1.

4.5.2 Bioassays

Bioassays will be conducted to determine acute and chronic toxicity of sensitive test organisms as a comparison to Oakland Bay, Shelton Harbor, and Hammersley Inlet samples. Toxicity tests will include amphipod mortality, juvenile polychaete growth, bivalve larvae development, and Microtox® (porewater) bioluminescence. Details on toxicity testing methodology are provided in Section 7.2.

5.0 Quality Assurance / Quality Control

The purpose of the project QA/QC is to provide confidence in project data results through a system of quality control performance checks with respect to data collection methods, laboratory analysis, data reporting, and appropriate corrective actions to achieve compliance with established performance and data quality criteria. This section presents the QA/QC procedures to ensure that the investigation data results are defensible and usable for their intended purpose.

5.1 Measurements of Data Quality

Data quality objectives (DQOs) are qualitative or quantitative statements derived from the planning process. DQOs are used to clarify the study objectives and define the appropriate type of data to collect to support project decisions. Additional guidance on the development of DQOs is found in *Guidance for the Data Quality Objective (DQO) Process,* USEPA 600/R-96/005 (USEPA 1996). Acceptance and performance criteria establish the quality and quantity of data needed to meet the project DQOs (Table 5-1). DQOs are based on PSDDA guidelines established for QA1 data review (PTI 1989a), and as updated by DMMP clarification paper *Modifications to the Chemical Testing Quality Assurance Guidelines* (Fox 2002). General acceptance or performance criteria for the collection, evaluation, or use of environmental data for this investigation are outlined in Section 7 – Laboratory Analytical Procedures.

Table 5-1. Project-specific data quality objectives.

	Replicate Criteria		Matrix Spike Criteria		Surrogate Spike Criteria	
Parameter	Warning Limits [a]	Action Limits [b]	Warning Limits [a]	Action Limits [b]	Warning Limits [a]	Action Limits [b]
Conventionals	None	20 %	NA	NA	NA	NA
Metals	None	20 %	None	75 - 125 %	NA	NA
Semivolatiles	35 %	50 %	50 - 150 %	None	50 %	EPA CLP
Pesticides	35 %	50 %	50 - 150 %	None	60 %	EPA CLP

[a] PSEP defines warning limits as "numerical criteria that serve to alert data reviewers and users to possible problems within the analytical system. When a warning limit is exceeded, the laboratory is not obligated to halt analyses, but the reported data may be qualified during subsequent QA/QC review."
[b] PSEP defines action limits as "numerical criteria that, when exceeded, require specific action by the laboratory before data may be reported. Action limits are intended to serve as contractual controls on laboratory performance".
Conventionals include the following analyses: TOC, ammonia, sulfides, grain size, TVS.
Metals include the following analyses: Metals and TBT.
Semivolatiles include the following analyses: SVOCs, PCBs, dioxin/furans, resins.
EPA CLPControl limits are compound specific limits established by EPA's Contract Laboratory Program (CLP).

Acceptance and performance criteria are often specified in terms of the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. Numerical acceptance criteria cannot be assigned to all PARCC parameters, but general performance goals are established for most data collection activities. Data assessment procedures throughout this SAP outline the steps to be taken, the responsible individuals, and the implications if QA objectives are not met. PARCC parameters are briefly defined below.

5.1.1 Precision

Precision measures the reproducibility of measurements under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average value, usually stated in terms of standard deviation or coefficient of variation. It also may be measured as the relative percent difference (RPD) between two values. Precision includes the interrelated concepts of instrument or method detection limits (MDLs) and multiple field sample variance. Sources of this variance are sample heterogeneity, sampling error, and analytical error.

5.1.2 Accuracy

Accuracy measures the bias of the measurement system. Sources of this error include sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and analysis. Data interpretation and reporting may also be significant sources of error. Typically, analytical accuracy is assessed through the analysis of spiked samples and may be stated in terms of percent recovery or the average (arithmetic mean) of the percent recovery. Blank samples are also analyzed to assess sampling and analytical bias (i.e., sample contamination). Background measurements similarly assess measurement bias.

5.1.3 Representativeness

Representativeness expresses the degree to which data represent a characteristic of a population, a parameter variation at a sampling point, or an environmental condition. Representativeness is a qualitative parameter, which is most concerned with proper design of the measurement program. Sample/measurement locations may be biased (judgmental) or unbiased (random or systematic). For unbiased schemes, the sampling must be designed not only to collect samples that represent conditions at a sample location, but also to select sample locations that represent the total area to be sampled.

5.1.4 Completeness

Completeness for sample collection is defined as the percentage of specified samples listed in the SAP that were actually collected. Completeness shall be 95% for this project. Completeness for acceptable data is defined as the percentage of acceptable data out of the total amount of data generated. Acceptable data includes data that passes all QC criteria or data that may not pass all of the QC criteria but has appropriate corrective actions taken.

5.1.5 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set may be compared to another. Sample data should be comparable with other measurement data for similar samples and sample conditions. This goal is achieved through the use of standard techniques to collect and analyze samples.

5.2 Quality Assurance and Quality Control for Chemistry Sediment Samples

Laboratory QC samples will be used to evaluate the data precision, accuracy, representativeness, and comparability of the analytical results.

Analytical performance is monitored through QC samples and spikes, such as laboratory method blanks, surrogate spikes, QC check samples, matrix spikes, matrix spike duplicates, duplicate samples, and duplicate injections. All QC samples are applied on the basis of a laboratory batch. Two basic types of batches are used: the preparation batch and the run (i.e., analytical) batch. The preparation batch includes all samples processed as a unit during organic sample preparation, metals digestion, or wet chemistry preparation. Preparation batches do not exceed 20 samples excluding associated QC samples. The QC samples associated with sample preparation include method blanks, laboratory control samples (LCS), matrix spikes, and duplicates. The run batch includes all samples analyzed together in the run sequence. The run sequence is typically defined by the analytical method. For some analyses, such as TOC, the run batch is equivalent to the preparation batch. The QC samples associated with the run sequence include calibration standards, instrument blanks, and reference standards.

Instances may arise where high sample concentrations, nonhomogeneity of samples, or matrix interferences preclude achieving the detection limits or associated QC target criteria. In such instances, data will not be rejected *a priori* but will be examined on a case-by-case basis. The laboratory will report the reason for deviations from these detection limits or noncompliance with QC criteria in the case narrative.

5.2.1 Laboratory Method Blanks

A laboratory method blank is an analyte-free material processed in the same manner and at the same time as a project sample. The laboratory method blanks serve to demonstrate a contamination-free environment in the laboratory. The goal is for method blanks to be free of contamination. Low level contamination may be present, but must be less than the PQL as defined by the method standard operating procedure (SOP). If contamination is greater, the samples are reanalyzed. If contaminants are present in the method blank but not in project samples, no further action is required. All sources of contamination that are not common laboratory contaminants as defined in the method SOPs must be investigated as part of the corrective action process. Sample results must not be blank-subtracted unless specifically required by the analytical method.

5.2.2 Surrogate Standards

For certain organic methods, all samples, including the laboratory method blank and standards, are spiked with a set of specific surrogate standards to monitor the accuracy of the analytical determination. Surrogate spikes are added at the start of the laboratory preparation process.

Surrogate recoveries must be within QC criteria for method blanks and LCSs to demonstrate acceptable method performance. If surrogate recoveries are outside QC criteria for method blanks or LCSs, corrective action is required and the QC Manager should be notified. Surrogate recoveries in the samples indicate the method performance on the particular sample matrix. Surrogate recoveries that are outside QC criteria for a sample indicate a potential matrix effect. Matrix effects must be verified based on review of recoveries from the method blank or LCS, sample reanalysis, or evaluation of interfering compounds. Sample clean-up procedures required by Ecology-approved SOPs must be implemented to alleviate potential matrix problems

5.2.3 Laboratory Control Sample

An LCS consists of a method blank spiked with target compounds of interest near the mid-point of the calibration range. The LCS is processed by the same sample preparation, standard addition, and analysis as the project samples. The recovery of target analytes in the LCS is an estimation of method accuracy.

LCS recovery must be within the control limits to demonstrate acceptable method performance. If the LCS recovery values are outside QC criteria for the target analytes, recovery values are significantly low, or the compounds were detected in the samples, then corrective action is required. After corrective action is complete, sample re-analysis is required for the failed parameters. For any deviations from the LCS control limits that cannot be resolved by sample re-analysis within holding times, the QC Manager must be notified immediately. If critical samples are affected, the Project Manager may determine that re-sampling is required.

5.2.4 Matrix Spike Sample

A matrix spike (MS) sample consists of a project sample split into two parts and processed as two separate samples in a manner identical to that of the rest of the samples. In addition to the regular addition of monitoring standards (internal standards, surrogate), spiking analytes are added to the sample aliquot. Generally, all method target analytes, if compatible, are added. A subset of target analytes may be used if indicated in the method SOP and approved during review of the SOP. An MS must be prepared for every batch of 20 samples (or fewer) for a given matrix if sufficient sample allows. Field and trip blanks must not be chosen for spiking. The laboratory must analyze a site-specific MS sample for every batch that contains samples from the site, even if the batch contains samples from other sites.

MS recovery values are a measure of the performance of the method on the sample being analyzed. MS recovery values outside the control limits applied to the LCS indicate matrix effects. Sample clean-up procedures may be warranted for samples with severe matrix effects. The laboratory should notify the QC Manager of these instances to determine an appropriate corrective action.

5.2.5 Matrix Spike Duplicate Sample

The matrix spike duplicate (MSD) sample is commonly prepared in conjunction with the MS sample. The MSD sample is prepared from a separate portion of the client sample and processed with the same additions as the MS. The MSD is prepared for methods that do not typically show concentrations of target analytes above MDLs, such as organic methods. The RPD values between the recovery values in the MS and MSD measure the precision of the analytical method on the actual project samples. For this project, QC criteria for RPDs are 35 percent for sediments unless the laboratory provides additional statistical criteria.

5.2.6 Duplicate Sample

A duplicate sample consists of a set of two samples obtained in an identical manner from the same project sample. The collection of duplicate samples from a heterogeneous matrix requires homogenization to ensure that representative portions are analyzed. One sample per batch of 20 samples or fewer per matrix is analyzed in lieu of a MSD.

The duplicate is prepared for methods that typically show concentrations of target analytes above MDLs, such as metals and wet chemistry analytes. The RPD values between the recovery values in the original and duplicate measure the precision of the analytical method on the actual project samples. For this project, QC criteria for RPDs are 35 percent for sediments unless the laboratory provides additional statistical criteria.

5.2.7 Other Laboratory QC Samples

The laboratory performs analysis of other QC samples or standards, depending on the analytical method. Standard QC samples or standards are documented in the specific method SOP. Method-specific QC samples or standards include internal standard spikes for gas chromatography (GC)/mass spectrometry (MS) methods; post-digestion spikes and serial dilutions for metals analysis; and interference check samples for inductively-plasma analysis. Results of all associated QC should be reported.

5.2.8 Performance Evaluation Samples

As part of the laboratory approval process, the laboratory must analyze external performance evaluation (PE) samples provided by an outside certifying agency on an annual basis. The laboratory must maintain acceptable scores on PE samples as part of the approval process. For this project any PE failures for project target compounds must be reported to the QC Manager immediately.

5.3 Quality Assurance and Quality Control for Bioassay Sediment Samples

The detailed SOPs for the bioassay tests proposed for this investigation will be provided by the selected biological laboratory upon request. This section summarizes toxicity test QA/QC procedures to be implemented to ensure the test results are valid. Standard QA/QC procedures include the use of negative controls, positive controls, reference sediment samples, laboratory replicates, and daily water quality measurements. In addition, close contact with the biological laboratory will be maintained prior to and during the testing period to resolve any QA/QC problems or testing methodology issues in a timely manner.

5.3.1 Negative Control

The negative control consists of clean, inert material (deionized or distilled water used for Microtox® [porewater] bioluminescence) tested in parallel with the test sediments under identical test conditions. The biological testing laboratory provides this clean material, which usually consists of sediment collected from the original location from which the test organisms were harvested. Test acceptability criteria are based on results of the negative control. A test with at least 90% survival (70% mean normal survivorship for larval development) in negative control test chambers is considered acceptable.

5.3.2 Positive Control

A positive control will be run for each bioassay. Positive controls are chemicals known to be toxic to the test organism and that provide an indication of the sensitivity of the particular organisms used in a bioassay. Cadmium chloride or another appropriate reference toxicant will be used for the amphipod mortality, larval development, and juvenile polychaete growth bioassays.

5.3.3 Reference Sediment

Reference sediments, which closely match the grain size characteristics of the test sediments, will be run with each test batch for all four bioassays. The reference sediment is used for test comparisons and interpretations. Carr Inlet will be used as the reference area; the specific collection sites will be determined based on sample physical characteristics. All reference sediments will be analyzed for SVOCs, pesticides, PCBs, metals, dioxins, furans, total solids, TOC, bulk ammonia, bulk sulfides, and grain size.

All bioassays have performance standards for reference sediments (PSEP 1995). Failure to meet these standards may result in the requirement to retest.

5.3.4 Laboratory Replication

Five laboratory replicates of each test sediment, reference sediment, negative control, and elutriate concentration will be run for each respective bioassay. The replication of tests provides multiple observations of effects to test organisms so that statistical comparisons can be made between test and reference sediments.

5.3.5 Bioassay Water Quality

Water quality monitoring will be conducted for the amphipod, larval development, juvenile polychaete growth, and Micortox® (porewater) bioluminenscence bioassays. This consists of daily measurements of salinity, temperature, pH, dissolved oxygen for amphipod, and larval development (every third day for juvenile polychaete growth bioassay). The temperature and pH for the Microtox® (porewater) bioluminenscence bioassay will be determined during test setup. For the amphipod, larval development, and juvenile polychaete growth bioassays, ammonia and sulfides will be determined at test initiation and termination and interstitial salinity will be determined prior to the test setup. Monitoring will be conducted for all test and reference sediments and negative controls (including seawater controls). Parameter measurements must be within the limits specified for each bioassay as listed in Table 5-2. Measurements for each treatment will be made on a separate chemistry beaker set up to be identical to the other replicates within the treatment group. In addition, interstitial ammonia measurements at test initiation and test termination will be conducted for the amphipod test.

Table 5-2. Water quality control limits.

Test (*Test Species*)	Temperature	Salinity	Dissolved Oxygen	pH
Amphipod Mortality (*E. estuarius; R. abronius*)	15 ± 1 °C	Ambient; [a] 28 ± 1 ppt	NA [b]	NCL
Larval Development (*D. excentricus*)	15 ± 1 °C	28 ± 1 ppt	> 60% saturation	NCL
Juvenile Polychaete Growth (*N. arenaceodentata*)	20 ± 1 °C	28 ± 2 ppt	NA [b]	NCL
Microtox® (porewater) bioluminescence	15 °C	20 ± 2 ppt [c]	50 to 100% saturation	7.9 to 8.2

[a] Same as interstitial salinity of test sediment
[b] Continuous aeration is required by the protocol, so the dissolved oxygen should not be a cause of concern
[c] If porewater salinity exceeds 20 ppt, the artificial seawater control should be adjusted to match the test sample salinity ± 2 ppt (Ecology 2008).
NCL – No control limit (pH is monitored as a water quality parameter. There are generally no control limits for pH; however, measurements of pH may be useful in interpreting results [Ecology 2003]).

5.4 Data Validation

At a minimum, all laboratory data will undergo a QA1 review (PTI 1989a). If requested by Ecology, the data will be reviewed following QA2 procedures (PTI 1989b). If data fail the review, the laboratory will be contacted and the data will be reanalyzed, qualified, or unqualified with an explanation. For each data type, the quality of the data will be summarized in validation memos.

In addition, laboratory data packages will be provided for the chemistry data to allow independent data verification and validation. The data packages will consist of the sample results followed by a cover letter describing procedures used and analytical problems encountered, qualifiers used, reconstructed ion chromatogram (GC/MS), mass spectra of detected target compounds (GC/MS), chromatograms, quantification reports, and calibration data summaries. Dilution volumes, sample sizes, percent moisture, and surrogate recoveries will be presented on each summary sheet with the analytical results. A similar package is also assembled for each quality control sample (e.g., method blank).

The following types of data will be reviewed:

- Analytical laboratory summary reports including QC summary data for surrogates, method blanks, LCSs, and MS/MSD samples. Acceptance and performance criteria will be developed from the current laboratory control limits even if those limits differ from the limits listed in Section 7

- Calibration summary data will be checked to verify that all positive results for target compounds were generated under an acceptable calibration as defined by the analytical method.

- Field QC results for blanks.

- Field data such as sample identifications and sample dates will be checked against the laboratory report.

Raw data files from the field and laboratory may not be reviewed unless there is a significant problem noted with the summary information.

After receipt from the laboratory, project data will be validated as described in the following section.

5.4.1 Evaluation of Completeness

The QC Manager verifies that the laboratory information matches the field information and that the following items are included in the data package:

- Chain-of-custody forms

- Case narrative describing any out-of-control events and summarizing analytical procedures

- Data report forms

- QA/QC summary forms
- Calibration summary forms
- Chromatograms documenting any QC problems.

If the data package is incomplete, the QC Manager contacts the laboratory, which must provide all missing information within one day.

5.4.2 Evaluation of Compliance

The actual data validation follows the procedures that are briefly outlined below:

- Review the data to check field and laboratory QC results to verify that holding times and acceptance and performance criteria were met, and to note any anomalous values
- Review chromatograms, mass spectra, and other raw data if provided as backup information for any apparent QC anomalies
- Ensure all analytical problems and corrections are reported in the case narrative and that appropriate laboratory qualifiers are added
- For any problems identified, review concerns with the laboratory, obtain additional information if necessary, and check all related data to determine the extent of the error
- Apply data qualifiers to the analytical results to indicate potential limitations on data usability.

QC Managers will follow qualification guidelines in applicable QA1 or QA2 guidelines. If no QA1 or QA2 guidelines exist, then applicable USEPA National and Regional Data Review guidelines will be used.

5.4.3 Data Validation Reporting

The QC Manager will perform the following reporting functions:

- Alert the Project Manager to any QC problems, obvious anomalous values, or discrepancies between the field and laboratory data, and resolve any issues.
- Discuss QC problems in a data validation memo for each laboratory report, the data validation memo and copy of the data package will be sent to Project Manager.

- Review the laboratory electronic data deliverable (EDD) and electronic field data, enter the data qualifiers into the database, and prepare analytical data summary tables. The tables will summarize those samples and analytes for which detectable concentrations were exhibited as well as complete analytical summary tables. The tables will include field QC samples

- At the completion of all field and laboratory efforts for site, the QC Manager will prepare a data review/validation memorandum. The memorandum will summarize planned versus actual field and laboratory activities and data usability concerns.

6.0 Field Procedures

This section describes the procedures for positioning, sample collection, processing, identification, documentation, equipment decontamination, and waste handling for the proposed field investigation. Samples will be collected for sediment and wood waste sediment chemistry, sediment toxicity, and radioisotope dating. The laboratory methods for chemical analysis, toxicity testing, and radio isotope analysis are presented in Section 7. Field activity SOPs are provided in Appendix A and field forms are presented in Appendix B. The Site-Specific Health and Safety Plan is provided in Appendix C. Sampling station coordinates and property landowner information are provided in Appendix D.

A total of 59 stations will be visited across the study area to collect surface grab and subsurface core samples (including reference samples). All samples will be comprised of sediment submitted to the laboratory for analysis, including those samples designated as wood waste (chunks of wood will be removed from the sample when filling the sample containers). A summary of sample numbers is provided in Table 6-1.

Table 6-1. Sample number summary for Oakland Bay Sediment Study.

	Surface Sediment	Subsurface Sediment [a]	Surface Wood waste	Subsurface Wood waste	Sediment Dating Core
Oakland Bay	14	14	3	3	2
Shelton Harbor	16	16	13	13	1
Hammersley Inlet	7	7	0	0	0
Carr Inlet	3	0	0	0	0
Total	40	37	16	16	3

[a] Oakland Bay and Hammersley Inlet samples to be analyzed based on surface sediment analytical results

6.1 Sampling Platforms

Two vessels, owned and operated by Research Support Services and Bio-Marine Enterprises, will be used for the surface and subsurface sediment/wood waste collection; the geophysical survey will be conducted by Global Geophysics from their vessel equipped with specialized survey equipment.

6.2 Station Positioning and Navigation

A differential global positioning system (DGPS) will be used for station positioning of all vessel sediment sampling stations. The vessels used for these activities will operate navigation equipment that provides accurate station positioning, and that assures sample stations and water depths are accurately recorded. The DGPS will be used aboard the vessel for station positioning.

The DGPS receiver will be capable of surveying positions to within 2 meter (m) accuracy. Horizontal coordinates will be referenced to the Washington State Plane coordinate system under the North American Datum of 1983 (NAD 83). The vertical datum will be the National Ocean Service mean lower low water (MLLW) datum. Vertical control collected by the vessel depth finder will be corrected for tidal influence after completion of the field activities.

Prior to initiating field work, a control check point will be established that can be accessed by the sampling vessel (e.g., dock, piling). At the beginning and end of each day, the check point will be surveyed from the vessel and compared to the known coordinates. The control check point position as recorded by the vessel should not differ by more than 2 m from the land-surveyed coordinates.

For vessel-deployed sampling, the DGPS receiver will be placed above the sampling device deployment boom to accurately record the position. At surface sediment grab stations, once the sampling device has been deployed, the actual position will be recorded when the device reaches the sediment floor and the deployment cable is in a vertical position. At these locations, water depths will be measured directly by lead-line and converted to mudline elevations after correction for tide.

Coordinates of the proposed sampling stations will be programmed as waypoints into the vessel's navigation system and used to guide the vessel to the appropriate locations. The target sample coordinates are provided in Appendix D.

6.3 Geophysical Survey Data Collection

Global Geophysics will perform the geophysical surveys in Shelton Harbor and Oakland Bay. The instrumentation and field methods are described below.

6.3.1 Navigation

The position of the vessel will be determined using the differential global positioning system (DGPS). A Trimbel Ag132, with differential correctors obtained from the U.S. Coast Guard beacon will be used for real-time positioning of the vessel. The navigation computer will be interfaced with the other geophysical instrumentation described below.

6.3.2 Precision Echosounder

Bathymetric data will be acquired with a Reson precision echosounder using a 300 kHz transducer. An analog paper record of data will be produced during the survey.

6.3.3 Seismic Reflection System

Subsurface relection data will be acquired with an EdgeTech Chirp system, high frequency (4 to 24 kHz) seismic reflection system that will discharge 3 times per second. A computer record of subsurface reflection data will be produced during the survey.

6.3.4 Side Scan Sonar

A digital image of the sea bottom will be created using side scan sonar. Lowrance Sonar/M1 side scan sonar (300 kHz) instrumentation will be used during the survey.

6.3.5 Electrical resistivity imaging (ERI) and Induced Polarization (IP)

Both ERI and IP will be collected simultaneously during the geophysical survey. The ERI method detects differences in electrical (resistivity) properties of geologic materials. These differences can result from variations in lithology and mineralogy, water content, or pore-water chemistry. The IP method detects differences in the metal content in sediment. The method involves transmitting an electric current into the ground between two current electrodes and measuring the voltage between two separate potential electrodes. The measured point, called a sounding, represents the apparent resistance of the entire area beneath the electrodes. A combination of different electrode arrangements is used to collect enough soundings to produce an apparent resistivity profile below the ERI survey transects.

The ERI and IP data will be acquired with an AGI SuperSting R8 system using up to 50 electrodes spaced at a three to five ft interval. Once the marine cable is laid out on the bottom of the bay, multiple soundings will be automatically conducted by the control unit. The data will be downloaded into a computer and processed using specialized inversion software.

6.4 Cultural Resources

This section addresses cultural resource procedures to be followed during the Oakland Bay Sediment Characterization Study. While sampling is limited to the collection of surface sediment and wood waste grabs and 4 inch diameter cores, and Oakland Bay is not a known archeological site, some potential exists for the inadvertent discovery of cultural resources within these samples. Archaeological, cultural, or historical objects, such as ruins, sites, buildings artifacts, fossils, or other objects of antiquity that may have significance from a cultural, historical, or scientific standpoint, may be inadvertently encountered during ground-disturbing activities. Typical examples of artifacts may include: bone and bone tools, shells, fibrous objects, projectile points and any other stone tools, flakes from stone tool production, and thermally altered rocks.

Field team members will follow the protocols listed in this document. In the event of a conflict between this document and any applicable law, the applicable law shall govern. These protocols are in part based on recommendations supplied by the Squaxin Island Tribe.

As requested by the Tribe, the Tribe's Cultural Resource Specialist/Archeologist, Mr. Larry Ross, will be notified prior to the field event and offered an opportunity to observe on-shore sediment sample handling. In cases where there is no Tribal representative present, sampling personnel will visually examine the sediment/wood waste samples, prior to and during processing, for the presence of artifacts of cultural significance, including human remains. In the event of an inadvertent discovery, Mr. Ross, or his representative from the Tribe's Cultural Resources Department (CRD), will act for the Tribe during the initial period after the discovery.

The following procedures will be followed in the event of an inadvertent discovery:

- Should the Tribe's representative or field personnel, using best professional judgment, identify the presence of potential artifacts of cultural significance, including human remains, during sample processing, all processing of that sample will cease. No further sampling will take place within 50 ft of this location until the Tribe and Department of Archaeology and Historic Preservation (DAHP) have been consulted concerning avoidance or minimization of further impacts.

- The find will immediately be documented using photographs, drawings and written descriptions with the exception of human remains. Documentation and handling of human remains will be left to the local authorities and the Tribe. For finds other than human remains, the entire sample will be placed in an appropriate container attempting to maintain strata or layers if present. The sample will be secured to ensure custody is maintained until turned over to the property owner, Tribe, or repository.

- The field leader will notify the Ecology Project Manager, Cynthia Erickson, and the cultural resource contact, Connie Groven. Ecology will contact the Tribe's CRD, DAHP, and the property owner, as soon as feasible.

- In the unlikely discovery of human remains, Ecology will treat the remains with dignity at all times. Ecology will not handle the remains, the remains will be covered, and reasonable efforts will be made to protect the area from further disturbance. The Shelton Police and the Medical Examiner/Coroner will immediately be contacted.

- Ecology's Project Manager will allow the Tribe and DAHP to determine the significance of the find and will consult with them to assess the potential effects on the project.

- With the property owner's permission, the samples and artifacts may be temporarily taken for identification or analysis by the Tribe or DAHP. Any samples or artifacts collected will be held in secure storage until such time as they can be analyzed or conveyed to an agreed repository, or returned to the property owner. Ecology agrees to encourage property owners to donate cultural materials discovered as the result of the project activities or to have them curated at the Tribe's Museum Library and Research Center (MLRC). If the artifact is exhibited in the Tribe's MLRC, the display information will include the property owner's name if they request it.

6.5 Sample Collection

6.5.1 Surface Samples

The following sections describe the collection and processing of surface samples. Tables 4-3, 4-5, and 4-7 list surface samples to be collected; Table 6-2 lists the analytical and biological testing methods, and sample container, volume, and preservation requirements.

Surface sediment and wood waste will be collected from a boat using a stainless-steel van Veen (modified 0.1 square meters [m^2]), Ekman, Petite Ponar, or similar grab device. A total of three grab attempts will be made at each proposed sampling location. If unsuccessful, the station will be moved to a new location within 10 m (33 ft) of the original station (sampling will be deemed unsuccessful if the sampler meets refusal or if the entire sample is composed of wood). If it is not possible to obtain a sample within this distance, the Ecology project manager will be consulted to determine an appropriate alternate action.

Surface sediment and wood waste samples will be collected from the 0 to 10 cm (0 to 4 inches [in]) interval. Multiple grabs will be necessary to obtain an adequate sample volume for all analyses. Samples will be collected as described in the SOP for surface sediment sampling (Appendix A). Samples will be carefully collected to ensure the following conditions are met, as required by Ecology (2008):

1. Make logbook and field form entries as necessary throughout the sampling process to ensure accurate and thorough record-keeping. Field documentation is described in Section 6.8.

2. Position the sampling vessel at the targeted sampling location.

3. Set the sampler jaws in the open position, place the sampler over the edge of the boat, and lower the sampler to the bottom.

4. Trip the sampler to collect the sample.

5. Record the location using the DGPS; measure and record the water depth.

Table 6-2. Sediment sample analysis summary, preservation, sample container, and holding times.

Number of Samples [a]	Analytical Parameters/ Method	Sample Preservation	Technical Holding Time [b]	Sample Container(s)
109	SVOCs/SW-846 Method 8270D	Cool to 4°C	Extract within 14 days of collection; analyze within 40 days of extraction.	One 8-oz wide-mouth glass jar with Teflon-lined lid.
		Freeze, -18°C	Extract within 1 year of collection, analyze within 40 days of extraction	
35	Wood Resin/ SW-846 Method 8270D	Cool to 4°C	Extract within 14 days of collection; analyze within 40 days of extraction.	One 8-oz wide-mouth glass jar with Teflon-lined lid.
		Freeze, -18°C	Extract within 1 year of collection, analyze within 40 days of extraction	
35	Chlorinated Guaiacols /NCASI CP-86.07	Cool to 4°C	Extract within 30 days of collection; analyze within 40 days of extraction.	One 8-oz wide-mouth glass jar with Teflon-lined lid.
		Freeze, -18°C	Extract within 1 year of collection, analyze within 40 days of extraction	
56	Dioxin/Furans/ USEPA Method 1613B	Cool to 4°C	Extract within 14 days of collection; analyze within 40 days of extraction.	One 8-oz wide-mouth glass jar with Teflon-lined lid.
		Freeze, -18°C	Extract within 1 year of collection, analyze within 40 days of extraction	
109	Pesticides/SW-846 Method 8081B	Cool to 4°C	Extract within 14 days of collection; analyze within 40 days of extraction.	One 8-oz wide-mouth glass jar with Teflon-lined lid.
		Freeze, -18°C	Extract within 1 year of collection, analyze within 40 days of extraction	
109	PCBs/SW-846 Method 8082	Cool to 4°C	Extract within 14 days of collection; analyze within 40 days of extraction.	One 8-oz wide-mouth glass jar with Teflon-lined lid.
		Freeze, -18°C	Extract within 1 year of collection, analyze within 40 days of extraction	
13	NWTPH-HCID/Ecology NWTPH-HCID	Cool to 4°C	Extract within 14 days of collection; analyze within 40 days of extraction.	One 8-oz wide-mouth glass jar with Teflon-lined lid.
9	Organotins /(Krone, et. al., 1989)	Cool to 4°C	Extract within 14 days of collection; analyze within 40 days of extraction.	One 8-oz wide-mouth glass jar with Teflon-lined lid.
		Freeze, -18°C	Extract within 1 year of collection, analyze within 40 days of extraction	

Table 6-2 (continued). Sample analysis summary, preservation, sample container, and holding times.

Number of Samples [a]	Analytical Parameters/ Method	Sample Preservation	Technical Holding Time [b]	Sample Container(s)
109	Metals/SW-846 Methods 6000/7000 Series	Cool to 4°C	180 days (28 days for mercury).	One 8-oz wide-mouth glass jar with Teflon-lined lid.
		Freeze, -18°C	2 years (28 days for mercury)	
130	TOC/SW-846 9060 (Plumb)	Cool to 4°C	14 days from collection.	One 8-oz wide-mouth glass jar with Teflon-lined lid.
		Freeze, -18°C	6 months from collection	
130	Grain Size/PSEP	Cool to 4°C	180 days from collection	One 16-oz wide-mouth glass jar with Teflon-lined lid.
35	Total Volatile Solids/ USEPA Method 160.4	Cool to 4°C	14 days from collection.	One 8-oz wide-mouth glass jar with Teflon-lined lid. No headspace
		Freeze, -18°C	6 months from collection	
130	Sulfide/SW-846 9030	Cool to 4°C, with 5ml of zinc acetate	7 days from collection.	One 2-oz wide-mouth glass jar with Teflon-lined lid. No headspace.
130	Ammonia/PSEP	Cool to 4°C	7 days from collection.	One 8-oz wide-mouth glass jar with Teflon-lined lid.
3 Cores	Core Dating (cesium 137 and lead 210)	Cool to 4°C	Analyze Cores as soon as possible.	Two 8-oz wide-mouth glass jar with Teflon-lined lid.
56	Sediment Toxicity (Bioassay) [d]	Cool to 4°C	14 days from collection	5.5 L in a poly bag
		Cool to 4°C, nitrogen atmosphere	8 weeks from collection	

[a] The number of samples presented is an estimate; the actual number of samples to be collected will be determined in the field.
[b] Holding times established in Ecology 2008, Table 10
[c] Samples will be analyzed by alpha and gamma spectroscopy.
[d] Bioassay consist of four toxicity tests: amphipod mortality, larval development, polychaete growth, and Microtox® (porewater) bioluminescence.
°C = Degrees Celsius.
Ecology =Washington Department of Ecology.
USEPA = U.S. Environmental Protection Agency
HCID = Hydrocarbon Identification.
NWTPH = Northwest total petroleum hydrocarbon.
oz = ounce.
PCBs = Polychlorinated Biphenyl Compounds.
Pesticides = Chlorinated Pesticides.
PSEP = Puget Sound Estuary Program Methods.
SVOCs = Semivolatile Organic Compounds.
SW-846 = *Test Methods for Evaluating Solid Waste, Physical Chemical Methods*, 3rd edition, SW-846, 1986.

6. Retrieve the sampler and place it securely in the sampling vessel.

7. Examine the sample for the following sample acceptance criteria:

   - ☐ The sampler is not overfilled with sample so that the sediment surface is not pressed against the top of the sampler.
   - ☐ The sample does not contain large foreign objects (i.e., trash or debris). A sample that is primarily wood or rock/gravel fill will be rejected in favor of depositional material (i.e., sand/silt/clay).
   - ☐ Overlying water is present in the sampler (indicates minimal leakage).
   - ☐ The overlying water is not excessively turbid (indicates minimal sample disturbance).
   - ☐ The sediment surface is relatively flat (indicates minimum of disturbance or winnowing).
   - ☐ The desired penetration depth is achieved (e.g., several centimeters more than the targeted sample depth).

8. If sample acceptance criteria are not achieved, the sample will be rejected and another sample collection attempt will be made.

9. Siphon off any overlying surface water.

10. Collect samples for total sulfides and ammonia analysis directly from the grab sampler and place the sediment aliquots in appropriate, pre-cleaned, labeled sample containers. Containers will be filled to the brim to minimize headspace (Table 6.1). The Microtox® sample will be containerized with a minimal disturbance of sediment.

11. Measure and collect the top 10 cm (4 in) with a stainless steel spoon, avoiding any sediment that is in contact with the inside surface of the grab sampler, then place the sediment into a stainless steel bowl, homogenize, and cover with aluminum foil.

12. Record the following observations of sediment sample characteristics on the field form (Appendix B); if more sample volume is required, repeat steps 4 through 12.

    - ☐ Texture
    - ☐ Color

- ☐ Biological organisms or structures (i.e., shells)
- ☐ Presence of debris (i.e., natural or anthropogenic objects, including wood and its general size, – identifying bark, wood chips, and sawdust relative abundance by percent)
- ☐ Presence of oily sheen or obvious contamination
- ☐ Odor (e.g., hydrogen sulfide, petroleum).

13. Wash excess sediment back into the water away from any areas remaining to be sampled.

14. Once sufficient sediment volume has been collected, samples should be placed in the appropriate, pre-cleaned, labeled sample containers as described in Section 6.6, placed in a cooler maintained at 4 ºC, and prepared for shipment to the analytical or biological laboratory as described in Section 6.7.

15. Confirm all relevant documentation has been completed, entries are accurate, and paperwork has been signed.

16. Decontaminate all sampling equipment as described in Section 6.9 before proceeding to the next sampling location.

Additional sample volume will be collected at stations requiring MS/MSD analysis (collected randomly at the field supervisor's discretion). Aliquots of homogenized sediment will also be collected for toxicity testing at designated locations.

Manual sampling methods (e.g., stainless steel spoon and bowl) may be used at locations exposed during low water conditions. Surface sediment will be collected from the 0 to 10 cm (0 to 4 in) interval. Samples will be collected as described in the SOP for surface sediment.

6.5.2 Wet Sieving

A homogenized sample aliquot of sediment collected at locations designated for toxicity testing will be wet sieved in the field. The purpose for wet sieving is to separate the coarse and fine-grained material comprising a sediment sample in order to match appropriate test and reference locations for toxicological testing. A 63-micron sieve is used to separate the silt and clay (fines), from the sand and gravel portion of the sediment sample. The grain size distribution of a given sediment sample is an important physical parameter when conducting bioassays in order to determine an appropriate reference sample for comparison with test sediments. The wet sieving of surface sediment samples is conducted in the field at the time of collection, so that reference samples with similar grain size distributions (as percent fines) can be targeted for the bioassays. The procedure for wet sieving is as follows:

1. Measure and record the exact volume of a small (100 ml) flat-topped beaker. (Note: the 100 ml gradation is generally located slightly below the rim of the beaker; hence, the actual beaker volume is greater than 100 ml).

2. Completely fill the beaker to the rim with an aliquot of homogenized sediment. Lightly tap the beaker on a hard surface to remove any air bubbles, and level the surface.

3. Rinse the entire contents of the beaker through a 63-micron (#230, 4 phi) sieve. Aggregates of material should be gently broken to facilitate sieving. Continue sieving until clear rinsewater passes through the sieve.

4. Carefully transfer the coarse-grained material from the sieve into a 250 ml graduated cylinder.

5. Divide the amount of material measured in the bottom of the graduated cylinder by the capacity of the beaker to determine the decimal percentage of coarse-grained material. Subtract the decimal percentage of coarse-grained material from 1 to determine the decimal percentage of fines (silt and clay).

6. Record the percentages of coarse and fine-grained material in the field logbook.

6.5.3 Subsurface Samples

Core samples will be collected using a vibracoring device. In most cases, the cores will be advanced to a little more than 4 ft to ensure adequate sediment retrieval (actual depth will depend on sediment characteristics). Each core will be divided into 1-ft intervals, depending on limitations of the equipment to reach targeted depth horizons. If significant wood waste is encountered, based on visual observations, another core will be advanced adjacent to the first core to the bottom of the wood waste, up to a maximum of 12 ft.

The general procedure for collecting sediment cores is as follows:

1. Make logbook and field form entries as necessary throughout the sampling process to ensure accurate and thorough record-keeping. Field documentation is described in Section 6.8.

2. Position the sampling vessel at the targeted sampling location.

3. Record the location using the DGPS; measure and record the water depth.

4. Insert pre-cleaned acetate core tubes equipped with an "eggshell" core catcher to retain material in the core barrel for deployment.

5. The core-sampler is positioned vertically on the bottom and advanced to a sampling depth of approximately 4 ft (1.2 m) or 12 ft (3.7 m) to include all targeted sampling intervals or until refusal.

6. Once sampling is complete, the sampler is extracted and core tube detached from the vibracorer. The core sample will be examined at each end to verify that sufficient sediment was retained. The condition and quantity of material within the core will then be inspected to determine acceptability. If sample acceptance criteria are not achieved, the sample will be rejected and another sample collection attempt will be made.

    - ◻ To verify whether an acceptable core sample has been collected the following criteria must be met:

        - Target penetration depth or refusal was achieved

        - Sediment recovery of at least 65 percent of the penetration depth;

        - Sample appears undisturbed and intact without any evidence of obstruction or blocking within the core tube or core catcher.

    - ◻ Percent sediment recovery will be determined by dividing the length of material recovered in the core tube by the depth of core penetration below the mudline. If the sample is deemed acceptable, overlying water will be siphoned from the top of the core tube, and each end of the tube will be capped and sealed with duct tape for storage until processing. The cores will be stored on ice until they are processed. The station number, station coordinates, date and time of collection, sediment description, field crew, and weather conditions will be recorded in the sediment coring log (Appendix B).

7. Record observations of sediment sample characteristics on the field form (Appendix B); if more sample volume is required repeat steps 4 through 11.

8. Process cores at a predetermined location onshore. Label the core, cap it, and store it in an upright vertical position in a container packed with ice until processed. Cores are to be processed as soon as possible.

9. Confirm all relevant documentation has been completed, entries are accurate, and paperwork has been signed.

10. Wash excess sediment back into the water away from any remaining sample areas.

11. Decontaminate all sampling equipment as described in Section 6.9 before proceeding to the next sampling location.

A single acceptable sample for each subsurface interval will be collected. All sediment cores will be processed at a designated processing location (extrusion, documentation, and sample collection for analysis). Disposable nitrile gloves will be worn for all handwork such as sectioning and extruding the core, sub-sampling, mixing samples, and filling sample containers. The gloves will be disposed of between sample composites in order to prevent cross contamination between samples. Sampling implements and processing equipment will be decontaminated prior to processing the sediment cores. Sediment cores will be processed in the same order as collected to minimize holding time. Each core tube will be cut open length-wise using electric snips or knife. Care will be taken to preserve the integrity of the core section strata. Once the sediment has been exposed, a visual characterization of the sample material will be immediately conducted. The core will then be visually described in the core log and will include the following information and characteristics:

- Station number
- Date and time of collection
- Station coordinates
- Weather conditions
- Names of persons collecting and logging the sample
- Penetration depth
- Percent sediment recovery
- Physical soil description in accordance with the Unified Soil Classification System (USCS)
- Color
- Odor (e.g., hydrogen sulfide, petroleum)
- Visual stratifications and lenses
- Vegetation
- Woody debris (identify bark, wood chips, and sawdust relative abundance by percent)

- Biological activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms)
- Presence of oil sheen or obvious contamination
- Any other distinguishing characteristics or features.

Representative aliquots of sediment will be collected from the 1 ft (0.3 m) intervals using decontaminated stainless steel spoons, to generate the composite sample. Up to 12 samples will be collected from each core representing a 1 ft (0.3 m) vertical horizon. Sediment will be collected from the center of the core that has not been smeared by, or in contact with, the core tube. The volumes removed will be placed in a decontaminated stainless steel bowl or pan, and mixed until homogenous in texture and color.

Sample aliquots for ammonia and sulfide will be separated from the 1-2 ft increment prior to sample homogenization and placed in appropriate, pre-cleaned, labeled sample containers. Containers will be filled to the brim to minimize headspace. The sample will be homogenized and sample aliquots for grain size and TOC will be collected for analysis. The remaining 1-2 ft core material will be placed in the applicable sample containers and analyzed immediately for Shelton Harbor, but stored for potential future analysis for Oakland Bay and Hammersley Inlet. Each of the remaining 1-ft core increments will be separately homogenized and placed in large sample jars for archiving.

6.5.4 Radioisotope Cores

Each core will be approximately 4 ft (1.2 m) in length. Cores will be divided by the laboratory into 2 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.

6.6 Sample Identification, Containers, and Labels

6.6.1 Sample Identification

Samples will be identified based on the sampling area, location, and sample depth. All samples collected during the investigation will be labeled clearly and legibly. Each sample will be labeled with a unique alphanumeric sample identification number that identifies characteristics of the sample as follows:

<u>Study Location</u>
SH - Shelton Harbor
OB - Oakland Bay
HI - Hammersley Inlet
RF - Reference

Station Location (associated with each Study Location)
01 - Sample Station 1

Matrix
SS - Sediment Surface
SC - Sediment Core
RI - Radioisotope
WS - Wood Waste Surface Sediment
WC - Wood Waste Core Sediment

Depth
00 - Surface
01 - 0-1 ft
12 - 1-2 ft
23 - 2-3 ft
34 - 3-4 ft
04 - 0-4 ft (radioisotope only)

For example:

- SH-01-RI-04 = Shelton Harbor, Station 1, Radioisotope, 0-4 ft interval
- OB-09-SC-12 = Oakland Bay, Station 9, Sediment Core, 1-2 ft interval.

6.6.2 Sample Containers

Pre-cleaned sample containers will be supplied by the analytical laboratory for the required analyses. Spare sample containers will be carried by the field samplers for archive sample collection, and in case of breakage or possible contamination. Sample containers, preservation techniques, and holding times will follow SAPA (Ecology 2008) guidelines (see Table 6-2).

6.6.3 Sample Labels

Sample labels will be made of self-adhering, waterproof material. An indelible pen will be used to fill out each label. Each sample label will contain:

- Project name
- Sample identification number
- Date of collection (day/month/year)
- Time of collection (military format)
- Analysis
- Preservative (as applicable)
- Company name and sampler initials (Herrera/GC).

Sample labels will be protected by packaging tape wrapped around the entire jar to prevent loss or damage of the labels during handling and storage.

6.7 Sample Storage and Delivery

An SOP for sample packing and shipment is provided in Appendix A. All samples will be stored in insulated coolers and preserved by cooling with ice or frozen gelpacks to a temperature of 4°C or below. Maximum sample holding and extraction times will be strictly adhered to by field personnel and the analytical and testing laboratories. Preparation of jars for shipment to fixed laboratories will be performed in the following manner:

- Samples will be packaged and shipped in accordance with U.S. Department of Transportation regulations as specified in 49 Code of Federal Regulations (CFR) 173.6 and 49 CFR 173.24.
- Place sample containers in plastic zip-loc bubble-pack bags, or wrap in bubble pack and secure with packaging tape.
- Prepare an empty insulated cooler by placing three to four ice packs in a garbage bag at the bottom of the cooler. Place sample containers in a garbage bag and fill with the sample bottles. Add additional bags of ice as needed to surround the bag containing the samples.
- Chain of custody (COC) forms will be enclosed in a plastic bag and taped to the inside lid of the cooler.
- Seal the cooler with strapping tape and a custody seal.

Samples for chemical analyses will be hand-couriered or shipped via overnight delivery to the analytical laboratories once per day or whenever a cooler is filled, and accompanied by the COC record, which identifies the shipment contents. The COC will be signed by the individual relinquishing samples to the onsite laboratory representative. Upon receipt of samples at the laboratory, the shipping container seal will be broken and the condition of the samples will be recorded by the receiver. The field personnel will be responsible for the following:

- Packaging the samples
- Signing the COC before placing inside the cooler to be sealed;
- Applying a shipping label, a waybill, a custody seal, and strapping tape to the cooler
- Shipping the samples in accordance with the maximum holding time allowed for the analyses to be performed
- Notifying the laboratory of when the samples are shipped
- Confirming receipt of the samples by the laboratory and that the samples were received in good condition.

All sediment samples to be archived by the laboratory will be frozen. Sediment cores will be processed in the field and placed into appropriate sample jars based on core depth interval. All sediment samples will be retained for a minimum of six months from the time they were received using standard laboratory handling procedures. They may be removed from the laboratory prior to the end of the six-month period only at the direction of the Ecology project manager.

6.8 Field Documentation

A complete record of field activities will be maintained. Documentation necessary to meet QA objectives for this project includes field notes and field forms, sample container labels, and COC forms. An SOP for field documentation is provided in Appendix A. The field documentation will provide descriptions of all sampling activities, sampling personnel, and weather conditions, and will record all modifications, decisions, and/or corrective actions to the study design and procedures identified in this SAP.

6.8.1 Field Notebooks

Field logbooks will be kept on site during field operations. Daily activities will be recorded in a bound field logbook of water-resistant paper. Separate logbooks consisting of bound, paginated field forms will be kept for sediment core sampling, sediment grab sampling, and an inventory of sample containers (separate from the COC documentation). All entries will be made legibly, in indelible ink, and will be signed and dated. Information recorded will include the following:

- Date, time, place, and location of sampling
- Onsite personnel and visitors
- Daily safety discussion and any safety issues
- Quality control samples (i.e., duplicate samples, field blanks, etc.)
- Field measurements and their units
- Number of attempts at each sampling station
- Observations about site and location (weather, current, odors, appearance, etc.)
- Observations about the samples (DGPS locations, depth as recorded by vessel depth sounder, maximum penetration depth, comments)
- General sediment characteristics (texture, color, biota, odor, sheen, etc.)
- Equipment decontamination verification.

Field logbooks are intended to provide sufficient data and observations to enable participants to reconstruct events that occur during project field activities. Entries should be factual, detailed, and objective. Unless restricted by weather conditions, all original data recorded in field logbooks, on sample identification tags, on COC records, and on field forms will be written in waterproof ink. If an error is made, the individual responsible may make corrections simply by crossing out the error and entering the correct information. The erroneous information will not be obliterated. All corrections will be initialed and dated. All documentation, including voided entries, will be maintained within project files.

6.8.2 Chain-of-Custody Procedures

Samples will be retained at all times in the field crew's custody until samples are delivered or shipped to the appropriate laboratory by field personnel. COC forms will be initiated at the time of sample collection to ensure that all collected samples are properly documented and traceable through storage, transport, and analysis. When all line items on the form are completed or when the samples are relinquished, the sample collection custodian will sign and date the form, list the time, and confirm the completeness of all descriptive information contained on the form. Each individual who subsequently assumes responsibility for the samples will sign and date the COC form. The field COC terminates when the laboratory receives the samples. The field sample custodian will retain a copy of the completed, signed COC form(s) for project files.

6.9 Equipment Decontamination Procedures

The vessel-deployed grab samplers, compositing pans, and sampling utensils will be thoroughly decontaminated prior to use in accordance with Sediment Sampling and Analysis Plan Appendix (SSAPA) guidance (Ecology 2008). The equipment will be washed with non-phosphate detergent and in situ water or by repeatedly submersing the equipment overboard. A final rinse with distilled water also will be performed. If a noticeable oily sheen or petroleum odor is observed, sampling bowls and utensils used to process those samples will not be used for subsequent sample processing.

All handwork will be conducted with disposable nitrile gloves, which will be changed after handling each individual sample and between sampling stations to prevent cross-contamination between samples.

Personal non-disposable field equipment (i.e., boots and waterproof gloves and garments) will be rinsed with water and brushed clean prior to leaving the immediate vicinity of the sample collection area. Special attention will be given to removing mud and sediments that may adhere to boot treads.

6.10 Waste Disposal

Investigation-derived waste (IDW) expected to be generated by sampling activities during the Oakland Harbor sediment study include:

- Sediment sample material not submitted to the laboratories
- Equipment decontamination fluids
- Disposable protective clothing and sampling supplies.

The disposal procedures identified below are consistent with guidance provided in Section 5.7 of the SSAPA (Ecology 2008).

6.10.1 Sediment Sample/Sediment Core

Surface sediment samples will be processed onboard the vessel and sediment core samples will be processed at an onshore station established for this investigation. To the extent practicable, excess sediment material will be returned to the site following completion of sample processing. Any sediment not returned to the site will be packed in sealable containers and disposed of properly.

6.10.2 Equipment Decontamination Fluids

Water-based decontamination fluids will be disposed of on site. Organic solvent fluids generated during equipment decontamination will be contained in sealable containers and disposed of properly following field activities.

6.10.3 Disposable Protective Clothing and Sampling Equipment

Used personal protective equipment (PPE), such as gloves and disposable supplies, such as paper towels and packaging, will be placed in plastic storage bags and disposed of as municipal waste. If PPE contains residual sediment, the PPE will be decontaminated using the procedures outlined in Section 6.9, and will be disposed of as non-hazardous waste. Waste material will be recycled as feasible (e.g., cardboard, aluminum).

7.0 Laboratory Analytical Procedures

All of the chemical analytical procedures used in this program will be performed in accordance with the most current SMS, PSEP, and Ecology's SSAPA (Ecology 2008) documentation, as applicable. Analytes include metals, SVOCs (PAHs, phthalates, and phenols), polychlorinated dibenzo-p-dioxin compounds (dioxins), polychlorinated dibenzofuran compounds (furans), chlorinated pesticides, total PCBs as Aroclors,, wood resin compounds, petroleum hydrocarbons, total volatile solids, grain size, TOC, ammonia, and sulfides. In addition, three cores will be analyzed for lead-210 and cesium-137.

Each laboratory participating in this program will be National Environmental Laboratory Accreditation Program - and/or Ecology-certified to perform the analyses. Each laboratory analysis will be required to conform to accepted standard methods and internal QA/QC.

7.1 Chemical Analyses

Chemical analysis will be conducted by laboratories subcontracted to Herrera. The specific analyses and conventional parameters to be measured, sample preparation methods, analytical methods, TDLs, and SMS numeric criteria (SQS and CSL) are presented in Table 7-1. The TDLs listed are the laboratory reporting limits (RLs); and may be subject to modification due to elevated sample concentrations, heterogeneous samples, and potential matrix interferences that may preclude obtaining the desired quantification limit. Several organic compounds in the SMS criteria are corrected for percent OC content. In the event the laboratory is unable to meet the OC-corrected SQS and CSL numeric values, the reasons for the deviation will also be reported.

Analytical laboratory reports will be accompanied by sufficient backup data and QC results to enable independent reviewers to evaluate the quality of the data results. Analytical data will be reported in the units specified by the RLs listed in Tables 7-1 and 7-2.

Analytical laboratory deliverables will include the following:

- Case narrative (including any problems encountered, protocol modifications, and/or corrective actions taken)
- Sample analytical and QA/QC results with units
- All protocols used during analyses
- Any protocol deviations from the approved sampling plan
- Surrogate recovery results

Table 7-1. Sediment SMS analyte list for the Oakland Bay Sediment Study.

Analyte	Prep Method [a]	Analytical Method [b]	Sediment RL [c,d]	SQS	CSL
Conventional Parameters					
Total Solids (%)	---	PSEP [5]	0.1 (wet weight)	---	---
Total Organic Carbon (%)	---	PSEP [5]	0.1	---	---
Total Sulfides (mg/kg)	---	PSEP [5]	10	---	---
Ammonia (mg/kg)	---	PSEP [5]	0.1	---	---
Grain Size (%)	---	PSEP [5]	1	---	---
Metals			mg/kg	mg/kg	
Arsenic	PSEP/3050B	6010B/6020	19	57	93
Cadmium	PSEP/3050B	6010B/6020	1.7	5.1	6.7
Chromium	PSEP/3050B	6010B/6020	87	260	270
Copper	PSEP/3050B	6010B/6020	130	390	390
Lead	PSEP/3050B	6010B/6020	150	450	530
Mercury	---	7471A	0.14	0.41	0.59
Silver	PSEP/3050B	6010B/6020	2	6.1	6.1
Zinc	PSEP/3050B	6010B/6020	137	410	960
Low Molecular Polycyclic Aromatic Hydrocarbons (LPAH)			µg/kg	mg/kg OC	
Naphthalene	3540C/3550B	8270C	700	99	170
Acenaphthylene	3540C/3550B	8270C	433	66	66
Acenaphthene	3540C/3550B	8270C	167	16	57
Fluorene	3540C/3550B	8270C	180	23	79
Phenanthrene	3540C/3550B	8270C	500	100	480
Anthracene	3540C/3550B	8270C	320	220	1,200
2-Methylnaphthalene	3540C/3550B	8270C	223	38	64
Total LPAH				370	780
High Molecular Polycyclic Aromatic Hydrocarbons (HPAH)			µg/kg	mg/kg OC	
Fluoranthene	3540C/3550B	8270C	567	160	1,200
Pyrene	3540C/3550B	8270C	867	1,000	1,400
Benzo(a)anthracene	3540C/3550B	8270C	433	110	270
Chrysene	3540C/3550B	8270C	467	110	460
Benzofluoranthenes, total	3540C/3550B	8270C	1,067	230	450
Benzo(a)pyrene	3540C/3550B	8270C	533	99	210
Indeno(1,2,3-c,d)pyrene	3540C/3550B	8270C	200	34	88
Dibenzo(a,h)anthracene	3540C/3550B	8270C	77	12	33
Benzo(g,h,i)perylene	3540C/3550B	8270C	223	31	78
Total HPAH				960	5,300
Chlorinated Benzenes			µg/kg	mg/kg OC	
1,2-Dichlorobenzene	3540C/3550B	8270C	35	2.3	2.3
1,4-Dichlorobenzene	3540C/3550B	8270C	37	3.1	9
1,2,4-Trichlorobenzene	3540C/3550B	8270C	31	0.81	1.8
Hexachlorobenzene	3540C/3550B	8270C	22	0.38	2.3

Table 7-1 (continued). Sediment SMS analyte list for the Oakland Bay Sediment Study.

Analyte	Prep Method [a]	Analytical Method [b]	Sediment RL [c,d]	SQS	CSL
Phthalate Esters			µg/kg	mg/kg OC	
Dimethyl phthalate	3540C/3550B	8270C	24	53	53
Diethyl phthalate	3540C/3550B	8270C	37	61	110
Di-n-butyl phthalate	3540C/3550B	8270C	467	220	1,700
Butyl benzyl phthalate	3540C/3550B	8270C	21	4.9	64
Bis(2-ethylhexyl)phthalate	3540C/3550B	8270C	433	47	78
Di-n-octyl phthalate	3540C/3550B	8270C	2,067	58	4,500
Ionizable Organic Compounds			µg/kg	µg/kg	
Phenol	3540C/3550B	8270C	140	420	1,200
2-Methylphenol	3540C/3550B	8270C	63	63	63
4-Methylphenol	3540C/3550B	8270C	223	670	670
2,4-Dimethylphenol	3540C/3550B	8270C	29	29	29
Pentachlorophenol	3540C/3550B	8270C	120	360	690
Benzyl alcohol	3540C/3550B	8270C	57	57	73
Benzoic acid	3540C/3550B	8270C	217	650	650
Miscellaneous Compounds			µg/kg	mg/kg OC	
Dibenzofuran	3540C/3550B	8270C	180	15	58
Hexachlorobutadiene	3540C/3550B	8270C	11	3.9	6.2
N-Nitrosodiphenylamine	3540C/3550B	8270C	28	11	11
Total PCBs	3540C/3550B	8082	6	12	65

[a] Recommended sample preparation methods are: PSEP (1997a,b) and USEPA 3000 series (sample preparation methods from SW-846 [USEPA 1986])

[b] Recommended sample cleanup methods are: USEPA SW-846 Methods 3640A, 3660B, and 3665A. Alternative cleanup procedures are described in PSEP and SW-846.

[c] RL, SQS, and CSL are on a dry weight basis.

[d] The recommended RL is based on a value equal to one third of the 1988 dry weight lowest apparent effects threshold value (Barrick et al. 1988) except for the following chemicals: 1,2-dichlorobenzene, 1,2,4-trichlorobenzene, hexachlorobenzene, hexachlorobutadiene, n-nitrosodiphenylamine, 2-methylphenol, 2,4-dimethylphenol, and benzyl alcohol, for which the recommended MRL is equal to the full value of the 1988 dry weight. As reported in Table 5, Ecology 2008.

CSL = Cleanup Screening Level.
HPAH = High molecular weight polycyclic aromatic hydrocarbon compounds.
LPAH = Low molecular weight polycyclic aromatic hydrocarbon compounds.
µg/kg = Micrograms per kilogram.
mg/kg = Milligrams per kilogram.
OC = Organic carbon.
PSEP = *Recommended Protocols for Measuring Metals in Puget Sound Water, Sediment and Tissue Samples*, Puget Sound Estuary Program, April 1997.
RL = Reporting limit.
SQS = Sediment Quality Standards
SW-846 = *Test Methods for Evaluating Solid Waste, Physical Chemical Methods*, 3rd edition, USEPA, SW-846, 1986.
USEPA = United States Environmental Protection Agency.

Table 7-2. Sediment non-SMS analyte list summary for Oakland Bay Sediment Study.

Parameter	Analysis Method [a]	Sediment RL
Metals [b]		
Antimony	SW 6010/6020	50
Nickel	SW 6010/6020	47
Chlorinated Pesticides [c]		
Aldrin	SW 8081	1.7
gamma-BHC (Lindane)	SW 8081	1.7
Heptachlor	SW 8081	1.7
Hexachlorobenzene	SW 8081	22
alpha-Chlordane	SW 8081	1.7
4,4'-DDD	SW 8081	3.3
4,4'-DDE	SW 8081	2.3
4,4'-DDT	SW 8081	6.7
Dieldrin	SW 8081	2.3
Organotin Compounds [c]		
Butyltin	Krone, et. al., 1989	4
Dibutyltin	Krone, et. al., 1989	6
TBT	Krone, et. al., 1989	4
Wood Resin Compounds [c]		
Retene	SW 8270	20
Guaiacols	modified SW 8270	20
4-Chloroguaiacol	modified SW 8270	TBD
3,4-Dichloroguaiacol	modified SW 8270	TBD
4,5-Dichloroguaiacol	modified SW 8270	50
4,6-Dichloroguaiacol	modified SW 8270	TBD
3,4,5-Trichloroguaiacol	modified SW 8270	75
3,4,6-Trichloroguaiacol	modified SW 8270	TBD
4,5,6-Trichloroguaiacol	modified SW 8270	50
Tetrachloroguaiacol	modified SW 8270	75
Pimaric acid	modified SW 8270	100
Sandracopimaric acid	modified SW 8270	100
Isopimaric acid	modified SW 8270	100
Palustric acid	modified SW 8270	100
Dihydroabietic acid	modified SW 8270	100
Abietic acid	modified SW 8270	100
Neoabietic acid	modified SW 8270	100
9,10-Dichlorostearic acid	modified SW 8270	TBD
Oleic acid	modified SW 8270	100
Linolenic acid	modified SW 8270	100
12-Chlorodehydroabietic acid	modified SW 8270	100
14-Chlorodehydroabietic acid	modified SW 8270	100
Dichlorodihydroabietic acid	modified SW 8270	100
NWTPH-HCID [c]		
Gasoline	NWTPH-HCID	20
Diesel #2	NWTPH-HCID	50

Table 7-2 (continued). Sediment non-SMS analyte list summary for Oakland Bay Sediment Study.

Parameter	Analysis Method [a]	Sediment RL
Motor Oil	NWTPH-HCID	100
CDD/CDF [d]		
2,3,7,8-TCDD	USEPA 1613B	0.1
Total TCDD	USEPA 1613B	0.1
1,2,3,7,8-PeCDD	USEPA 1613B	0.5
Total PeCDD	USEPA 1613B	0.5
1,2,3,4,7,8-HxCDD	USEPA 1613B	0.5
1,2,3,6,7,8-HxCDD	USEPA 1613B	0.5
1,2,3,7,8,9-HxCDD	USEPA 1613B	0.5
Total HxCDD	USEPA 1613B	0.5
1,2,3,4,6,7,8-HpCDD	USEPA 1613B	0.5
Total HpCDD	USEPA 1613B	0.5
OCDD	USEPA 1613B	1.0
2,3,7,8-TCDF	USEPA 1613B	0.1
Total TCDF	USEPA 1613B	0.1
1,2,3,7,8-PeCDF	USEPA 1613B	0.5
2,3,4,7,8-PeCDF	USEPA 1613B	0.5
Total PeCDF	USEPA 1613B	0.5
1,2,3,4,7,8-HxCDF	USEPA 1613B	0.5
1,2,3,6,7,8-HxCDF	USEPA 1613B	0.5
1,2,3,7,8,9-HxCDF	USEPA 1613B	0.5
2,3,4,6,7,8-HxCDF	USEPA 1613B	0.5
Total HxCDF	USEPA 1613B	0.5
1,2,3,4,6,7,8-HpCDF	USEPA 1613B	0.5
1,2,3,4,7,8,9-HpCDF	USEPA 1613B	0.5
Total HpCDF	USEPA 1613B	0.5
OCDF	USEPA 1613B	1.0

[a] Krone, et al., 1989. A method for analysis of butyltin species and measurement of butyltin in Sediment and Engish sole livers from Puget Sound. Marine Environment Research, **27**, 1-18.
[b] Metal reporting limits (RL) are on a dry weight basis in mg/g.
[c] Organic Compounds RL are on a dry weight basis in µg/g.
[d] CDD and CDF RL are on a dry weight basis in pg/g.
CDD = Chlorinated dibenzo-p-dioxin.
CDF = Chlorinated dibenzofuran.
USEPA 1613B = *Method 1613 Tetra- through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGC/HRMS*. U.S. Environmental Protection Agency, Office of Water, Engineering and Analysis Division. October 1994.
HCID = Hydrocarbon Identification.
HxCDD = Hexachlorodibenzo-p-dioxin.
HxCDF = Hexachlorodibenzofuran.
HpCDD = Heptachlorodibenzo-p-dioxin.
HpCDF = Heptachlorodibenzofuran.
NWTPH = Northwest total petroleum hydrocarbon.
OCDD = Octachlorodibenzo-p-dioxin.
OCDF = Octachlorodibenzofuran.
PeCDD = Pentachlorodibenzo-p-dioxin.
PeCDF = Pentachlorodibenzofuran.
RL = Reporting limit.
SW = *Test Methods for Evaluating Solid Waste, Physical Chemical Methods*, 3rd edition, USEPA, SW-846, 1986.
TBD = To be determined.
TCDD = Tetrachlorodibenzo-p-dioxin.
TCDF = Tetrachlorodibenzofuran.

- MS/MSD results
- Laboratory duplicate/triplicate results
- Blank results
- Sample custody records (including original COC forms)
- Analytical results in electronic Environmental Information Management (EIM) system.

7.2 Bioassay Analyses

This section describes specific procedures for the suite of bioassays used for SMS biological analysis. Sediment collected at predetermined locations will be submitted for bioassay testing. Bioassay testing requires that test samples be matched and tests run with appropriate reference sediments to factor out background conditions and sediment grain-size effects on bioassay organisms. The contractor will collect the identified reference sediments at the same time that other samples are collected. The reference sediment sampling location will be recorded to the nearest 0.1 second (NAD 83).

All sediment samples selected for bioassay analysis will be stored at 4 °C with no headspace until bioassay testing commences. All bioassays will commence within 14 days from collection of the first grab sample of the sediment composite to be tested. The laboratory will maintain COC procedures throughout biological testing.

Bioassay testing will be initiated as soon as possible after the last sample (to define a batch) is received by the laboratory. This includes obtaining test organisms and control/reference sediments in a timely manner.

Four bioassays (Table 7-3) including amphipod mortality, larval development, juvenile polychaete growth, and Microtox® (porewater) bioluminescence, will be conducted on each sample identified for biological testing. All biological testing will be conducted in strict compliance with Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments (PSEP 1995), with appropriate modifications as specified in the annual review process. General biological testing procedures and specific procedures for each sediment bioassay are summarized in the following sections.

The specific QA/QC measures employed as part of the biological analyses are discussed in detail in Section 5.0.

Table 7-3. Bioassay suite for the Oakland Harbor Sediment Study.

Bioassay Test	Test Organisms
10-day Amphipod Mortality Test	*Eohaustorius estuaries* or *Rhepoxynius abronius*
48-hour Larval Development Test [a] (bivalve)	*Dendraster excentricus*
20-day Juvenile Polychaete Growth Test	*Neanthes arenaceodentata*
Microtox® (porewater) bioluminescence	*Vibrio fischeri* (strain NRRL B-11177)

[a] Actual test length may vary based on larval development stage.

7.2.1 Amphipod Mortality Bioassay

This test involves exposing *Rhepoxynius abronius* or *Eohaustorius estuarius* to test sediment for 10 days and counting the surviving animals at the end of the exposure period. Daily emergence data and the number of amphipods failing to rebury at the end of the test will be recorded as well. The control sediment has a performance standard of 10 percent mortality. The reference sediment has a performance standard of 25 percent mean mortality. The amphipod chosen is based on the interstitial water salinity (i.e., greater than or equal to 25 parts per thousand [ppt], or less than 25 ppt) and the percentage of sediment fines (i.e., greater than or equal to 60 percent fines, or less than 60 percent fines) as described in the SSAPA (Ecology 2008).

E. estuarius is the preferred test organism for sediments with percent fines greater than or equal to 60 percent. *R. abronius* is the preferred amphipod species for coarser-grained sediments (less than 60 percent fines). Based on historical grain size data from previous investigations, both *E. estuarius* and *R. abronius* could be used in the investigation.

No treatment for confounding factors will be performed on the sediment sample during the bioassay procedure. Ammonia reference toxicant tests may be conducted if elevated ammonia concentration is suspected in test sediments.

7.2.2 Larval Development Bioassay

This test monitors larval development of a suitable echinoderm or molluscan species (e.g., *Dendraster excentricus* or *Mytilus galloprovincialus*) in the presence of test sediment. *M. galloprovincialis* is the preferred species, followed by *D. excentricus*. However, the primary factor in selection of species for the larval test is the time of year. Therefore, *D. excentricus* will be used for this study, as indicated in the SSAPA (Section 2.2.1.1) (Ecology 2008). The sediment larval bioassay has a variable endpoint (not necessarily 48 hours) that is determined by the developmental stage of organisms in a sacrificial seawater control (PSEP 1995). At the end of the test, larvae from each test sediment exposure are examined to quantify abnormality and mortality. The seawater control has a performance standard of 70 percent mean normal survivorship. Initial counts will be made for a minimum of five 10 ml (0.34 oz) aliquots. Final counts for seawater control, reference sediment, and test sediment will be made on 10 ml (0.34 oz) aliquots.

No treatment for confounding factors will be performed on the sediment sample during the bioassay procedure. Ammonia reference toxicant tests may be conducted if elevated ammonia concentration is suspected in test sediments.

7.2.3 Juvenile Polychaete Growth Bioassay

This sublethal, static-renewal toxicity test can be used to determine the relative toxicity of marine sediments using the juvenile polychaete, *Neanthes arenaceodentata*. The test is conducted in accordance with the methods described by PSEP (1995) and modifications to the test approved by the Dredged Material Management Program (DMMP) agencies.

The toxicity test involves a 20-day exposure to sediments and the response of the organisms to test sediments as compared to their response in control (clean) and reference sediment. The test endpoint is mean individual growth (expressed as mg/individual/day).

The control sediment has a performance standard of 10 percent mortality. The reference sediment has a performance standard of 80 percent of the control growth. The DMMP agencies have established a target control growth performance guideline of greater than or equal to 0.72 mg/individual/day. The *N. arenaceodentata* negative control performance guideline is a target growth rate of greater than or equal to 0.72 mg/individual/day; the negative control performance standard is greater than 0.38 mg/individual/day (below which the test is considered a QC failure). Use of worms smaller than 0.25 mg (dry weight) at the beginning of the test will also be considered a QC failure.

7.2.4 Full-Spectrum Lighting

Under certain conditions, when PAHs are exposed to ultraviolet (UV) radiation of sufficient quality and quantity, photo-activation may occur (Kosian et al.1998). Photo-activation has been demonstrated to result in increased acute and chronic toxicity (Arfsten et al.1996). Benthic and aquatic organisms exposed to selected PAHs and simultaneously to specific wavelengths and intensities of UV radiation may be at significantly greater risk to toxic effects than organisms exposed to the same PAHs absent the UV radiation (Ahrens 2002). When the following site conditions are encountered, all bioassays will be performed in the presence of full-spectrum lighting that includes UV wavelengths of sufficient intensity to mimic conditions at the site (Ecology 2008):

- If either sediment depth is 12 ft or less (4 m) than MLLW for more than 25 percent of the surface sediment or surface sediment covers more than 1/2 acre

- The presence or presumed presence of any of the photo-activated PAHs listed in Table 7-4 is expected (Nagpal 1993).

Table 7-4. Photo-activated polycyclic aromatic hydrocarbons.

PAHs	PAHs
Anthracene	Benz[c]acridine
Acridine	Benzathrone
Phenazine	Benzo[a]pyrene
Fluoranthene	Benzo[e]pyrene
1H-benzo[a]fluorene	Perylene
1H-benzo[b]fluorene	Dibenz[a,h]acridine
Pyrene	Dibenz[a,h]anthracene
Benz[a]anthracene	Dibenz[a,j]anthracene
Benz[b]anthracene	Benzo[b]chrysene
Chrysene	Dibenz[a,c]phenazine
Benzo[k]fluoranthene	Benzo[b]triphenyline
Benz[a]acridine	Benzo[g,h,i]perylene

Based on historical data from previous sampling events in Oakland Bay, bioassays on sediment samples collected at water depths of 12 ft or less (MLLW) will be conducted using full-spectrum lighting. Samples collected from depths greater than 12 ft will be conducted under standard lighting conditions.

Standard fluorescent laboratory lighting fixtures are not full spectrum and do not produce "natural" wavelengths and intensity of light. Therefore the laboratory must use two light sources with different radiation characteristics. The full spectrum fluorescent lamp needed must include the following (Ecology 2008):

- UV-B output (280 nanometers (nm) $< \lambda <$ 315 nm) photo-activating wavelengths
- UV-A output (315 nm $< \lambda <$ 400 nm), this may have an effect upon burial and feeding behavior
- Correct Color temperature: 'warm' red to 'cold' blue expressed in degrees Kelvin. Daylight at noon is typically estimated at 5,500 °K
- High Color Rendering Index (CRI): Color rendering is the degree to which a light source shows the true color of objects it illuminates. This is measured on a CRI rated from 0–100. A normal fluorescent lamp rates 54 on the CRI scale. High quality fluorescent lamps will rate 90–98 on the same scale.

In addition to the quality of the lamp, its proximity to the animal, its output intensity, and duration of use are also critical. It is absolutely critical that nothing is placed between the envelope of the lamp tube and the recipient test organism or vessel. UV-B is greatly attenuated by glass, plastic, and ultra-fine mesh. The amount of UV-B received is also diminished with distance. It is recommended that any UV-B tubes be no further than 12 in (30 cm) away from the organism or vessel (Ecology 2008).

The recommended lab conditions for full spectrum testing include:

- Light intensity: 50–100 ft candles
- Light duration: 16:8 (light/dark)
- Overlying water depth: not greater than 15 cm (6 in)
- Lamp to water surface distance: not greater than 30 cm (12 in)
- UV wavelength range: 3–8 percent UV-B (280 nm < λ < 315 nm), (3-5 percent preferred)
- 20–35 percent UV-A (315 nm < λ < 400 nm).

7.2.5 Microtox® (Porewater) Bioluminescence Bioassay

This test assesses toxicity in sediment porewater using the bioluminescent properties of the marine bacteria *Vibrio fischeri*. The test is conducted in accordance with the methods described in the SSAPA Appendix B (Ecology 2008).

The toxicity test involves a rapid (15 minute) exposure of the bacteria to sediment porewater. The light emitted by the test bacteria is compared to light emission of a control group in clean seawater. The test endpoint is measured luminescence.

The control and reference samples have a performance standard of a final luminescent output greater than or equal to 80 percent of the initial output. In addition, the reference sample and test sample initial outputs must be greater than 80 percent of the control sample initial output (Ecology 2008).

7.2.6 Bioassay Interpretation

Test interpretations consist of endpoint comparisons to controls and reference on an absolute percentage basis as well as statistical comparison to reference. The SMS biological effects criteria are presented in Table 7-5.

7.3 Radioisotope Analyses

Laboratory analysis will consist of lead-210 and cesium-137 radioisotope activity measurements. Percent dry weight and lead-210 in disintegrations per minute per gram (dpm/g) and cesium-137 in dpm/g, will be determined for each sample. Lead-210 analysis will be performed on every third 2 cm (0.8 in) section; cesium-137 will be performed on two core sections.

Table 7-5. SMS biological effect criteria.

Biological Test	Sediment Quality Standards	Cleanup Screening Levels
Amphipod Mortality	The test sediment has a significantly higher (t-test, P≤0.05) mean mortality than the reference sediment, and the test sediment mean mortality is more than 25% greater, on an absolute basis, than the reference sediment mean mortality.	The test sediment has a significantly higher (t-test, P≤0.05) mean mortality than the reference sediment, and the test sediment mean mortality is more than 30% greater, on an absolute basis, than the reference sediment mean mortality.
Larval Development	The test sediment has a mean survivorship of normal larvae that is significantly less (t-test, P≤0.1) than the mean normal survivorship in the reference sediment, and the mean normal survivorship in the test sediment is less than 85% of the mean normal survivorship in the reference sediment.	The test sediment has a mean survivorship of normal larvae that is significantly less (t-test, P≤0.1) than the mean normal survivorship in the reference sediment, and the mean normal survivorship in the test sediment is less than 70% of the mean normal survivorship in the reference sediment.
Juvenile Polychaete Growth	The mean individual growth rate of polychaetes in the test sediment is less than 70% of the mean individual growth rate of the polychaetes in the reference sediment, and the test sediment mean individual growth rate is statistically different (t-test, P P≤0.05) from the reference sediment mean individual growth rate.	The mean individual growth rate of polychaetes in the test sediment is less than 50% of the mean individual growth rate of the polychaetes in the reference sediment, and the test sediment mean individual growth rate is statistically different (t-test, P P≤0.05) from the reference sediment mean individual growth rate.
Microtox® (porewater) bioluminescence	The mean light output of the highest concentration of the test sediment is less than 80 % of the mean light output of the reference sediment, and the two means are statistically different (t-test, P≤0.05).	Not Applicable

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8.0 Data Analysis and Reporting

This section describes data analysis and reporting requirements for the data collection activities described above.

8.1 Data Analysis

8.1.1 Analysis of Sediment Chemistry Data

The analysis of chemistry data will include a comparison of the results to SMS numeric criteria and to other applicable criteria for analytes without SQS and/or CSL numeric criteria. Results will also be compared to reference area data. Reference sediment samples will be analyzed to evaluate whether Oakland Bay results are elevated above what are considered to be Puget Sound background concentrations. Sediment chemistry data will be summarized and presented in tables indicating sampling locations and detected contaminants and any detection limits that exceed SQS and/or CSL numeric criteria, along with any data qualifiers assigned by the laboratory or during data validation efforts. Sample locations with chemistry exceeding numeric criteria will be mapped to delineate any areas that may require cleanup or other remedial action.

8.1.2 Fingerprinting Analysis of Sediment Data

A screening-level "fingerprinting" evaluation of TPH, PAH, and dioxin/furan sediment data will be conducted to provide a preliminary indication of the usefulness of the analytical data to differentiate between sources of contaminants. Three lines of forensic evidence will be qualitatively investigated: TPH, PAHs, and dioxin/furans (PCDD/PCDFs).

Petroleum hydrocarbons will be analyzed using the TPH method NWTPH-HCID for Hydrocarbon Identification. NWTPH-HCID is a qualitative and semi-quantitative screening tool that will be used to confirm the presence and type of petroleum product in a sediment sample. Results are qualitatively reported as gasoline, diesel, or heavy oils. The method is most useful for elimination of the need for more detailed petroleum analyses where NWTPH-HCID results indicate TPH concentrations are below regulatory limits. The reporting limits for sediment are 20 mg/kg for gasoline, 50 mg/kg for #2 diesel, and 100 mg/kg for motor oil. Pattern matching with known reference product chromatograms is used to identify (i.e. "fingerprint") the type of hydrocarbon. A laboratory analyst will categorize the TPH based on chromatogram identification. Herrera personnel will also visually evaluate the sample chromatograms to identify unique patterns, if any, associated with potential sources.

Both PAHs and PCDD/PCDFs have characteristic patterns and distributions in materials. For example, petroleum and wood combustion sources have different PAH analyte patterns, while wood industry and smelter activities generate different patterns of PCDD/PCDFs. The sediment data will be evaluated for relative analyte concentrations of PAHs and PCDD/PCDFs and compared to published data on the relative ratios in potential source materials. PAH and

PCDD/PCDF analyte distribution in samples from potential source areas will also be visually evaluated to identify unique patterns, if any, associated with those sources.

While the analytical data should meet the data quality objectives necessary to provide qualitative screening for guidance regarding the utility of the data for source differentiation, given the limited number of samples at each potential source, quantitative evaluation of the data on a statistically significant basis will likely not be possible.

8.1.3 Analysis of Biological Data

The analysis of biological data will include comparison to SMS biological effects criteria. Toxicity test data results will be summarized and presented in tables indicating sampling locations and test results that exceed SQS and/or CSL biological effects interpretive criteria, along with the results of statistical comparisons to reference sediment test results. The sampling locations with sediment toxicity exceeding the SMS criteria will be mapped to delineate any areas that may require cleanup or other remedial action.

8.1.4 Radioisotope Dating

Sedimentation rate information, including sediment age in years, year of deposition, sediment accumulation rate (cm/yr), and sedimentation rate (g/cm^2/yr) will be determined and reported. The sedimentation rate is normally derived from lead-210 results; however, in some cases the cesium-137 data may be used to determine the sedimentation rate and sediment ages. Cesium-137 results are normally used to verify dates determined with sedimentation rates.

8.2 Sediment Investigation Report

A written SIR documenting all activities associated with collection, management, chemical analyses, and biological testing of collected samples will be prepared. The report will include recommendations for further action or investigation based on data comparisons to established evaluation criteria. Chemical, biological, and QA/QC reports will be included as appendices. As a minimum, the following will be included in the report:

- Description of sampling and analysis activities
- Protocols used during sampling and testing and an explanation of any deviations from SAP protocols
- Physical descriptions of samples
- Methods used for station positioning, sample collection locations reported in latitude and longitude to the nearest tenth of a second (NAD 83)

- Map showing actual locations of sampling stations and results of data comparisons to SMS and other criteria
- Chain-of-custody records
- Chemistry and biological testing results and laboratory reports
- Comparison of data results to interpretive criteria
- Fingerprinting analysis of sediment data results and interpretation
- Radioisotope results and interpretation
- QA/QC summary
- Data validation reports.

A geomorphic assessment of the shoreline and marine waters of Shelton Harbor and the southern shoreline of Oakland Bay will be based on site observations, historical assessment, core logs, and the geophysical surveys. This analysis will include the geomorphic ramifications of human activities cataloged in the historical analysis and the probable fate of past sediment-bound pollutant discharges discovered previously. It will include a listing of the physical processes potentially responsible for transport of existing polluted areas, as compiled from previous hydrographic studies in the area (e.g., Oakland Bay Dye Study), those processes interpreted from the geophysical survey and sedimentological features found in the core logs. In so doing, the assessment will provide the framework to interpret the results of the geophysical surveys and document the limits of particle-born pollutant transport in the study area. A technical memorandum will be produced describing geomorphic conditions in the study area with attached georeferenced graphics illustrating all salient features.

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APPENDIX A

Standard Operating Procedures

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Title:	**FIELD ACTIVITY LOGBOOKS**
Category:	DOC 2.1
Revised:	April 1998

STANDARD OPERATING PROCEDURE

FIELD ACTIVITY LOGBOOKS

ecology and environment, inc.
368 Pleasant View Drive / Lancaster, New York 14086 / (716) 684-8060

TITLE:	FIELD ACTIVITY LOGBOOKS		
CATEGORY:	DOC 2.1	REVISED:	April 1998

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1. Summary

This Standard Operating Procedure (SOP) establishes requirements for the entry of information into logbooks to ensure that E & E field activities are properly documented. The project manager (PM) and the field team leader (FTL) are responsible for ensuring that logbook entries provide sufficient information for the completion of an accurate and detailed description of field operations and meets the requirements of the contract or technical direction document (TDD).

This SOP describes logbook entry requirements for all types of projects, specifies the format that should be used, and provides examples. Some flexibility exists when implementing the SOP because different types of projects require different data collection efforts. This SOP does not address site safety logbook requirements or geotechnical logbook entries.

2. Purpose

Complete and accurate logbook entries are important for several reasons: to ensure that data collection associated with field activities is sufficient to support the successful completion of the project; to provide sufficient information so that someone not associated with the project can independently reconstruct the field activities at a later date; to maintain quality control (QC) throughout the project; to document changes to or deviations from the work plan; to fulfill administrative needs of the project; and to support potential legal proceedings associated with a specific project.

2.1 Adequate Field Information/Quality Control

QC procedures for data collection begin with the complete and systematic documentation of all persons, duties, observations, activities, and decisions that take place during field activities. It is especially important to fully document any deviations from the contract, project scope, work plans, sampling plans, site safety plans, quality assurance (QA) procedures, personnel, and responsibilities, as well as the reasons for the deviations.

Prior to entering the field, the project manager must indicate to the field team what pertinent information must be collected during field activity in order to meet the desired objectives of the data collection effort. The PM is responsible for reviewing the adequacy of the project logbooks both during and following completion of field activities, and is also responsible for meeting with the field team members to discuss any findings and to direct activities to correct any deficiencies, as appropriate. The PM also has the responsibility of ensuring that the logbooks become part of the project or TDD file.

2.2 Work Plan Changes/Deviation

The logbook is the document that describes implementation of the work plan and other appropriate contract documents and provides the basis for the project reports. It must include detailed descriptions of any and all deviation from the work plan and the circumstances that necessitate such changes. These changes will be reviewed for compliance with data quality objectives and include:

- Changes in procedures agreed to in the project planning stages;
- Any conditions that prevent the completion of the field effort, or that result in additional fieldwork must be noted (i.e., weather delays, government actions, physical obstructions, personnel/ equipment problems, etc.). Persons from whom permission was obtained to make such changes must be clearly documented.
- Any modifications requested by the client or client's representative that are contradictory to the contract or outside of the existing scope of work must be documented in detail because the cost of the project could be affected by such modifications.

2.3 Evidentiary Documentation

Field activity documentation can become evidence in civil and/or criminal judicial proceedings, as well as in administrative hearings. Field logbooks serve this purpose. Accordingly, such documentation is subject to judicial or administrative review. More importantly, it is subject to the review of an opposing counsel who will attempt to discredit its evidentiary value.

The National Enforcement Investigation Center (NEIC) and the United States Environmental Protection Agency (EPA) have prepared documents outlining their documentation needs for legal proceedings. These guidelines indicate the importance of accurate and clear documentation of information obtained during the inspections, investigations, and evaluations of uncontrolled hazardous waste sites. Consequently, attention to detail must be applied by E & E personnel to all field documentation efforts for all E & E projects. Project personnel must document where, when, how, and from whom any vital project information was obtained. This information is necessary to establish a proper foundation for admissible evidence.

3. Guidelines

Logbooks should contain a summary of any meeting or discussion held with a client or with any federal, state, or other regulatory agency that was on site during the field activities. The logbook should also describe any other personnel that appear on site, such as representatives of a potential responsible party (PRP).

The logbook can be used to support cost recovery activities. Data concerning site conditions must be recorded before the response activity or the passage of time eliminates or alters those conditions. Logbooks are also used to identify, locate, label, and track samples and their final disposition. In addition, data recorded in the logbook will assist in the interpretation of the analytical results.

Logbooks are subject to internal and external audits. Therefore, the recorded information should be consistent with and capable of substantiating other site documentation such as time cards, expense reports, chain-of-custody forms, shipping papers, and invoices from suppliers and subcontractors, etc. Logbooks also act as an important means of reconstructing events should other field documents such as data collection forms become lost or destroyed. Therefore, all mission-essential information should be duplicated in the logbook.

3.1 General Instructions

The following general guidelines must be used for all logbooks:

- At a minimum, one separate field activity logbook must be maintained for each project or TDD.
- All logbooks must be bound and contain consecutively numbered pages.
- No pages may be removed for any reason, even if they are partially mutilated or illegible.
- All field activities must be recorded in the site logbook (e.g., meetings, sampling, surveys, etc.).
- All information must be **printed legibly** in the logbook using waterproof ink, preferably black. If weather conditions do not permit this (i.e., if it is too cold or too wet to write with ink), another medium, such as pencil, may be used. The reason that waterproof ink was not used should be specifically noted in the logbook.
- The language used in the logbook should be objective, factual, and free of personal feelings or terminology that might prove inappropriate.
- Entries should be made in chronological order. Contemporaneous entries are always preferred because recollections fade or change over time. Observations that cannot be recorded during field activities should be recorded as soon after as possible. If logbook entries are not made during field activities, the time of the activity/ observation and the time that it is recorded should be noted.
- The first entry for each day will be made on a new, previously blank page.
- Each page should be dated and each entry should include the time that the activity occurred based on the 24-hour clock (e.g., 0900 for 9 a.m., 2100 for 9 p.m.).
- At the completion of the field activity, the logbook must be returned to the permanent project or TDD file.

3.2 Format

The information presented below is not meant to be all-inclusive. Each project manager is responsible for determining the specific information requirements associated with a field activity logbook. If someone other than the Project Manager is keeping the logbook, the Project Manager is responsible to convey to that individual, prior to the start of fieldwork, specific instructions on what type of information is required to be entered into the logbook. Information requirements will vary according to the nature and scope of the project. (Refer to Appendix A for an example of a completed logbook.)

Title Page

The logbook title page should contain the following items:

- Site name,
- Location,
- TDD No. or Job No.,
- PAN (an EPA site/task identification number), if applicable,
- SSID No. (Site ID number-assigned under CERCLA), if applicable,
- Start/Finish date, and
- Book ___ of ____.

First Page

The following items should appear on the first page of the logbook prior to daily field activity entries:

- TDD No. or Job No.,
- Date,
- Summary of proposed work (Reference work plan and contract documents, as appropriate),
- Weather conditions,
- Team members and duties, and
- Time work began and time of arrival (24-hour clock).

Successive Pages

In addition to specific activity entries and observations, the following items should appear on every logbook page:

- Date,
- TDD or Job No., and
- Signature (bottom of each page). If more than one person makes entries into the logbook, each person should sign next to his or her entry.

Last Page

In addition to specific activity entries and observations and the items that should appear on each successive page, the last page of the logbook should contain a brief paragraph that summarizes the work that was completed in the field. This summary can become especially important later on if more or less work was accomplished during the duration of the field activity.

3.3 Corrections

If corrections are necessary, they must be made by drawing a single line through the original entry in such a manner that it can still be read. *Do not erase or render an incorrect notation illegible*. The corrected entry should be written beside the incorrect entry, and the correction must be initialed and dated. Most corrected errors will require a footnote explaining the correction.

4. Documentation

Although the requirements and content of the field logbook will vary according to the site and the tasks to be performed, the following information should be included in every logbook:

4.1 Prior to Fieldwork

Summary of Proposed Work

The first paragraph of **each** daily entry should summarize the work to be performed on that day. For example:

> "Collect soil and groundwater samples from previously installed wells and ship samples to Analytical Services Center (ASC). Discuss removal with site owner."

The first paragraph becomes especially important later when discussing work plan deviations or explaining why more or less work was accomplished for that day.

Personnel

Each person to be involved in activities for the day, his/her respective role (sampler, health and safety, etc.), and the agency he/she represents should be noted in the logbook.

On-Site Weather Conditions

Weather conditions may have an impact on the work to be performed or the amount of time required to perform the proposed work; therefore, all weather on-site weather conditions should be noted, including temperatures, wind speed and direction, precipitation, etc., and updated as necessary. Similarly, any events that are impacted by weather conditions should be noted in the logbook.

Site Safety Meeting

Although minutes should be recorded for all site safety meetings under separate cover, the logbook should briefly summarize the site safety meeting and any specific site conditions and resultant site safety concerns.

4.2 Site Sketch

A site sketch should be prepared on the first day of field activities to indicate prominent site and environmental features. The sketch should be made either to scale or by noting the approximate distances between site feature. Area-specific sketches should be prepared as work is undertaken in such areas, and updated sketches should be drawn as work progresses.

Site Features

Examples of features to be noted on the site sketch include the following:

- Structures such as buildings or building debris;
- Drainage ditches or pathways, swales, and intermittent streams (include direction of overland runoff flow and direction of stream flow);
- Access roads, site boundaries, and utility locations;
- Decontamination and staging areas;
- Adjacent property data: the type of property that borders the site, information pertaining to ownership, and available addressees; and
- North arrow.

Changes in Site Conditions

Any deviation from previous site sketches or drawings presented in the work plan, and any changes that have occurred since the last site visit must be noted. Differences to be noted include the following:

- Demolished buildings;
- Changes to access routes;
- Damage to wells or equipment, or changes to the amount of such equipment believed to be on site,
- Changes resulting from vandalism;
- Destruction of reference points;
- Changes resulting from environmental events or natural disasters; and
- Locations of excavations, waste piles, investigation-derived waste (IDW), drum staging areas, etc.

In short, *any* site condition that varies from the conditions described in the work plan should be noted.

4.3 Monitoring Equipment and Activities

Any monitoring equipment used during field activities should be documented in the logbook. Information to be noted includes:

- The type of equipment with model and serial numbers. (HNu, OVA, etc.);
- The frequency at which monitoring is performed;
- Calibration results and the frequency at which the equipment is calibrated or tested;
- Background readings;
- Any elevated or unusual readings; and
- Any equipment malfunctions.

It is particularly important to note elevated or unusual equipment readings because they could have an impact on personal protection levels or the activities to be performed on site. If a change in the proposed work or protection levels occurs, it should be clearly noted in the log-book.

4.4 Sample Collection Activities

Because it represents the first step in an accurate chain-of-custody procedure, field sampling documentation must be complete. The following items should be documented in the logbook:

Sample Collection Procedures

The following items pertaining to sample collection procedures should be included in the logbook:

- Any pre-sampling activities (i.e., well purging and the number of volumes purged before sample collection);
- Results of the pre-sampling activities (i.e., pH/conductivity/ temperature readings for well water, results of hazard categorization testing, etc.);
- Any environmental conditions that make sample collection difficult or impossible (i.e., dry or flooded drainage paths, inclement weather conditions, etc.); and
- Any deviation from the work plan (i.e., additional samples and the reason for their collection, alternate sample locations, etc.).

Sample Information

The following information regarding sample data should be recorded in the logbook:

- Sample number and station location including relationship to permanent reference point(s);
- Name(s) of sampler(s);
- Sample description and any field screening results;
- Sample matrix and number of aliquots if a composite sample;
- Preservatives used, recipient laboratory, and requested analyses;
- QA/QC samples; and
- Shipping paper (airbill) numbers, chain-of-custody form numbers, and jar lot numbers.

Investigation-Derived Waste/Sample Shipment

Details pertaining to sampling equipment, decontamination, and IDW should be clearly delineated in the work plan. However, the following information should be included in the log-book:

- The type of IDW generated an the number of containers generated (each drum should be numbered and its contents noted);
- All information relevant to the characterization of the IDW;
- Any directions received from the client/workplan/contract relative to the management of the IDW;
- The disposition of IDW (left on site or removed from site);
- The number of sample containers shipped to the ASC or laboratory and the courier used (i.e., Federal Express, Airborne Express, etc.);
- Airbill or shipment tracking numbers; and
- The type of paperwork that accompanied the waste/sample shipment (e.g., manifests, etc.).

4.5 Photodocumentation

Photographs should be taken during all relevant field activities to confirm the presence or absence of contaminants encountered during fieldwork. Specific items to be documented in-clude:

- Sample locations and collection activities;
- Site areas that have been disturbed or impacted, and any evidence of such impacts (i.e., stressed vegetation, seepage, discolored water, or debris);
- Hazardous materials requiring disposal, including materials that may not appear in the work plan;
- Any evidence that attests to the presence or absence of contamination; and
- Any features that do not appear in the work plan or differ from those described in the work plan.

Documentation of any photographs taken during the course of the project must be provided in the logbook with a detailed description of what is shown in the photograph and the reason for taking it. This documentation should include:

- Make, model, and serial numbers of the camera and lens,
- Film type and number of exposures,
- Roll and frame number of the photograph;
- Direction or view angle of the photograph, and
- Name of the photographer.

4.6 Data Collection Forms

Certain phases of fieldwork may require the use of project-specific data collection forms, such as task data sheets or hazard categorization data sheets. Due to the specific nature of these forms, the information that should be included in the logbook cannot be fully discussed in this SOP. However, the following data should be included in the logbook:

- Results of any field tests or hazard categorization tests (i.e., ignitability, corrosivity, reactivity, etc.);
- The source from which any field sample was collected and its condition (i.e., drum, tank, lagoon, etc.).
- Other conclusions as a result of the data collected on data collection forms.

In many cases, rubber stamps that contain routine data collection forms can be manufactured ahead of time. These forms can be stamped into the logbook on an as-needed basis.

Appendix A

Sample Logbook

RI 6130

WEDNESDAY JANUARY 26, 1994

PROPOSED WORK FOR DAY: COLLECT GROUNDWATER SAMPLES FROM WELLS AND PIEZOMETERS AT SITE 1 AND SITE 3. SHIP SAMPLES TO THE ASC. CONTAINERIZE PURGE WATER. MEET WITH FRED CANSLER AND DISCUSS REMOVAL OF CANOPIES AT SITES 1 AND 3 AND FILLING OF EXCAVATIONS.

WEATHER ON SITE: CLOUDY AND WARM WITH A HIGH TEMPERATURE OF 50° F. RAIN SHOWERS WITH WINDS FROM THE SW AT 5-15 MPH.

E&E PERSONNEL ON SITE: G. JONES, J. MAYS, S. McCONE

LOG

1330 ARRIVED ON SITE. THE GROUNDWATER SAMPLING CREW WAS PREPARING TO PURGE THE WELLS AND PIEZOMETERS IN THE FIELD ACROSS THE ROAD FROM SITE 1. PURGING OF WELLS BEING COMPLETED WITH HAND BAILERS SINCE PUMP IS INOPERATIVE.

1340 ARRIVED AT SITE 3. MW3-1 AND MW3-5 UNLOCKED AND OPEN; SECURED BOTH WELLS.

38 [signature] 1/26/94

RI 6130 1/26/94

1350 FRED CANSLER ARRIVED ON SITE. DISCUSSED REMOVAL OF CANOPIES AND CLOSURE OF EXCAVATIONS AT SITES 1 AND 3. FRED CANSLER STATED THAT HE HAS A SOURCE FOR THE ROCK AND FOR THE TOP SOIL FOR THE EXCAVATIONS.

1405 ARRIVED AT THE SITE WHERE FRED CANSLER PROPOSES TO REMOVE THE FILL FOR THE EXCAVATIONS. A HILL ON THE WEST SIDE OF THE WOODEN NICKLE IS IN THE PROCESS OF BEING REMOVED. THE ROCK CONSISTS OF WEATHERED SHALE SIMILAR TO THE ROCK REMOVED FROM THE EXCAVATIONS. FRED CANSLER PROPOSES TO USE THE ROCK TO FILL THE EXCAVATIONS TO WITHIN ONE FOOT OF GRADE.

1415 ARRIVED AT THE SITE WHERE FRED CANSLER PROPOSES TO REMOVE TOP SOIL FOR THE EXCAVATIONS. TOP SOIL REMOVED FROM THE YELLOW FREIGHT LOT IS IN PILES ON THE NORTH SIDE OF THE LOT.

1430 RETURNED TO SITE 3. FRED CANSLER WILL ARRANGE TO REMOVE THE CANOPY OVER THE EXCAVATION AT SITE 3 ON THURSDAY MORNING AND WILL ARRANGE TO BRING THE ROCK IN ON THURSDAY AFTERNOON. TWO TRUCKS WILL BE USED TO HAUL THE FILL. THE SUPPORTS HOLDING THE CANOPY

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TITLE: FIELD ACTIVITY LOGBOOKS

CATEGORY: DOC 2.1

REVISED: April 1998

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1430 (CONT) WILL BE CUT AND THE CANOPY DRAGGED AWAY FROM THE EXCAVATION.

1445 CONTACTED JOY INMAN FROM ENVIRONICS. TANKERS WILL BE ON SITE ON THURSDAY TO PUMP OUT THE EXCAVATION AT SITE 3 AND ON FRIDAY TO REMOVE WATER AT SITE 1. A FRAC TANK WILL BE DELIVERED TO SITE 1 ON THURSDAY.

1515 SAMPLING CREW COMPLETED PACKING SAMPLES COLLECTED AT SITE 1. ALL WELLS AND PIEZOMETERS AT SITE 1 HAVE BEEN SAMPLED.

1530 SAMPLING CREW COMPLETED PACKING SAMPLES AND SECURING DRUMS OF PURGE WATER.

1535 SAMPLING CREW DEPARTED SITE TO DELIVER SAMPLES TO FEDERAL EXPRESS.

1600 CONTACTED TIM GRADY FROM E+E. DISCUSSED CONVERSATION WITH FRED CANSLER AND STATUS OF WELL/PIEZOMETER SAMPLING.

1615 SECURED FOR DAY.

WORK COMPLETED: COLLECTED GROUNDWATER SAMPLES FROM SITE 1 WELLS AND PIEZOMETERS. DISCUSSED REMOVAL OF CANOPIES AND FILLING OF EXCAVATIONS WITH FRED CANSLER. SHIPPED SAMPLES TO ASC.

1/26/94

THURSDAY JANUARY 27, 1994

PROPOSED WORK FOR DAY: COMPLETE COLLECTION OF GROUNDWATER SAMPLES AT SITE 3 AND SHIP THE SAMPLES TO THE ASC. REMOVE THE CANOPIES COVERING THE EXCAVATIONS AT SITES 1 AND 3. PUMP THE WATER OUT OF THE EXCAVATIONS AT SITES 1 AND 3 AND SHIP THE WATER OFF SITE TO OSCO. BACKFILL THE EXCAVATION AT SITE 3. REMOVE THE DRUMS FROM THE ROLL OFF BOX AND TRANSFER THE DRUMS TO THE WAREHOUSE.

WEATHER ON SITE: CLOUDY AND COOL WITH A HIGH TEMPERATURE OF 45°F. WINDS VARIABLE 10-20 MPH.

E+E PERSONNEL ON SITE: G. JONES, J. MAYS, S. MCCUNE

LOG

0700 SCOTT MCCUNE ARRIVED AT SITE 3.

0710 ENVIRONICS PERSONNEL ARRIVED AT SITE 3.

0715 HELD SITE SAFETY MEETING. DISCUSSED PHYSICAL AND CHEMICAL HAZARDS ASSOCIATED WITH SITE AND PROPOSED WORK FOR THE DAY.

0725 E+E SAMPLING TEAM ARRIVED ON SITE

 1/27/94

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0730 E+E SAMPLING CREW COMMENCED COLLECTING SAMPLES AND PURGING MW3-1 AND MW3-2.

0800 FRED CANSLER ARRIVED ON SITE WITH PERSONNEL TO REMOVE THE CANOPY OVER THE EXCAVATION AT SITE 3. THE SUPPORTS WERE CUT AND THE CANOPY WAS DRAGGED AWAY FROM THE EXCAVATION WITH TWO TRACTORS.

0845 THE CANOPY REMOVAL AT SITE 3 COMPLETED AND THE CREW DEPARTED FOR SITE 1.

0850 COMMENCED PUMPING WATER FROM THE EXCAVATION INTO BRYSON TRAILER # 618CS.

0915 THE E+E SAMPLING TEAM COMPLETED COLLECTING THE GROUNDWATER SAMPLES FROM MW3-1, MW3-2, MW3-3, AND MW3-4. COMMENCED PACKING SAMPLES.

0935 COMPLETED FILLING BRYSON TRAILER #618CS WITH 5,000 GALLONS OF WATER AND PREPARED MANIFEST #00941 FOR LOAD. COMMENCED LOADING BRYSON TRAILER #429.

1000 E+E SAMPLING TEAM DEPARTED THE SITE TO DELIVER SAMPLES TO FEDERAL EXPRESS.

1030 ARRIVED AT SITE 1. THE CANSLER CREW IS IN THE PROCESS OF REMOVING THE CANOPY OVER THE EXCAVATION. CANOPY IS NOT MOVING AS A UNIT.

42 [signature] 1/27/94

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1045 RETURNED TO SITE 3. ALL WATER IN THE EXCAVATION HAS BEEN REMOVED EXCEPT FOR THE ICE. BRYSON TRAILER # 429 LOADED WITH 5,200 GALLONS OF WATER. PREPARED MANIFEST # 00942 FOR LOAD. BOTH TANKERS DEPARTED THE SITE.

1100 ENVIRONMENTAL PERSONNEL OPENED THE DRUMS OF DRILLING FLUIDS, DEVELOPMENT WATER AND PURGE WATER AND FOUND THE DRUMS FULL OF ICE. ENVIRONMENTAL WILL CONTACT GARY SHOCKLEY AND RECOMMEND THAT THE DRUMS OF LIQUIDS BE TRANSPORTED TO OSCO FOR TREATMENT SINCE THEY CAN NOT BE BULKED.

1200 CANSLER CREW COMMENCED LOADING TRUCKS WITH STONE FROM THE SITE WEST OF THE WOODEN NICKEL.

1230 ARRIVED AT THE SITE WHERE THE STONE WAS BEING LOADED. THE FILL MATERIAL IS ALL UNDISTURBED WEATHERED BEDROCK.

1245 ARRIVED AT SITE 3. TWO LOADS OF ROCK FILL HAVE BEEN DUMPED IN THE EXCAVATION; AN ESTIMATED FOUR MORE LOADS OF STONE WILL BE NEEDED TO FILL THE EXCAVATION.

1300 ARRIVED AT SITE 1. BRYSON TRAILER #617

43 [signature] 1/27/94

Title:	**GEOTECHNICAL LOGBOOK/ TRIP REPORT PREPARATION**
Category:	DOC 2.4
Revised:	April 1998

STANDARD OPERATING PROCEDURE

GEOTECHNICAL LOGBOOK/ TRIP REPORT PREPARATION

ecology and environment, inc.
368 Pleasant View Drive / Lancaster, New York 14086 / (716) 684-8060

TITLE:	GEOTECHNICAL LOGBOOK/ TRIP REPORT PREPARATION		
CATEGORY:	DOC 2.4	REVISED:	April 1998

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1. Introduction

This Standard Operating Procedure (SOP) outlines the procedures followed by Ecology and Environment, Inc. (E & E), for the entry of information into the geotechnical logbook, thereby ensuring that field activities are properly documented.

It is the responsibility of the site geologist to ensure that the proper information is collected in the field in order to fulfill the obligations of the contract.

2. Purpose

The purpose of this document is to establish the minimum content requirements of the geotechnical logbook entries for drilling projects. The document provides guidance to ensure that the documentation for drilling projects is correct, complete, and adequate for use in any potential legal proceeding. It is important to remember that field activity documentation can become evidence in civil and criminal law- enforcement proceedings, as well as in administrative hearings. Accordingly, such documentation is subject to judicial or administrative review; even more importantly, it is subject to the review of an opposing attorney attempting to discredit its value as evidence. Complete and accurate entries in the geotechnical logbook are important for two reasons: to maintain quality control, and to support any legal proceedings associated with the project.

3. Geotechnical Logbook Procedures

3.1 General Information

Information concerning the project can be found in the geotechnical logbook. The majority of the information should be obtained prior to arriving on site. Figure 1 is an example of a completed general information sheet.

CLIENT: Chemical Corporation of America
JOB NUMBER: ZZ-1020

SITE NAME: ABC Landfill

DRILLER: Paul Barth E+E Drilling and Testing Company

LOCATION: CITY/TOWN: Midway

STATE: Tennessee

PROJECT MANAGER: Buff Walter

FIELD TEAM LEADERS: Marilyn Frappa /

SITE SAFETY OFFICER(S): Greg Jones /

TEAM MEMBERS: Paul Barth (EEDT)

Kevin Williamson (EEDT)

JOB START/FINISH DATE: 1/4/94 / 1/18/94

BOOK 1 OF 3

E&E CORPORATE: (716) 684-8060	FAX (716) 684-0844
E&E EMERGENCY RESPONSE CENTER: (716) 684-8940	
E&E ANALYTIC SERVICE CENTER: (716) 631-0360	FAX (716) 631-0378
E&E EQUIPMENT SERVICE CENTER: (716) 681-9797	FAX (716) 681-4356
FEDERAL EXPRESS TOLL FREE: (800) 238-5355	

PROJECT/CLIENT CONTACT(S)	AFFILIATION	PHONE
Buff Walter	E + E	703/522-6065

For inquires regarding the distribution, scope, and/or organization of the Geotechnical Logbook please contact:

Figure 1 General Information

3.2 Daily Logs

3.2.1 General Guidelines

The following includes general guidelines for preparing the geotechnical logbook:

- A separate logbook must be maintained for each project.

- No pages can be removed for any reason, even if they are partially mutilated or illegible.

- All field activities (e.g., meetings, sampling, surveying) must be recorded in the geotechnical logbook.

- All information is **printed** legibly into the logbook in waterproof ink, preferably black. If weather conditions do not permit this (i.e., if it is too cold or too wet to write with ink), another medium such as a pencil may be used, but it should be specifically noted in the logbook why waterproof ink was not used.

- The language used in the geotechnical logbook should be objective, factual, and free of personal feelings or terminology that might prove inappropriate.

- Chronological entries are preferred. If entries cannot be made at the time observed, record them as soon as possible, noting both the time of the entry and the time of the observation.

- Each successive day's first entry is made on a new, blank page.

- Each page should be dated, and all entries should have a time notation based on the 24-hour clock (e.g., 0900 for 9:00 a.m., 2100 for 9:00 p.m.).

- At the completion of the drilling activity, the geotechnical logbook must be placed in the permanent project file.

3.2.2 Format

The information listed below is not meant to be all-inclusive. Each project manager is responsible for determining the information requirements for each geotechnical logbook; such information requirements will vary depending on the nature and scope of the project.

First Page: On the first page of every daily entry, the date and project number should be entered on the top line. The proposed work for the day, weather on site, and personnel on site follow below the date. Log entries include the time that personnel arrive on site, the time personnel depart the site, the time that site safety meetings are held (with signatures of the personnel attending the briefing), the levels of personal protection used by the team, specific activities undertaken (e.g., drilling operations, air monitoring, sample collection), and equipment calibration data. At the bottom of the page, the signature of the person keeping the log and the date should be entered.

Successive Pages: The date and project number should appear at the top of each successive page, and the person keeping the log should sign and date the page.

Last Page: On the last page of the daily log, the work completed that day and future plans and recommendations should be entered.

Samples: Each sample must be properly accounted for in the geotechnical logbook. Information entered in the log should include the location where the sample was collected; the time that the sample was collected; the type of sample (e.g., subsurface composite soil sample or groundwater sample); on-site measurement data (e.g., pH, temperature, conductivity); a preliminary description of the sample; preservatives used (if any); air monitoring instrument readings; and the Federal Express (or other carrier's) air bill number.

3.2.3 Photographs

If photographs are taken of soil samples, drill cuttings, or core samples, the following information should be entered in the geotechnical logbook:

- Time, location, direction, and weather conditions.
- Complete description or identification of the subject in the photograph and reason for taking the picture.
- Sequential number of photograph and film number.
- Camera type and serial number (e.g., Olympus 35-mm #1164916), and lens size and serial number (if appropriate).
- Name of photographer.

Upon return to the office, the above information will be used to prepare photograph logs.

3.2.4 Signature

Each page of the geotechnical logbook must be initialed by the person recording the information. When two individuals make entries on the same page, they must initial their own entries. The individual making the last entry on the page must sign and date the bottom of the page.

3.2.5 Corrections

If corrections are necessary, they may be made by drawing a single line through the entry and writing the corrected entry next to it. The correction must be initialed and dated. Do not render the incorrect notation illegible; make the correction in such a manner that the original entry can still be read.

3.3 Drilling Information

Information concerning the installation of the borehole is entered in the drilling log. The geotechnical logbook is divided in such a manner that the information for four boreholes can be entered in one logbook. In addition to information about the location, start and finish dates, drill rig, and driller, a sketch indicating the location where the borehole or well was installed should be drawn.

Sample information should also be included in this section. The number of blows it took to drive the split-barrel sampler 2 feet below the bottom of the hollow-stem augers in 6-inch intervals should be recorded. The amount of soil recovered in the split-barrel sampler, organic vapor readings noted in the sample, and soil components must also be recorded in this section. An example of a completed drilling log can be found in Figure 2.

3.4 Lithologic Description

A description of the materials used in the construction of the monitoring well and the type of well (e.g., screened or open-hole well) must also be recorded. Figure 3 is an example of a completed well installation diagram. In addition to the well installation diagram, a narrative description of the lithology of the soil and bedrock encountered is also recorded in this section.

3.5 Well Development Record

The proper development of monitoring wells will prevent the buildup of fines on the screened interval and will provide groundwater samples that are representative of the groundwater conditions. To determine the volume of water to be removed from the well, the inside diameter of the monitoring well or diameter of the borehole is determined and the appropriate line is found on the table in Figure 4.

DRILLING LOG FOR MWI-1

Project Name ABC Landfill RI

Site Location Midway, TN

Date Started/Finished 1/6/94 – 1/6/94

Drilling Company E&E Drilling & Testing

Driller's Name Paul Barth

Geologist's Name Marylyn Frappa

Geologist's Signature Marylyn Frappa

Rig Type (s) DIEDRICH D50

Drilling Method (s) 4.25" HSA

Bit Size (s) ____ Auger Size (s) 8" O.D.

Auger/Split Spoon Refusal 24 ft

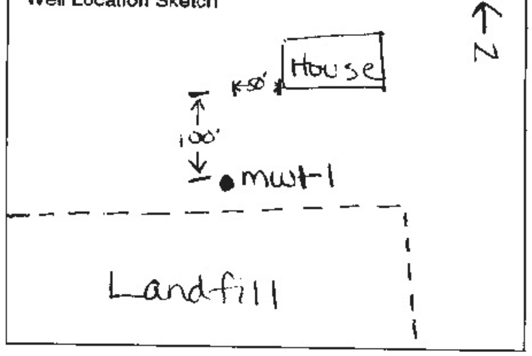
Total Depth of Borehole is 24 ft

Total Depth of Corehole is N/A

Water Level (TOIC)

Date	Time	Level (Feet)
1/6/94	1640	16.25
1/8/94	0920	13.75
1/14/94	0830	13.86
1/14/94	1020	14.26

Well Location Sketch



Depth (Feet)	Sample Number	Blows on Sampler		Soil Components CL SL S GR	Rock Profile Recovery	(PPM) Head Space	Run Number	Core Recovery	RQD	Fracture Sketch	OVA (ppm)	Comments
0'-.5' Asphalt												
1		10	9									
2	1	16	19	SL/S	16"	ØPPM	1	N/A		NONE	ØPPM	
3		7	8									
4	2	10	9	SL/S	6"	ØPPM	2	N/A		NONE	ØPPM	
5		6	8									
6	3	5	9	SL/S	10"	ØPPM	3	N/A		NONE	ØPPM	
7		4	11									
8	4	23	10	SL/S	6"	ØPPM	4	N/A		NONE	ØPPM	
9		7	8									
10	5	10	9	SL/S	4"	ØPPM	5	N/A		NONE	ØPPM	
11		6	9									
12	6	26	32	S/GR	5"	28PPM	6	N/A		NONE	1PPM	
13		12	24									
14	7	34	48	S/GR	6"	ØPPM	7	N/A		NONE	ØPPM	

Figure 2 Drilling Information

SCREENED WELL

Stick-up 2 ft

Inner Casing Material PVC

Inner Casing Inside Diameter 2 Inches

Top of Grout 0 ft

Borehole Diameter 8 Inches ft

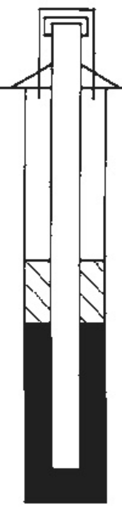
Top of Seal at 10 ft

Bottom of Seal at 12 ft

Top of Screen at 14 ft

Pack Type/Size:
- [x] Sand 00N
- [ ] Gravel
- [ ] Natural

Bottom of Screen at 24 ft



Lock Number IG031

Quanity of Material Used:
Betonite Pellets 2 Buckets

Cement 4 Bags

Cement/ Bentonite

Grout

Top of Sand Pack 12'

Screen Slot Size 0.010

Screen Type Continuous
- [x] PVC 2"
- [ ] Stainless Steel

Bottom of Hole at 24 ft

Bottom of Sandpack at 24'

OPEN-HOLE WELL

Stick-up ft

Inner Casing Material

Inner Casing Inside Diameter Inches

Top of Grout ft

Bottom of Outer Casing ft

Borehole Diameter ft

Bedrock ft

Bottom of Rock Socket/ Grout/Casing ft

Corehole Diameter

Bottom of Corehole ft

NOTE: See page 109 and 110 for well construction diagrams

Depth-ft.	NARRATIVE LITHOLOGIC DESCRIPTION	Moisture Content: Dry	Moist	Wet
1	8" Asphalt then Fill - Black + Dry (Cuttings)	●	○	○
2	↓	●	○	○
3	Fill Materials, Mainly Black Cinders, Some white Ash Last 3"	●	○	○
4	↓	●	○	○
5	Brown Sandy-Silt Matrix about 50% Small Large Gravels, Subangular	●	●	○
6	↓	●	●	○
7	Same as above	○	●	○
8	↓	○	●	○
9	Same as about	○	●	○
10	↓	○	●	○
11	Same as about with large Gravel ~-2", Moist, 1PPM	○	●	○
12	↓	○	●	○
13	3" Rock + Ground Rock, Grey Sands Wet	○	●	○
14	↓	○	○	●
		○	○	●

Figure 3 Well Construction/Lithologic Description

WELL DEVELOPMENT RECORD

SITE ABC Landfill DATE 1/14/94

LOCATION Midway, TN WELL NO. MWI-1

MEASUREMENT OF WATER LEVEL AND WELL VOLUME

- Prior to sampling, the static water level and total depth of the well will be measured with a calibrated weighted line. Care will be taken to decontaminate equipment between each use to avoid cross contamination of wells.
- The number of linear feet of static water (difference between static water level and total depth of well) will be calculated.
- The static volume will be calculated using the formula:

$$V = Tr^2 (0.163)$$

Where:
V = Static volume of well in gallons;
T = Depth of water in the well, measured in feet;
r = Inside radius of well casing in inches;
and 0.163 = A constant conversion factor which compensates for r^2h factor for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and (pi).
1 well volume (v) = _____ gallons.

Volume of Water in Casing or Hole

Diameter of Casing or Hole (n)	Gallons per Foot of Depth	Cubic Feet per Foot of Depth	Liter per Meter of Depth	Cubic Meters per Meter of Depth
1	0.041	0.0055	0.509	0.509×10^{-3}
11/2	0.092	0.0123	1.142	1.142×10^{-3}
2	0.163	0.0218	2.024	2.024×10^{-3}
21/2	0.255	0.0341	3.167	3.167×10^{-3}
3	0.367	0.0491	4.558	4.558×10^{-3}
31/2	0.500	0.0668	6.209	6.209×10^{-3}
4	0.653	0.0873	8.110	8.110×10^{-3}
41/2	0.826	0.1104	10.260	10.260×10^{-3}
5	1.020	0.1364	12.670	12.670×10^{-3}
51/2	1.234	0.1650	15.330	15.330×10^{-3}
6	1.469	0.1963	18.240	18.240×10^{-3}
7	2.000	0.2673	24.840	24.840×10^{-3}
8	2.611	0.3491	32.430	32.430×10^{-3}
9	3.305	0.4418	41.040	41.040×10^{-3}
10	4.080	0.5454	50.670	50.670×10^{-3}
11	4.937	0.6600	61.310	61.310×10^{-3}
12	5.875	0.7854	72.960	72.960×10^{-3}
14	8.000	1.0690	99.350	99.350×10^{-3}
16	10.440	1.3960	129.650	129.650×10^{-3}
18	13.220	1.7670	164.180	164.180×10^{-3}
20	16.320	2.1820	202.680	202.680×10^{-3}
22	19.750	2.6400	245.280	245.280×10^{-3}
24	23.500	3.1420	291.850	291.850×10^{-3}
26	27.580	3.6870	342.520	342.520×10^{-3}
28	32.000	4.2760	397.410	397.410×10^{-3}
30	36.720	4.9090	456.020	456.020×10^{-3}
32	41.780	5.5850	518.870	518.870×10^{-3}
34	47.160	6.3050	585.680	585.680×10^{-3}
36	52.880	7.0690	656.720	656.720×10^{-3}

1 Gallon = 3.785 liters
1 Meter = 3.281 feet
1 Gallon water weighs 8.33 lbs. = 37.785 kilograms
1 Liter water weighs 1 kilogram = 2.205 pounds
1 Gallon per foot of depth = 12.419 liters per foot of depth
1 Gallon per meter of depth = 12.419×10^{-3} cubic meters per meter of depth

INITIAL DEVELOPMENT WATER

WATER LEVEL (TOIC) 13.86'
WELL DEPTH (TD) 24
COLOR Brown Silty
ODOR Musty
CLARITY Opaque

FINAL DEVELOPMENT WATER

WATER LEVEL (TOIC) 14.26'
WELL DEPTH (TD) 24'
COLOR Clear
ODOR None
CLARITY Clear

DESCRIPTION OF DEVELOPMENT TECHNIQUE Stainless Steel Hand Bailer. measured volume removed with bucket.

Figure 4 Well Development Record

3.6 Well Development—Parameter Measures

Physical measurements are made on samples of the groundwater during well development. At routine intervals, a sample of the development water is tested for temperature, conductivity, corrosivity (pH), and turbidity. The results of each test are recorded as shown in Figure 5. When two consecutive tests have the same readings, development of the well is considered complete.

3.7 Investigation-Derived Waste Inventory

In most instances, the drill cuttings, drilling fluids, development and purge water, and personal protective equipment must be containerized and handled as a hazardous waste as described by the Resource Conservation and Recovery Act (RCRA) until analytical results are available to reclassify the wastes. All hazardous wastes must be properly marked and labeled and must be disposed of in a specific period of time. The contents of each container, the source of the waste, the date that the waste was generated, the approximate volume of waste in the container, and the location where the container is being stored must be noted in the geotechnical logbook. Figure 6 is an example of a completed investigation-derived waste inventory sheet.

4. Trip Report

The geologist or team leader is responsible for filing a trip report upon returning to the office. The trip report must include information regarding the persons making the trip; the date of the trip; location of the trip; and, most importantly, the purpose of the trip. The trip report provides the means to convey information gathered and observed to the project manager. Trip reports should be written and submitted within two working days of return from a trip. Figure 7 shows the format for a trip report.

5. References

United States Environmental Protection Agency, 1986, RCRA Groundwater Monitoring Technical Enforcement Guidance Document, OSWER Directive 9950-1, September 1986.

__________, 1986, Region IV Engineering Support Branch, Standard Operating Procedures and Quality Assurance Manual, April 1986.

WELL DEVELOPMENT - PARAMETER MEASUREMENTS

TIME	TOTAL VOL. WITHDRAWN		pH	COND. (umhos/cm)	TEMP. (c)	TURB. (NTU)	COMMENTS
	GALS.	BORE VOL.					
0830	0	26	9.23	4.86	20°C	—	
0838	2	26	8.52	4.69	20.2°	—	
0845	4	26	8.49	4.67	20.3°	—	
0852	6	26	8.37	4.65	20.4°	—	
0900	8	26	8.14	4.63	20.5°	—	
0908	10	26	8.05	4.63	20.5°	—	
0913	12	26	7.96	4.58	20.4°	—	
0926	14	26	7.92	4.50	20.4°	—	
0933	16	26	7.91	4.49	20.6°	—	
0945	18	26	7.90	4.48	20.7°	—	
0953	20	26	7.89	4.42	20.8°	—	
1005	22	26	7.88	4.40	21.0°	—	
1014	24	26	7.88	4.39	21.1°	—	
1020	26	26	7.88	4.39	21.1°	—	

DEVELOPED BY: Kevin Williamson DATE 1/14/94

Figure 5 Well Development-Parameter Measurements

INVESTIGATION-DERIVED WASTE INVENTORY SHEET

Site: ABC Landfill, Midway, TN (ZZ-1020) No. of Drums 6

Inventory Date: January 15, 1994

Waste Source	Drum/Container ID Number	Date Generated	Contents (Solid, Liquids, etc.)	Approximate Volume	Drum Location/ Comments
MW1-1	ZZ001	1/6/94	Drill Cuttings	Full	Site 1 Staging Area
MW1-1	ZZ002	1/6/94	Drill Fluids	Full	Site 1 Staging Area
MW1-2	ZZ003	1/7/94	Drill Cuttings	Full	Site 1 Staging Area
MW1-2	ZZ004	1/7/94	Drill Fluids	Full	Site 1 Staging Area
MW1-1	ZZ005	1/14/94	Dev. / Purge Water	½ Full	Site 1 Staging Area
MW1-2	ZZ006	1/14/94	Dev./Purge Water	½ Full	Site 1 Staging Area

Figure 6 Investigation-Derived Waste Inventory

TRIP REPORT

Project No. __________

FROM: Persons Making Trip

TO: Project Manager and/or Staff Members

DATE: Date of Trip

LOCATION: Region, Municipality, or Agency with Address Visited

PURPOSE: Reason for Trip

TRIP DISCUSSION: ____

List of Accompanying Contact Reports (if appropriate)
Person Contacted and Date

Figure 7 Trip Report Format

Title:	**SAMPLE PACKAGING**
Category:	ENV 3.16
Revised:	May 2001

STANDARD OPERATING PROCEDURE

SAMPLE PACKAGING

ecology and environment, inc.
368 Pleasant View Drive / Lancaster, New York 14086 / (716) 684-8060

TITLE:	SAMPLE PACKAGING		
CATEGORY:	ENV 3.16	REVISED:	May 2001

TABLE OF CONTENTS

1. Introduction

Liquid and solid environmental samples are routinely collected by E & E during field surveys, site investigations, and other site visits for laboratory analysis. Unless the samples have anesthetic, noxious, or other properties that could inhibit the ability of a flight crew member to perform his or her duty or are known to meet the established U.S. Department of Transportation criteria for hazardous material (i.e., explosive, corrosive, flammable, poisonous), they are not regulated as hazardous materials.

This Standard Operating Procedure (SOP) describes the packaging procedures to be used by E & E's staff to ensure the safe arrival of the samples at the laboratory for analyses. These procedures have been developed to reduce the risk of damage to the samples (i.e., breakage of the sample containers), promote the maintenance of sample temperature within the cooler, and prevent spillage of the sampled material should a container be broken.

In the event the sample material meets the established criteria of a DOT hazardous material, the reader is referred to E & E's Hazardous Materials/Dangerous Goods Shipping Guidance Manual (see H&S 5.5).

2. Scope

This SOP describes procedures for the packaging of environmental samples in:

- Coolers;
- Steel, aluminum and plastic drums; and
- 4GV fiberboard boxes.

The Hazardous Materials/Dangerous Goods Shipping Guidance Manual will complete the information needed for shipping samples by providing guidance on:

- Hazard determination for samples which meet the USDOT definition of a hazardous material;
- Shipping profiles for "standard" shipments;
- Shipping procedures for "non-standard" shipments;
- Marking of packages containing hazardous materials;
- Labeling of packages containing hazardous materials; and
- Preparation of shipping papers for hazardous materials shipment.

3. Sample Packaging Procedures

3.1 General

It is E & E's intent to package samples so securely that there is no chance of leakage during shipment. This is to prevent the loss of samples and the expenditure of funds for emergency responses to spills and the efforts necessary to re-obtain the sample.

Over the years, E & E has developed several "standard" package configurations for the shipping of environmental samples. These standard package configurations are described below.

Liquid samples are particularly vulnerable. Because transporters (carriers) do not know the difference between a package leaking distilled water and a package leaking a hazardous chemical, they will react to a spill in an emergency fashion, potentially causing enormous expense to E & E for the cleanup of the sample material. Therefore, liquids are to be packed in multiple layers of plastic bags and absorbent/cushioning material to preclude any possibility of leaks from a package. This section defines the standard packaging configurations for environmental samples.

3.2 Liquid Environmental Sample Packaging Procedures

Liquid environmental samples should be collected and preserved as outlined in the Standard Operating Procedures (SOP) for Surface Water Sampling (ENV 3.12), and Groundwater Well Sampling (ENV 3.7). ***Preserved water samples are not considered to meet the HM/DG definitions of Class 8 (Corrosive) and are therefore considered to be nonhazardous samples.*** Liquid environmental samples may be shipped using an 80-quart cooler or an outer package consisting of either a steel or aluminum drum. Because the steel and aluminum drums provide little insulating capability, they should not be used for samples that require icing.

Packaging Liquid Environmental Samples Using the 80-Quart Cooler

- Label and seal all water sample bottles according to appropriate sampling SOPs;
- Secure the bottle caps using fiberglass tape; and
- Place each amber, poly, and volatile organic analysis (VOA) bottle in a sealable plastic bag. Mark the temperature blank VOA bag for identification.

If a foam block insert is used:

- Line the cooler with two plastic bags;
- Place a foam insert (with holes cut to receive the sample bottles) inside the plastic bag;
- Place the bottles in the holes in the foam block;

- Fill void spaces with bagged ice to the top of the cooler;
- Fold over the plastic bags lining the cooler and secure shut with tape;
- Place Chain-of-Custody (C-O-C) form in a sealable bag and tape it to the inside of the cooler lid; and
- Secure the cooler with strapping tape and custody seal. Cover the custody seals with clear tape.

If vermiculite is used:

- Place 1 inch of inert absorbent material (vermiculite) in the bottom of the cooler;
- Line the cooler with two plastic bags;
- Place each sample bottle inside the inner bag;
- Fill the void spaces around the bottles with vermiculite to about half the height of the large bottles;
- Fill the remainder of the void spaces with bagged ice to within 4 inches of the top of the cooler, making sure the VOAs are in direct contact with a bag of ice;
- Fold over the plastic bags lining the cooler and secure shut with tape;
- Fill the remaining space in the cooler with vermiculite to the top of the cooler;
- Place C-O-C form in a sealable bag and tape it to the inside of the cooler lid; and
- Secure the cooler with strapping tape and custody seal. Cover the custody seals with clear tape.

Alternate Packaging Using 1A2/1B2 Drum

- Place 3 inches of inert absorbent material (vermiculite) in the bottom of the drum;
- Line the drum with two plastic bags;
- Place each sample bottle inside the inner bag;
- Fill the void spaces around the bottles with vermiculite to the height of the larger bottles;

- Fold over the plastic bags lining the drum and secure shut with tape;
- Fill the remaining space in the drum with vermiculite to the top of the drum;
- Place C-O-C form in a sealable bag and tape it to the inside of the drum lid; and
- Secure the drum with closing ring and apply custody seals. Cover the custody seals with clear tape.

3.3 Soil/Sediment Environmental Sample Packaging Procedures

Soil/sediment environmental samples should be collected as outlined in the SOP for Soil Sampling (ENV 3.13), and SOP for Sediment Sampling (ENV 3.8). Soil/sediment environmental samples may be shipped using an 80-quart cooler, a 4GV fiberboard combination package, or an outer package consisting of either a steel or aluminum drum. Because the steel and aluminum drums provide little insulating capability, they should not be used for samples that require icing.

Packaging Soil/Sediment Environmental Samples

- Label and seal each sample container according to SOPs;
- Secure the bottle caps using fiberglass tape;
- Place each sample bottle inside a sealable plastic bag and place it in its original shipping box or in individual fiberboard boxes. Mark the temperature blank bag for identification; and
- Secure the original shipping box with strapping tape, place shipping box in a plastic bag, and secure the plastic bag with tape.

If an 80-quart cooler is used:

- Place bubble pack or similar material on the bottom and sides of an 80-quart cooler;
- Place the bagged shipping boxes in the cooler with a layer of bubble pack between each box;
- Fill the void spaces with “blue ice” or ice in baggies to the top of the cooler;
- Place C-O-C form in a sealable baggie and tape it to the inside of the cooler lid; and
- Secure the cooler with strapping tape and custody seal. Cover the seals with clear tape.

If a 1A2/1B2 drum is used:

- Place 3 inches of inert absorbent material (vermiculite) in the bottom of the drum;
- Line the drum with two plastic garbage bags;
- Place the boxes inside the inner bag;
- Fill the space around the samples with vermiculite;
- Fold over the plastic bags lining the drum and secure shut with tape;
- Fill the remaining space around the bags with vermiculite to the top of the drum;
- Place C-O-C form in a sealable bag and tape it to the inside of the drum lid; and
- Secure the drum with the closing ring and apply custody seals. Cover the custody seals with clear tape.

Note: If a small number of samples are being shipped, it may be more practical to package them using the vermiculite or foam block configurations used for shipping liquid samples.

4. Shipping Procedures

Environmental samples are to be shipped as nonhazardous cargo. Unless the samples have anesthetic, noxious, or other properties that could inhibit the ability of a flight crew member to perform his or her duty or are known to meet the established U.S. Department of Transportation criteria for a hazardous material (i.e., explosive, corrosive, flammable, poisonous), they are not regulated as hazardous materials. When preparing the containers (i.e., cooler, drum, or box) for shipment, E & E staff must remove all labels from the outside container. Labels indicating that the contents may be hazardous are misleading and are not appropriate. Markings indicating ownership of the container, destination, and chain of custody labels are acceptable and can be attached as required.

When completing the paperwork for shipment, the standard nonhazardous forms must be used. Do not use the hazardous materials/dangerous goods airbills, either in total or in part; these forms are coded and their use will invite unnecessary questions. This will only serve to confuse Airborne or Federal Express' terminal personnel and will cause much frustration and the delay of sample shipment.

Environmental sample packages can be shipped overnight by both Airborne and Federal Express. When choosing between the two, cost should be considered. It is normally much cheaper to ship Airborne. For work conducted and paid for by E & E, it is E & E's policy that you must first attempt to ship by Airborne before considering Federal Express. In addition, Airborne tends to have remote locations open later in the evenings than Federal Express, which may be helpful when trying to complete a full day's sampling effort and still make the flights on time. Although both companies offer pickup of samples at the site, it is advisable to call ahead and ensure that this service is offered beforehand. In almost all cases, both companies will deliver to the laboratory of your choice on Saturdays. When planning for sampling activities, check with the companies in advance to verify pick-up and delivery schedules.

APPENDIX B

Field Forms

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HERRERA ENVIRONMENTAL CONSULTANTS

2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
(206) 441-9080
FAX (206) 441-9108

CHAIN OF CUSTODY RECORD

PROJECT NAME: Oakland Bay	PROJECT NUMBER: 06-03386-007	CLIENT: Ecology
REPORT TO: Gina Catarra, Herrera		COPY TO:
SAMPLED BY:		DELIVERY METHOD:
LABORATORY:	REQUESTED COMPLETION DATE:	TOTAL # OF CONTAINERS:
LAB USE:		

SAMPLE ID:	DATE:	TIME:	SAMPLE DESCRIPTION	# OF CONTAINERS:	ANALYSES REQUESTED															

REMARKS:

RELINQUISHED BY (NAME/CO.):	SIGNATURE:	DATE/TIME:	RECEIVED BY (NAME/CO.):	SIGNATURE:	DATE/TIME:
RELINQUISHED BY (NAME/CO.):	SIGNATURE:	DATE/TIME:	RECEIVED BY (NAME/CO.):	SIGNATURE:	DATE/TIME:

HERRERA
ENVIRONMENTAL
CONSULTANTS

SEDIMENT CORE RECORD

Sample Station Number ____________________

Sheet ________ of ________

Project name Oakland Bay Sediment Characterization

Project number 06-03386-007

Client Ecology

HEC Samplers ____________________

Date Sampled ____________________

Location ____________________

Photo number ____________________

Wood chips (Y or N)	Soil Description / Comments	Time Sampled	Depth (feet)	Sample Interval	Sediment Core Log
			1		
			2		
			3		
			4		

APPENDIX C

Health and Safety Plan

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HEALTH AND SAFETY PLAN

Oakland Bay Sediment Characterization
Shelton, Washington

Prepared for

Washington State Department of Ecology

September 19, 2008

Health and Safety Plan
Review and Approval

Client: Ecology	Site Name: Oakland Bay
Project Name: Oakland Bay Sediment Characterization	Project No.: 06-03386-007
Start Date: 9/29/08	End Date: 10/29/08

Plan Expiration Date: 12/31/08
(Last day of expected fieldwork or no longer than 6 months).

The following individuals have reviewed this health and safety plan and have approved its use for the dates specified.

Brady Hanson		
Plan Completed by	Signature	Date
Gina Catarra		
Field Manager	Signature	Date
Peter Jowise		
Corporate Health & Safety Officer	Signature	Date
Bruce Carpenter		
Site Health and Safety Officer	Signature	Date
Eric Parker		
Subcontractor Field Supervisor	Signature	Date

This Health and Safety Plan (HASP) complies with federal regulations at 29 CFR Part 1910.120 and State of Washington regulations at WAC 296-843-120, and is applicable only to employees of Herrera Environmental Consultants, Inc. Consultants, subconsultants, and contractors other than Herrera working at this jobsite are responsible for the health and safety of their own employees and are required to develop their own health and safety plan. Other contractor personnel, who provide site-specific information, may review this HASP; however, Herrera assumes no responsibility or liability for the use of this document by other parties.

Due to the potential hazardous nature of this site and the activity occurring thereon, it is not possible to discover, evaluate, and provide protection for all possible hazards, which may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury at this site. The health and safety guidelines in this Plan were prepared specifically for this site based on site conditions, purposes, dates, and personnel specified, and must be amended if these conditions change. This HASP should not be used on any other site without prior research by trained health and safety specialists.

Contents

Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
BTEX	benzene, toluene, ethylbenzene, and xylene
CFR	Code of Federal Regulations
CPR	cardiopulmonary resuscitation
Ecology	Washington Department of Ecology
E&E	Ecology and Environment
ERP	Emergency Response Plan
ESCBA	escape self-contained breathing apparatus
FID	flame ionization detector
HASP	health and safety plan
HAZWOPER	Hazardous Waste Operations/Emergency Response
IDLH	immediately dangerous to life and health
LEL	lower explosive limit
LFC	lowest feasible concentration
mg/m3	milligrams per cubic meter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MSDS	Material Safety Data Sheet
MTCA	Model Toxics Control Act
NIOSH	National Institute of Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
OVA	organic vapor analyzer
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PEL	permissible exposure limit
PID	photoionization detector
PPE	personal protective equipment
PPL	personal protection level (A, B, C, D)
ppm	parts per million
REL	recommended exposure limit
RSS	Research Support Services
SCBA	self-contained breathing apparatus
SHSO	site health and safety officer
STEL	short-term exposure limit
SVOC	semivolatile organic compound
TLV	threshold limit value
TWA	time weighted average
VOC	volatile organic compound
U.S. EPA	United States Environmental Protection Agency
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety and Health Act
WWTP	wastewater treatment plant

1.0 General Site Requirements and Background Information

1.1 Health and Safety Plan Organization and Responsibilities

1.1.1 Key Personnel

Herrera Principal-in-Charge:	Rob Zisette
Corp. Health & Safety Officer:	Peter Jowise
Herrera Project Manager:	Peter Jowise
Herrera Site Health and Safety Officer:	Bruce Carpenter
Herrera Field Personnel:	Brady Hanson
	Bruce Carpenter
	Gina Catarra
	George Iftner
Subcontractor Field Supervisor (RSS):	Eric Parker
Prime Consultant Project Manager (E&E):	Andy Hafferty
Client Project Manager (Ecology):	Cynthia Erickson

1.1.1.1 Principal in Charge

The Principal in Charge provides a point of contact if the Project Manager cannot be accessed during emergency situations.

1.1.1.2 Project Manager

The Project Manager provides technical support to the Site Health and Safety Officer for health and safety decision-making. Prior to beginning onsite work, the Project Manager will ensure that employee training and medical clearance are current and up-to-date.

1.1.1.3 Site Health and Safety Officer

The Site Health and Safety Officer (SHSO) shall be responsible for coordinating emergency response measures during this project. All workers shall report to the Site Health and Safety Officer in the event of an emergency. Within 24 hours of the end of fieldwork, the SHSO will submit the completed HASP to the Corporate Health and Safety Officer.

The SHSO will oversee the overall Plan. He has the authority to stop work or prohibit any personnel from working on the site at any time for not complying with any aspect of the Plan.

1.1.1.4 Subcontractor Field Supervisor

The Subcontractor Field Supervisor is responsible for implementing the Plan for his own employees.

1.1 All Onsite Personnel

Each person on the site has responsibility for their own health and safety, as well as assisting others in carrying out the Plan. Any person observed to be in violation of the Plan should be assisted in complying with the Plan, or reported to the SHSO or the Subcontractor Field Supervisor.

Any site personnel may shut down field activities if there is a real or perceived immediate danger to life or health.

1.2 Minimum Training, Respirator Fit-Testing, and Medical Surveillance Requirements for Site Personnel

1.2.1 Training

All field workers have received health and safety training required by OSHA (29 CFR 1910.120) and WISHA (WAC 296-843-200), including some or all of the following:

- 40/80 hrs. Hazardous Waste Operations/Emergency Response training (HAZWOPER)
- 8 hrs. Annual HAZWOP Refresher training
- 8 hrs. Supervisor HAZWOP training for Site Health and Safety Officer
- First Aid and CPR training
- Annual Respirator Fit Testing
- Annual Medical Clearance.

Copies of personnel training certifications are presented in Attachment 3 of this HASP.

1.2.2 Medical Surveillance

The Herrera medical surveillance program is described in the corporate health and safety plan. In summary, all Herrera employees potentially exposed to hazardous substances or health hazards for 30 days or more a year will participate in the program. The medical surveillance program includes a determination of fitness for each individual to work in hazardous environments, including use of various levels of personal protective equipment. Medical examinations are conducted on a regular basis (usually annually) and each person's condition reviewed at that time. The Corporate Health and Safety Officer maintains medical records in a designated file and are available for review by each affected employee.

2.0 Post

Local Emergency and Project Telephone Numbers

2.1 Site Address and Phone Number

Site Address: NA (for hospital route map use Shelton Marina - 661 E. Pine St.)

Site Phone Number: NA

2.2 Local Emergency Phone Numbers

	Name	Telephone No.*
Hospital	Mason General Hospital	360-426-1611
Ambulance	Mason County Medic One	360-426-3403
Police/Sheriff	Shelton City Police Department	360-426-4441
Fire	Shelton Fire Department	360-426-3348
Utilities	UULS (Washington)	(800) 424-5555
Other:	Emergency pager/cell phone	

* Include phone numbers other than "911".

2.3 Project Personnel Phone Numbers

	Name	Telephone No.
Site Health and Safety Officer	Bruce Carpenter	(206) 441-9080 wk
Project Manager	Peter Jowise	(206) 441-9080 wk; (206) 780-5712 hm
Principal-in-Charge	Rob Zisette	(206) 441-9080 wk; (206) 930 6585 cell
Client Contact	Cynthia Erickson	(360) 407-6361
Corporate Health & Safety Officer	Peter Jowise	(206) 441-9080 wk; (206) 780-5712 hm
Subcontractor Field Supervisor	Eric Parker	(206) 550-5202 cell

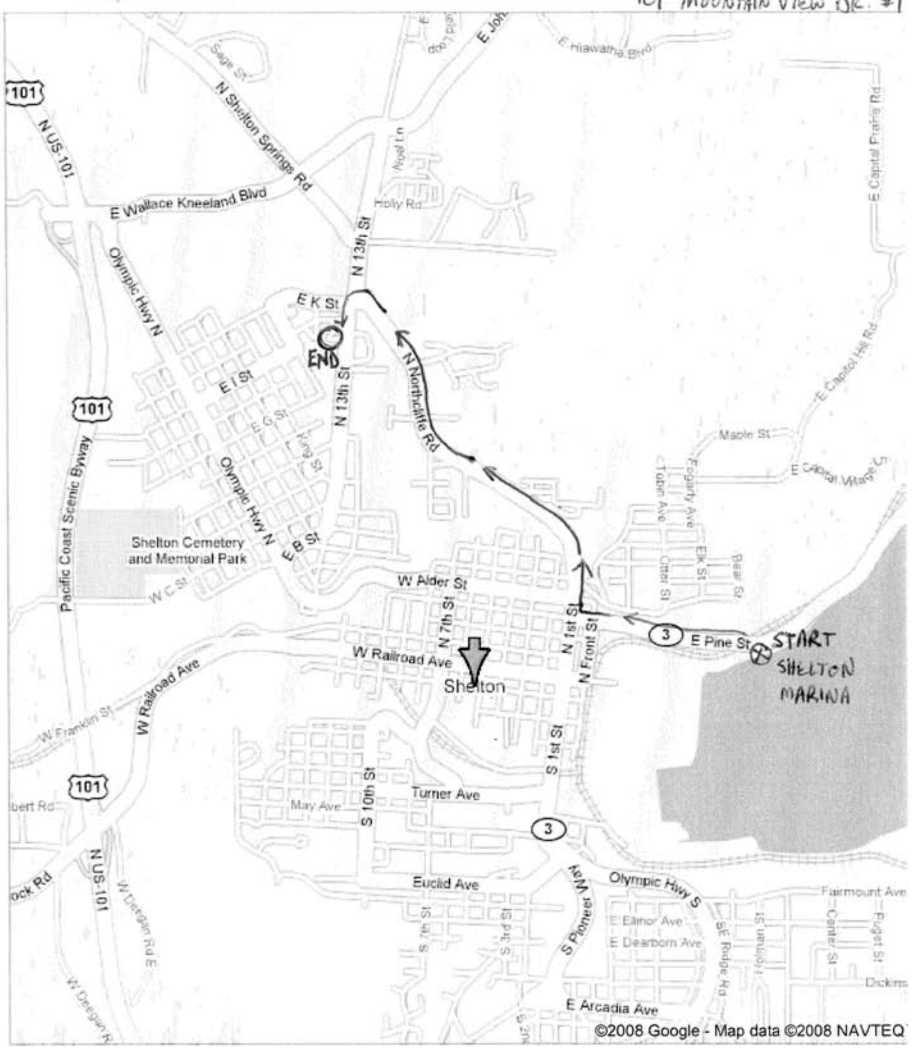
3.0 Post

Hospital Location Map

loc: Shelton, WA - Google Maps Page 1 of 1

Google Maps Address **Shelton, WA**

Notes: Hospital Route Map
MASON GENERAL HOSPITAL
360-426-1611
901 MOUNTAIN VIEW DR. #1



http://maps.google.com/maps?hl=en&ie=UTF8&near=Shelton,+WA&fb=1&ll=47.218694,-123.10... 4/4/2008

4.0 Emergency Response Plan

4.1 Injury or Exposure

If an injury or exposure occurs, take the following actions:

- Get First Aid for the person immediately.
- Notify the Site Health and Safety Officer (SHSO). The SHSO is responsible for immediately notifying the Project Manager, and preparing and submitting an Injury/Exposure Report (Attachment 1) to the Corporate Health and Safety Officer within 24 hours, as well as notifying the employee's supervisor and Principal-in-Charge. If a subcontractor employee is injured, the Subcontractor Field Supervisor will also complete their own injury/exposure investigation and submit a copy of their report to the Corporate Health and Safety Officer as well.
- The SHSO will assume charge during a medical emergency.

4.2 Site Incident

If an incident occurs, take the following action:

- Notify the SHSO immediately. The SHSO is responsible for immediately notifying the Project Manager, and preparing and submitting a Site Incident Report (Attachment 1) to the Corporate Health and Safety Officer within 24 hours.

Local Emergency and Project Telephone Numbers See page 5.

4.3 Emergency Routes

Also see Hospital Location Map–page 6.

Hospital Name:	Mason General Hospital
Hospital Address:	901 Mountain View Drive #1
Hospital Phone Number:	360-426-1611

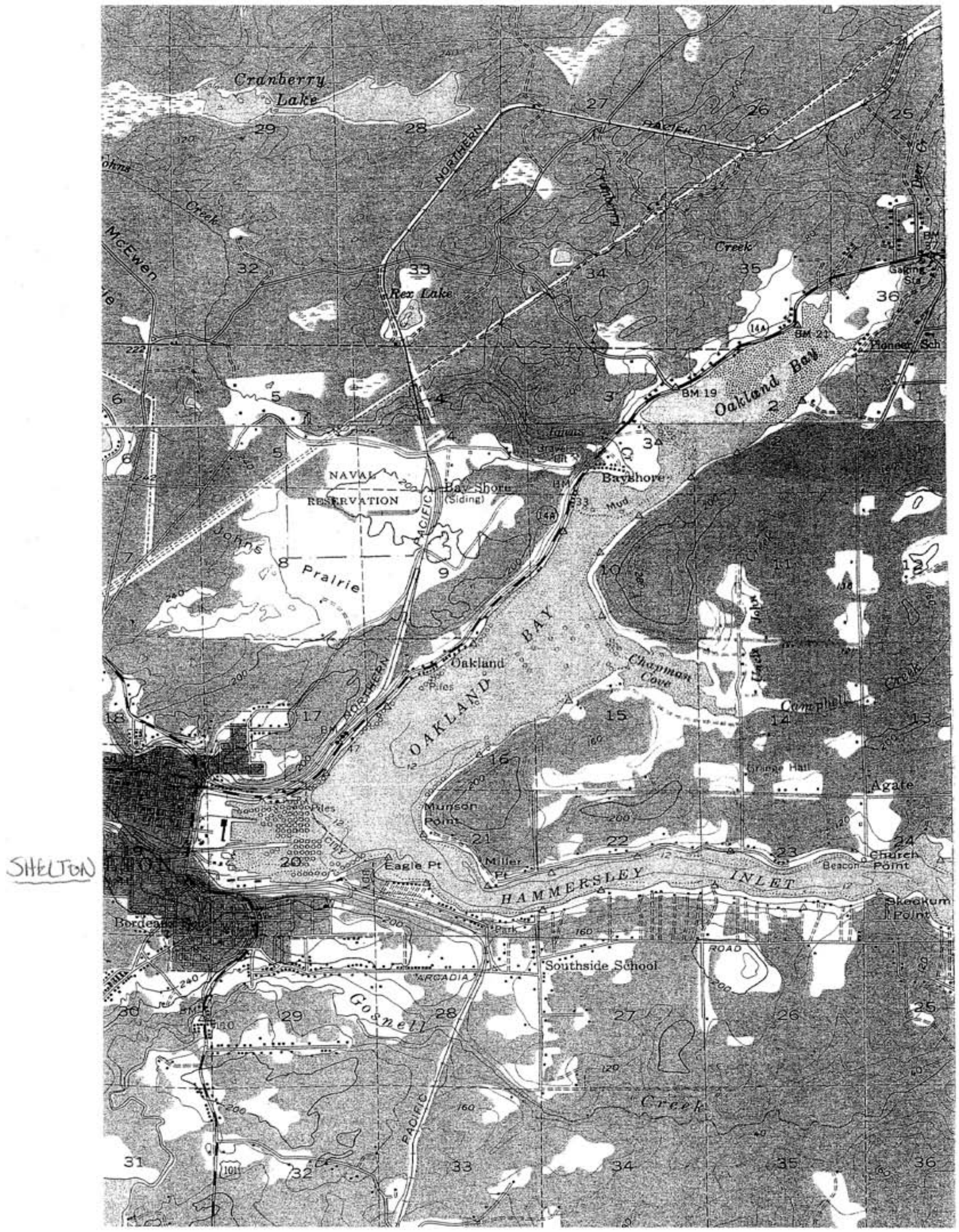
Route from onsite work area to hospital:

- Take E. Pine St. (Hwy 3) West towards Shelton (0.5 mile)
- Turn RIGHT (north) on N. 1^{st} St. (0.1 mile)
- N. 1^{st} St. becomes N. Northcliffe Rd. (1.1 miles)
- Turn LEFT (south) on N. 13^{th} Street (69 feet)
- Turn RIGHT (west) on Mountainview Drive Rd. (Hospital is straight ahead.)

5.0 Post

Site Map

(Include work/exclusion zones)



6.0 Scope of Work

The purpose of this work assignment is to perform a characterization of marine sediment throughout Oakland Bay, including northeast Oakland Bay, Shelton Harbor, and the west end of Hammersley Inlet (i.e., to Miller Point) to support the prioritization of cleanup and restoration actions under the Puget Sound Initiative.

Field crews will be collecting surface and subsurface sediment samples to be processed and sent to the laboratory for chemical analysis.

6.1 Detailed Description of Specific Tasks Planned

Number each separate task in order of progression:

	Task Description
Task 1.	Collection of sediment samples for chemical analysis.
Task 2.	
Task 3.	
Task 4.	
Task 5.	

6.2 Initial Site Entry

Has this been performed by Herrera? (Yes/No): No

If yes, describe:

6.3 Interior Work and Confined Spaces

Will any work be done inside an enclosure, building, or confined space? (Yes/No): No

If yes, describe:

6.4 Excavation and Trenching

Excavation and/or trenching will be done on this site? (Yes/No): No

6.5 Landfills and Other Areas Potentially Containing Explosive Gas or Vapor

Site is in an area containing a current/former landfill, or the geology contains known/suspected pockets of explosive gas/vapor? (Yes or No): No

If yes, describe:

6.6 Time of OnSite Work

Work will be done during daylight hours? (Yes/No): Yes

If no, describe:

6.7 Hazardous Materials

Will any hazardous materials (chemicals) be used on-site? (If so, include MSDSs under Attachment 5.) (Yes/No): No

If yes, describe:

7.0 Site Characteristics

7.1 Facility/Site Description

Identify structures, buildings, pits, impoundments, and work area, as well as water supply and mains, telephone, radio, power lines, traffic patterns, gas lines, terrain, vacant lots, debris, other physical hazards, etc.:

Work will be conducted in boats and on foot along the shoreline throughout Oakland Bay.

7.2 Site Status

Site Status: Occupied? (Yes or No): Yes

If yes, describe current activities and relationship to field work: Boat traffic and log rafting operations are expected to be encountered, primarily in Shelton Harbor. Shellfish beds also will be crossed, primarily in north Oakland Bay.

7.3 Site History and Background Information

Oakland Bay is a shallow estuary located in South Puget Sound, with the City of Shelton and its industrial waterfront and harbor located at the southwest corner of the bay. Water depth of the bay ranges between 10 and 35 feet, with shallow and broad intertidal zones exposed during low tides at the north end of the bay and in Shelton Harbor. Due to the restrictive nature of Hammersley Inlet, a long narrow waterway linking the bay to the Puget Sound Basin, the water in Oakland Bay has high refluxing, low flushing, and high retention rates. Eight major freshwater creeks discharge into the bay. The waters of Shelton Harbor and the northern portions of Oakland Bay are currently listed as impaired by the State of Washington because of fecal coliform bacteria levels. Fecal coliform contamination from excessive infiltration and inflow to Shelton's aging sewer and stormwater collection systems, residential septic systems, and surface water runoff from small farms, may have contributed to recent closures of shellfish harvesting in portions of the bay.

The Shelton waterfront and harbor have been historically and are currently used by a number of timber and wood product manufacturing industries, including saw mills and plywood manufacturing, pulp and paper production, and insulation board and fiber board manufacturing. Over the years, process chemicals and wastewater from wood-product manufacturing processes have either been discharged through onsite industrial stormwater systems or were released due to accidental spills and leaks to the harbor, to Shelton and Goldsborough Creeks, or across upland portions of the waterfront.

Barges loaded with wood chips used by the pulp mill for processing into pulp, have historically moored in the harbor adjacent to the pulp mill. Logs used in lumber, plywood, and fiber board manufacturing were rafted and stored in the water prior to processing at sawmills and plywood plants from the late 1800s through the late 1960s. Log rafts continue to be stored throughout Shelton Harbor and Oakland Bay.

Bulk fuel storage marine terminals have operated either at the north end of Shelton Harbor or about a half mile northeast of Shelton along the west shore of Oakland Bay. Petroleum-related contaminants have been identified in sediments collected within the intertidal zone adjacent to the former Evergreen Fuel marine terminal at the north end of the harbor.

The scope of this study is limited geographically to the intertidal and aquatic areas of Oakland Bay, including northeast Oakland Bay, Shelton Harbor, and the west end of Hammersley Inlet (i.e., to Miller Point).

8.0 Personal Protective Equipment Requirements

The Site Health and Safety Officer is responsible for establishing and coordinating procedures for evacuation of all onsite personnel, including non Herrera personnel, prior to commencement of work. This plan will be reviewed at the site safety meeting conducted at the beginning of the first day of work (and at subsequent site safety meetings as warranted by changing conditions and addition of new site workers). A Daily Tailgate Health and Safety Meeting Form (Attachment 2) is to be completed and signed by all personnel who attended the site safety meetings.

In the event of a potential emergency, as determined by any onsite worker, the Site Health and Safety Officer will be notified and all site personnel assembled at an area designated during the site safety meeting. The Project Manager, with the aid of the Site Health and Safety Officer and other site workers, will decide the appropriate response depending onsite conditions.

The following equipment shall be maintained onsite at all times:

- First-aid kit
- Emergency eye wash
- Fire extinguisher (A, B, C).

All personnel who perform work on-site will be minimally required to meet the protective clothing and safety equipment requirements listed here for Level D. Level D status will apply to fieldwork on the site unless the trigger mechanism(s) to Level C are activated.

Personal Protection - Level D

('X' if applicable)

	Protective Clothing		Safety Equipment
X	Cotton coveralls/long-sleeved shirt and pants		Photoionization detector
X	Rubber boots		Flame ionization detector
X	Hard hat (required when davit in use)	**X**	Personal floatation devices (PFD)
X	Safety glasses/goggles	**X**	Visual distress signal (VDS), (flashlight or orange flag)
X	Work gloves	**X**	U.S. Coast Guard-certified fire extinguisher
X	Solvex gloves (for sample handling)		
	Disposable boot covers		
	Ear plugs		
	Reflective vests		
	Insulated coveralls		

Personal Protection – Level C

Level 'C' personal protection includes level 'D' plus:

General Protective Clothing	Specific Model or Type
Air-purifying respirator	
Cartridges	
Inner gloves	
Outer gloves	
Chemical resistant boots or boot covers	
Chemical resistant suit	

The Site Health and Safety Officer must notify the Health & Safety Manager at the end of work that day if Level 'C' was used.

Personal Protection – Level B

Level 'B' personal protection includes level 'D' plus:

General Protective Clothing	Specific Model or Type
Self-contained breathing apparatus or supplied air respirator	
Inner gloves	
Outer gloves	
Chemical resistant boots or boot covers	
Chemical resistant suit	

The Site Health and Safety Officer must notify the Health & Safety Manager at the end of work that day if Level 'B' was used.

9.0 Hazard Identification

Hazards may exist in a number of forms on the site and shall be classified among three general categories: chemical, physical, and biological. The following list is meant to convey the general hazard classes that may be encountered on the site.

(Shade all hazard classes that will or may exist on the site.)

Chemical Hazards	Physical Hazards	Biological Hazards
Asbestos	Animal/Human Contact	Coliform Bacteria
Flammable Liquids/Gases	Climatic Hazards	CSO Effluent
Metals	Confined Space Entry	Hospital Waste
PCBs	Drilling Rigs	Human Blood
Pesticides/Herbicides	Earth Moving Equipment	Landfill Waste
Petroleum Hydrocarbons	Electrical Hazards	Pathogens
Volatiles	Explosives	Untreated Sewage
Semivolatiles	Falling Hazards	WWTP Sludges
Toxic Liquids/Gases	Heavy Lifting	Poisonous Insects/Snakes
Dioxins	Radioactive Isotopes	Viruses
	Transportation Hazards	
	Water Hazards	

9.1 Potential Chemical Hazards

Chemical hazards will be evaluated both by visual examination of site conditions, as well as by use of monitoring equipment. Visual indications of potential chemical hazards include evidence of dead or dying vegetation, dead animals, discolored vegetation or soil, sheens on water, non aqueous liquids, etc. Monitoring equipment to be used at this site is discussed in under General Site Procedures.

(List the specific compounds and matrices that have been or may be encountered on the site. If none or unknown, list as "none" or "unknown". Do not leave a list blank. If the concentration is known include either or both the average and maximum values.)

Petroleum Products			**Volatiles**		
Chemical	Matrix	Regulatory Action Level	Chemical	Matrix	Regulatory Action Level
Diesel	Sed	2,000 mg/kg			
Lube oil	Sed	2,000 mg/kg			

Semivolatiles			**Metals**		
Chemical	Matrix	Regulatory Action Level	Chemical	Matrix	Regulatory Action Level
Benzo(a)pyrene	Sed	0.1 mg/kg	Arsenic	Sed	20 mg/kg
			Cadmium	Sed	2 mg/kg
			Chromium	Sed	2,000 mg/kg
			Lead	Sed	250 mg/kg
			Mercury	Sed	2 mg/kg

Pesticides/PCBs			**Other**		
Chemical	Matrix	Regulatory Action Level	Chemical	Matrix	Regulatory Action Level
PCB Mixtures	Sed	1 mg/kg	Dioxins/Furans (tcdd;2,3,7,8-)	Sed	6.67E-06
DDT	Sed	3 mg/kg			

References: MTCA method A and method B (2007).

9.2 Potential Physical Hazards

"X" if applicable	Hazards	Hazard Control Measures
	Overhead utilities (describe):	Identify/locate and mark existing utilities prior to work. Ensure that overhead utility lines are at least 15 feet away from project activities. Contact utility companies to confirm locations, as necessary. Complete Utility Clearance Log (Attachment 2)
	Underground utilities (describe):	Identify/locate and mark existing utilities prior to work. Contact utility companies to confirm locations, as necessary. Complete Utility Clearance Log (Attachment 2)
	Geoprobe drilling	Wear hard hat, steel-toe boots, and noise protection. Maintain line of sight between drillers and field personnel.
	Drilling	Identify/locate underground utilities prior to drilling activities. Hand auger first 5 feet to ensure clearance of underground utilities. Wear hard hat, steel-toe boots, and noise protection. Maintain line of sight between drillers and field personnel.
	Excavation/Trenching	Ensure that any required sloping or shoring systems are approved as per 29 CFR 1926 Subpart P. Identify special PPE and monitoring needs if personnel are required to enter approved excavated areas or trenches. Maintain line of sight between equipment operators and personnel in excavations/trenches. Suspend or shut down operations at signs of cave in, excessive water, defective shoring, changing weather, or unacceptable monitoring results.
X	Heavy Equipment Operation (Vibracore)	Define equipment routes, traffic patterns, and site-specific safety measures. Maintain line of sight between equipment operators and ground personnel and that both are informed of proper hand signals and communication protocols. Ensure that lifting capacities, load limits, etc., are not exceeded. Identify special PPE and monitoring needs. Ensure that field personnel do not work in close proximity to operating equipment.
	Heat Exposure	Provide cool break area and adequate breaks. Provide cool non-caffeinated beverages. Promote heat stress awareness. Use active cooling devices (e.g., cooling vests) where specified.
	Cold Exposure	Provide warm break area and adequate breaks. Provide warm non-caffeinated beverages. Promote cold stress awareness.
X	Weather Extremes	Establish site-specific contingencies for severe weather situations. Provide for frequent weather broadcasts. Weatherize safety gear, as necessary. Identify special PPE needs. Discontinue work during severe weather.

"X" if applicable	Hazards	Hazard Control Measures
	Oxygen deficiency	Monitor for oxygen level. Do not enter area if less than 19.5% oxygen. Use SCBA if area has less than 19.5% oxygen.
	Confined space	Complete the confined space entry form. Attach permit for confined space entry.
	Noise	Establish noise level standards for onsite equipment and operations. Inform personnel of hearing protection requirements. Define site-specific requirements for noise monitoring.
	Ionizing radiation	Identify special PPE and monitoring needs prior to entering area suspected of ionizing radiation.
	Fire/Explosion	Inform personnel of the location(s) of potential fire/explosion hazards. Establish site-specific procedures for working and handling around flammables. Ensure that appropriate fire suppression equipment and systems are available and in good working order. Define requirements for intrinsically safe equipment. Identify special monitoring needs. Remove ignition sources from flammable atmospheres. Establish contingency plans and review daily with team members.
	Electrical	Locate and mark energized lines. De-energize lines as necessary. Ground all electrical circuits. Guard or isolate temporary wiring to prevent accidental contact. Evaluate potential areas of high moisture or standing water and define special electrical needs.
	Work Surfaces	
	Holes/ditches	Identify special safety control needs -
	Steep grades	Identify special safety control needs -
X	Slippery surfaces	Identify special safety control needs - Take extra care entering and exiting boats.
X	Uneven terrain	Identify special safety control needs - Take extra care entering and exiting boats.
X	Unstable surfaces	Identify special safety control needs – Be alert when working in close quarters on boats during sample collection/retrieval. Develop a system so all field personnel understand their role.
	Elevated work surfaces	Identify special safety control needs (e.g., lanyards, safety nets, etc.) -
X	Traffic hazards	Be aware of other vessel traffic during sample collection, as well as boat positioning.
	Other:	

9.3 Potential Biological Hazards

(List all potential biological hazards including specific pathogens, bacteria, or diseases likely to be encountered onsite.)

Biological Hazard	Matrix
Untreated sewage/coliform bacteria	water

9.4 Exposure Pathways and Permissible Exposure Limits (PELs)

The following is a list of potential exposure pathways, and the PELs and TWAs for chemical and biological hazards that may be encountered on the site. The potential exposure pathways are not limited to those listed. Acute systems of exposure along with odor thresholds and descriptions are given when that information is known. Odor thresholds are not exact and vary with susceptibility or sensitivity involved.

9.5 Predominant Potential Site Chemical Hazards

	Exposure Limits (TWA)							
Chemical (or Class)	OSHA PEL	NIOSH REL	STEL	Other Pertinent Limits	Warning Properties	Routes of Exposure Or Irritation	Acute Health Effects	Chronic Health Effects/Target Organs
Gasoline		LFC Carcinogenic		Carcinogenic	Fuel petroleum/ aromatic odor	Inhalation, absorption, ingestion, skin and/or eye contact	Irritated eyes, skin, mucous membranes; headache, weakness, exhaustion, blurred vision, dizziness, slurred speech, confusion, convulsion, chemical pneumonia	Carcinogen A1 – Eyes, skin, respiratory system, central nervous system, muscular neurological systems, liver and kidney cancer (benzene maximum of 3%)
Diesel	500 ppm			ACGIH TLV = 100 ppm	Fuel petroleum odor	Inhalation, ingestion, skin	Irritated eyes and respiratory system, headaches, dizziness, drowsiness, pulmonary function changes	Carcinogen A4 – Eyes, respiratory system, muscular neurological systems, cancer
Coal tar pitch volatiles (creosote and coal tar); PAHs Acenaphthene Dibenzofuran Fluorene Phenanthrene Anthracene Pyrene Benzo(a)anthracene Chrysene Benzo(b)fluoranthene Benzo(k)fluoranthene Benzo(a)pyrene Indeno(1,2,3-cd)pyrene Dibenz(a,h)anthracene Benzo(g,h,I)perylene	0.2 mg/m^3	0.1 mg/m^3 Carcinogenic		IDLH = 80 mg/m^3 Carcinogenic	Black or dark brown oil/tar, mothball-like odor	Inhalation, absorption, skin and/or eye contact	Irritated eyes, skin, and respiratory system; dermatitis, bronchitis	Carcinogen A1 – Respiratory system, skin, bladder, kidneys (lung, kidney, and skin cancer) (potential occupational carcinogen)
Bis(2-Chloro-ethyl)ether (Dichloroethyl ether)	15 ppm (90 mg/m^3) [skin]	Carcinogenic 5 ppm (30 mg/m^3)	NIOSH = 10 ppm (60 mg/m^3) [skin]	IDLH = 100 ppm Carcinogenic	Colorless liquid with a chlorinated solvent-like odor	Inhalation, absorption, ingestion, skin and/or eye contact	Irritated nose, throat, respiratory system; discharge of tears, cough, nausea, vomiting	Eyes, respiratory system, liver (liver tumors) (potential occupational carcinogen)

	Exposure Limits (TWA)							
Chemical (or Class)	OSHA PEL	NIOSH REL	STEL	Other Pertinent Limits	Warning Properties	Routes of Exposure Or Irritation	Acute Health Effects	Chronic Health Effects/Target Organs
2,4,5-/2,4,6-Trichlorophenol					Colorless needles, gray flakes, or off-white lumpy solid with phenolic-like odor	Inhalation, skin and/or eye contact	Irritated eyes, nose, respiratory system, redness, edema, chemical burns on skin, nose and pharynx systemic effects	Carcinogen A2 –
Naphthalene	10 ppm (50 mg/m^3)	10 ppm (50 mg/m^3)	15 ppm (75 mg/m^3)	IDLH = 250 ppm	Colorless to brown solid with mothball-like odor	Inhalation, absorption, ingestion, skin and/or eye contact	Irritated eyes; headache, confusion, excitement, malaise, nausea, vomiting, abdominal pain, irritated bladder, profuse sweat, jaundice, blood in urine, hemoglobinuria, renal shutdown, dermatitis, optical neuritis, corneal damage	Carcinogen A4 – Eyes, skin, blood, liver, kidneys, central nervous system
Dimethylphthalate	5 mg/m^3	5 mg/m^3		IDLH = 2,000 mg/m^3	Colorless, oily liquid with a slight aromatic odor	Inhalation, ingestion, skin and/or eye contact	Irritated eyes, upper respiratory system; stomach pain	Eyes, respiratory system, gastrointestinal tract
Diethylphthalate		5 mg/m^3			Colorless to water-white, oily liquid with a very slight aromatic odor	Inhalation, ingestion, skin and/or eye contact	Irritated eyes, skin, nose, throat; headache, dizziness, nausea, discharge of tears; pain, numbness, weakness, exhaustion, spasms in arms & legs,	Eyes, skin, respiratory system, central nervous system, peripheral nervous system, reproductive system, possible polyneuropathy, vestibular dysfunction
Di-n-octylphthalate Di(2-ethylhexyl) phthalate; DEHP; bis-(2-ethylhexyl) phthalate	5 mg/m^3	5 mg/m^3 LFC Carcinogenic	NIOSH = 10 mg/m^3	IDLH = 5,000 mg/m^3 Carcinogenic	Colorless, oily liquid with a slight odor	Inhalation, ingestion, skin and/or eye contact	Irritated eyes, mucous membranes	Carcinogen A2 – Eyes, respiratory system, central nervous system, reproductive system, liver, gastrointestinal tract (liver tumors), (potential occupational carcinogen)
Pentachloro-phenol (PCP)	0.5 mg/m^3 [skin]	0.5 mg/m^3 [skin]		IDLH = 2.5 mg/m^3	Colorless to white, crystalline solid with benzene-like odor (fungicide)	Inhalation, absorption, ingestion, skin and/or eye contact	Irritated eyes, nose, throat; sneezing, coughing, weakness, exhaustion, sweating, anorexia, low weight, headaches, dizziness, nausea, vomiting, breathing difficulty, chest pain, high fever, dermatitis	Eyes, skin, respiratory system, cardiovascular system, liver, kidneys, central nervous system

	Exposure Limits (TWA)							
Chemical (or Class)	OSHA PEL	NIOSH REL	STEL	Other Pertinent Limits	Warning Properties	Routes of Exposure Or Irritation	Acute Health Effects	Chronic Health Effects/Target Organs
Heptachlor Heptachlor epoxide	0.5 mg/m^3 [skin]	0.5 mg/m^3 [skin] LFC Carcinogenic ACGIH TLV = 0.05 mg/m^3 [skin]		IDLH = 35 mg/m^3 Carcinogenic	White to light tan crystals with a camphor-like odor	Inhalation, absorption, ingestion, skin and/or eye contact	Tremors, convulsions, incoordination	Carcinogen A2 – Central nervous system, liver (potential occupational carcinogen)
Dieldrin	0.25 mg/m^3 [skin]	0.25 mg/m^3 [skin] LFC Carcinogenic		IDLH = 50 mg/m^3 Carcinogenic	Colorless to light tan crystals with a mild chemical odor (insecticide)	Inhalation, absorption, ingestion, skin and/or eye contact	Headache, dizziness, nausea, vomiting, malaise, sweating, myoclonic limb jerks, convulsions, coma	Carcinogen A4 – Central nervous system, liver, kidneys, skin (potential occupational carcinogen)
4,4'-DDT 4,4'-DDE 4,4'-DDD	1 mg/m^3 [skin]	0.5 mg/m^3 LFC Carcinogenic		IDLH = 500 mg/m^3 Carcinogenic	Colorless crystals or white powder with a slight aromatic odor	Inhalation, absorption, ingestion, skin and/or eye contact	Irritated eyes, skin; paresthesia tongue, lips, face; tremors, anxiety, dizziness, confusion, convulsions, malaise, headache, weakness, exhaustion, vomiting	Carcinogen A2 – Eyes, skin, central nervous system, kidneys, liver, peripheral nervous system (potential occupational carcinogen) (liver, lungs, and lymphatic tumors)
Toxaphene (Chlorinated camphene)	0.5 mg/m^3 [skin]	LFC Carcinogenic [skin]		IDLH = 200 mg/m^3 Carcinogenic	Amber, waxy solid with a mild, piney, chlorine- and camphor-like odor	Inhalation, absorption, ingestion, skin and/or eye contact	Nausea, confusion, agitation, tremors, convulsions, unconsciousness; dry red skin	Carcinogen A4 – central nervous system, skin (liver cancer) (potential occupational carcinogen)
PCB [Chlorodiphenyl 42% chlorine (Aroclor 1242)	1 mg/m^3 [skin]	0.001 mg/m^3 LFC Carcinogenic		IDLH = 5 mg/m^3 Carcinogenic	Colorless to light-colored, viscous liquid with a mild hydrocarbon odor	Inhalation, absorption, ingestion, skin and/or eye contact	Irritated eyes, chloracne	Carcinogen A1 – Skin, eyes, liver, reproductive system (pituitary gland and liver tumors, leukemia)

	Exposure Limits (TWA)							
Chemical (or Class)	OSHA PEL	NIOSH REL	STEL	Other Pertinent Limits	Warning Properties	Routes of Exposure Or Irritation	Acute Health Effects	Chronic Health Effects/Target Organs
PCB [Chlorodiphenyl 54% chlorine (Aroclor 1254)	0.5 mg/m^3 [skin]	0.001 mg/m^3 LFC Carcinogenic		IDLH = 5 mg/m^3 Carcinogenic	Colorless to pale-yellow, viscous liquid with a mild hydrocarbon odor	Inhalation, absorption, ingestion, skin and/or eye contact	Irritated eyes, chloracne	Carcinogen A1 – Skin, eyes, liver, reproductive system (pituitary gland and liver tumors, leukemia)
Arsenic	0.010 mg/m^3	LFC Carcinogenic		IDLH = 5 mg/m^3 Carcinogenic CEILING (NIOSH) = 0.002 mg/m^3 (15 min.)	Silver-gray or tin-white, brittle, odorless solid as pure substance; in tailings not distinguishable	Inhalation, absorption, ingestion, skin and/or eye contact	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin	[Potential occupational carcinogen] - Liver, kidneys, skin, lungs, lymphatic system (lung and lymphatic cancer)
Cadmium	0.005 mg/m^3	LFC Carcinogenic		IDLH = 9 mg/m^3 Carcinogenic	Silver-white, blue-tinged lustrous, odorless solid as pure substance; in tailings not distinguishable	Inhalation, ingestion	Pulmonary edema, breathing difficulty, cough, chest tightness; headache, chills, muscle aches; nauseous, vomiting, diarrhea; anosmia, emphysema, proteinuria, mild anemia	Carcinogen – Respiratory system, kidneys, prostate, blood (prostatic and lung cancer)
Chromium	1 mg/m^3	0.5 mg/m^3		IDLH = 250 mg/m^3	Blue-white to steel-gray, lustrous, brittle, hard, odorless solid as pure substance; in tailings not distinguishable	Inhalation, ingestion, skin and/or eye contact	Irritated eyes and skin, lung fibrosis (histologic)	Eyes, skin, respiratory system
Lead	0.050 mg/m^3	0.050 mg/m^3		IDLH = 100 mg/m^3	Heavy, ductile, soft, gray solid as pure substance; in tailings not distinguishable	Inhalation, ingestion, skin and/or eye contact	Irritated eyes, weakness, exhaustion, insomnia, facial pallor, anorexia, weight loss, constipation, abdominal pain, colic, tremors, paralysis wrists and ankles, hypotension	Carcinogen – Eyes, gastrointestinal tract, central nervous system, blood, kidneys, gingival tissue

	Exposure Limits (TWA)							
Chemical (or Class)	OSHA PEL	NIOSH REL	STEL	Other Pertinent Limits	Warning Properties	Routes of Exposure Or Irritation	Acute Health Effects	Chronic Health Effects/Target Organs
Mercury		Vapor = 0.05 mg/m^3 [skin]		IDLH = 10 mg/m^3 CEILING (OSHA & NIOSH) = 0.1 mg/m^3 [skin]	Silver, white heavy odorless liquid as pure substance; in tailings not distinguishable	Inhalation, absorption ingestion, skin and/or eye contact	Irritated eyes, skin; cough , chest pain, breathing difficulty, bronchitis pneumonitis, tremors, insomnia, headache, irritability, indecision, weakness, exhaustion, salivation, gastrointestinal disturbances, anorexia, weight loss	Eyes, skin, respiratory system, central nervous system, kidneys
Nickel	1 mg/m^3	0.015 mg/m^3 LFC Carcinogenic		IDLH = 10 mg/m^3 Carcinogenic	Lustrous, silvery odorless solid as pure substance; in tailings not distinguishable	Inhalation, ingestion, skin and/or eye contact	Sensitization dermatitis, allergic asthma, pneumonitis	[Potential occupational carcinogen] – Nasal cavities, lungs, skin (lung and nasal cancer)
Silver	0.01 mg/m^3	0.01 mg/m^3		IDLH = 10 mg/m^3	White, lustrous solid as pure substance; in tailings not distinguishable	Inhalation, ingestion, skin and/or eye contact	Blue-gray eyes, nasal septum, throat, skin; irritation, ulceration of skin, gastrointestinal disturbance	Nasal septum, skin, eyes
Zinc (zinc oxide)	5 mg/m^3 (respirable dust and fume) 15 mg/m^3 (total dust)	5 mg/m^3 (dust and fume)	10 mg/m^3	IDLH = 500 mg/m^3 CEILING (dust; NIOSH) = 15 mg/m^3	Odorless, white to brown metallic solid as pure substance; in tailings not distinguishable	Inhalation	Metal fume fever (chills, muscle ache, nausea, fever, dry throat, cough), weakness, exhaustion, metallic taste, headache, blurred vision, vomiting, malaise, tight chest, breathing difficulty, decreased pulmonary function	Respiratory system

PEL-TWA = Permissible Exposure Limit-Time Weighted Average (8 hours).
REL-TWA = Recommended exposure limit – time weighted average.
TLV-TWA = Threshold Limit Value-Time Weighted Average (8 hours).
STEL = Short Term Exposure Limit (15 minutes).
IDLH = Immediately Dangerous to Life or Health.
LFC = Lowest feasible concentration (no-effect exposure)
CEILING = Ceiling Limit (not to be exceeded, even instantaneously).

Carcinogenicity Status (ACGIH)
A1 - Confirmed human carcinogen
A2 - Suspected human carcinogen
A3 - Animal carcinogen
A4 - Not classified as a human carcinogen

References: ACGIH Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. 93-94.
NIOSH Pocket Guide to Chemical Hazards, U.S. Dept. of Health and Human Services, 10/2003.

9.6 Action Level Table for Chemical Monitoring

No air monitoring will be conducted during field activities at this site because contaminants of concern are not volatile. Odor and visual screening of sediment will be used to determine if contaminated sediment is encountered during sample collection.

10.0 General Site Health and Safety Procedures

10.1 Site Security

Site Health and Safety Officer is responsible for monitoring entry onto active areas of the site and for knowing who is on-site at all times.

- Work site area perimeter identification method (describe equipment and procedures to be used): Sediment sampling equipment and one to three boats will be used for sample collection. Field activity will be performed in an isolated area open to the public. The boat tenders and other field personnel will be aware of visitors and keep the general public away from the sampling area.

- Work area security (on- and off-hours) used: Herrera site health and safety manager will monitor site access within the sediment processing work zone. Boat captains will monitor areas surrounding the vessels during sediment collection.

- Work will be done around heavy equipment (e.g. drill rig, backhoe, etc.): (Yes/No): Yes

  Both the vibracore equipment used to collect cores and surface sediment samplers will involve use of davits/yardarms on boats that swing across the deck. Crew members must be aware of swinging equipment during use.

- Work will be done in or adjacent to a road, street or highway: (Yes/No): No

  If yes, describe:

- Reflective vests will be worn around heavy equipment or when working in or around traffic.

- Prior to working on-site, a general inspection of hazards will be made by the Site Health and Safety Officer.

- If an onsite command post is necessary, ensure that it is located upwind from source areas, given prevailing winds, and locate/identify on Site Map (p.7).

- Onsite personnel must be able to call offsite via a telephone within 150 feet of work.

- Designate at least one vehicle for emergency use.

10.2 Work Limitations and Restrictions

- Be aware of unstable conditions associated with rocking boats.
- No eating or drinking is allowed in the area of work.
- No smoking or lighting of matches or lighters is allowed in the area of work.
- No rings, watches, bracelets, necklaces, or other jewelry that could trap chemical contamination or get caught in moving equipment.
- Buddy system at all times when working around heavy equipment.

10.3 Perimeter Identification and Personal Protection Equipment

To protect workers from potential contaminants in sample media, protective clothing will be worn during sampling activities. Protective clothing will be discarded or decontaminated between uses.

10.3.1 Level of Protection

- **Level D** - No respiratory protection. Safety glasses, hard hat, steel-toe boots, long-sleeved shirt and pants. Hearing protection, gloves, and other PPE as required.

10.3.2 Work Zone Boundaries

This job will require one or all of the following “zones” or “boundaries” to be established during work.

- **a. Exclusion Zone** - Required when workers within that zone must wear PPE (usually Level B or C)
- **b. Contamination Reduction Zone** - Required when decontamination of people and equipment leaving the Exclusion Zone is required (usually Level B or C)
- **c. Support Zone** - The location where administrative and other support activities are conducted (usually Level B or C)
- **d. Work Area Boundary** - Excludes non-workers from entering a potentially hazardous environment (usually Level B, C, or D).

10.4 Heat and Cold Stress

The Site Health and Safety Officer will monitor weather broadcasts before the start of outdoor work each day, and more frequently as necessary. No work will be done outdoors during hazardous weather conditions (e.g. lightning storms).

For Heat Stress:

- For temperatures above 75°F, each person will take their pulse at rest. At breaks, the pulse should be less than 110 beats per minute after one minute. Before returning to work, the pulse should be no more than 10 beats greater than the resting pulse.

- If the air temperature is greater than 95°F, work should be done for 30 minutes with a rest break of 10 minutes for Level ‘D’. At least 8 ounces (1 cup) of cool water, Gatorade-type drink, or dilute fruit juice should be consumed at each rest break or at least one cup every 20 minutes.

- Work should stop if any of the following symptoms occur: muscle spasm and/or pain in the limbs or abdomen (heat cramps); weak pulse, heavy sweating, dizziness, and/or fatigue (heat exhaustion); or rapid pulse, no sweating, nausea, dizziness, and/or confusion (heat stroke). Provide First Aid immediately.

- Use sunscreen on unprotected skin to protect against ultraviolet exposure as necessary.

For Cold Stress:

- For temperatures below 40°F, adequate insulating clothing must be worn. If the temperature is below 20°F, workers will be allowed to enter a heated shelter at regular intervals. Warm sweet drinks should be available. Coffee intake should be limited.

- No one should begin work or return to work from a heated shelter with wet clothes. Workers should be aware of signs of cold stress such as heavy shivering, pain in the fingers or toes, drowsiness, or irritability. Onsets of any of these signs are indications for immediate return to a heated shelter.

10.5 Noise

A noise hazard exists when working in the immediate vicinity of heavy machinery operations. In addition to the potential for hearing damage, noise may interfere with critical communication and recognition of other potential hazards at the work site, such as moving vehicles. To minimize potential injuries, field employees will utilize hearing protection devices, (ear plugs, headphones), as necessary, and maintain a high level of alertness at all times.

11.0 Decontamination

Following are the decontamination procedures that will be employed to prevent contamination of personnel and to prevent cross contamination of sampling equipment during the collection of samples.

11.1 Personnel Decontamination

Decon Solutions:	Soap and tap water
Decon Method:	Remove and dispose of Tyvek, rain suits, or coveralls; clean boots (if muddy) with water from the bay and tap water; remove and dispose gloves; wash and rinse hands and face with soap and water.
Exposure Monitoring:	None
Level of Protection:	D
Location:	Support zone (work zone c)

11.2 Sampling Equipment Decontamination

Decon Solutions:	Liquinox detergent and distilled water
Decon Method:	Bowls and spoons - Scrub with Liquinox/water solution, rinse with site water, rinse with distilled water.
Exposure Monitoring:	None
Level of Protection:	D
Location:	Support zone (work zone c) Bowls and spoons – at the site.

12.0 Waste Characteristics

12.1 Waste Generation

Waste Anticipated (Yes/No): No

Waste Type	Description	Quantity
Solid	Excess core sediment stored in drums.	< 5 drums
Liquid	Decon water disposed in bay.	
Sludge	None.	
Incidental	Disposable gloves and paper towels will be placed in a trash bag and disposed with general refuse.	10 bags
Other		

12.2 Expected Health Characteristics

Corrosive ______ Flammable/Ignitable ______ Radioactive ______
Toxic ______ Reactive ______ Unknown ______
Explosive ______ Medical/Pathogenic ______ Carcinogenic ______
Other (specify) ______

12.3 Packaging Requirements for Waste Material

Open head 55-gallon drum: Excess sediment.

Plastic trash bag: Incidental refuse.

Other:

12.4 Disposal and/or Treatment Methods Proposed

Waste	Disposal and/or Treatment
Plastic trash bags of incidental refuse.	Municipal waste dumpster.
Sediment	Permitted waste facility.

13.0 Employee Training and Medical Clearance

The following is a summary of training information for personnel who will perform work on the site. Copies of personnel training certificates are presented in Attachment 3.

1. Name Brady Hanson Title Geologist Approved PPL ______

Field Responsibilities: Site Health and Safety Officer

Training	Dates (Month/Year)
Current 8-Hour Refresher	9/08
40-Hour Hazardous Waste	8/00
Supervisor	
First Aid; CPR	10/07 (both)
Medical Clearance	
Other	

2. Name Gina Catarra Title Chemist Approved PPL ______

Field Responsibilities: Sample collection / processing

Training	Dates (Month/Year)
Current 8-Hour Refresher	1/08
40-Hour Hazardous Waste	12/02
Supervisor	
First Aid; CPR	8/07; 8/07
Medical Clearance	
Other	

3. Name Bruce Carpenter Title Sr. Hydrogeologist Approved PPL ______

Field Responsibilities: Sample collection / processing

Training	Dates (Month/Year)
Current 8-Hour Refresher	9/08
40-Hour Hazardous Waste	12/87
Supervisor	2/90
First Aid; CPR	8/07; 8/07
Medical Clearance	
Other	

4. Name George Iftner Title Geologist Approved PPL ______

Field Responsibilities: Sample collection

Training	Dates (Month/Year)
Current 8-Hour Refresher	9/08
40-Hour Hazardous Waste	4/98
Supervisor	
First Aid; CPR	2/06; 2/06
Medical Clearance	
Other	

14.0 Health and Safety Plan — Acknowledgement and Agreement Form

The following field personnel have read this health and safety plan and understand the potential and actual hazards present on the site and shall abide by its strictures.

Name	Signature	Company	Date
Name	Signature	Company	Date
Name	Signature	Company	Date
Name	Signature	Company	Date
Name	Signature	Company	Date
Name	Signature	Company	Date
Name	Signature	Company	Date
Name	Signature	Company	Date
Name	Signature	Company	Date

ATTACHMENT 1

Injury/Exposure Report and Site Incident Report

Injury/Exposure Report

(Attach additional documentation as necessary)

DATE OF INCIDENT: ______ CASE NO. ______ TIME OF DAY ______

EMPLOYEE NAME ______ DATE OF BIRTH ______

HOME ADDRESS ______ PHONE NO. ______

SEX MALE ___ FEMALE ___ AGE ___ JOB TITLE ______ SOCIAL SECURITY NO. ______

OFFICE LOCATION ______ DATE OF HIRE ______

WHERE DID INCIDENT OCCUR? (INCLUDE ADDRESS) ______

ON EMPLOYER'S PREMISES? YES ___ NO ___ PROJECT NAME/NO. ______

WHAT WAS EMPLOYEE DOING WHEN INCIDENT OCCURRED? (BE SPECIFIC) ______

HOW DID THE INCIDENT OCCUR? (DESCRIBE FULLY)

WHAT STEPS COULD BE TAKEN TO PREVENT SUCH AN INCIDENT?

OBJECT OR SUBSTANCE THAT DIRECTLY CAUSED INCIDENT? ______

DESCRIBE THE INJURY OR EXPOSURE ______ PART OF BODY AFFECTED ______

NAME AND ADDRESS OF PHYSICIAN ______

IF HOSPITALIZED, NAME AND ADDRESS OF HOSPITAL ______

LOSS OF ONE OR MORE DAYS OF WORK? YES ___ NO ___ IF YES, DATE LAST WORKED ______

HAS EMPLOYEE RETURNED TO WORK? YES ___ NO ___ IF YES, DATE RETURNED ______

DID EMPLOYEE DIE? YES ___ NO ___ IF YES, DATE ______

COMPLETED BY (PRINT) ______ EMPLOYEE SIGNATURE ______
(Supervisor or Site Health & Safety Officer

DATE ______

SIGNATURE ______ PIC SIGNATURE ______

DATE ______ DATE ______

This report must be completed by the employee's supervisor or Site Health and Safety Officer immediately upon learning of the incident. The completed report must be reviewed and signed by the Principal-in-Charge and transmitted to Corporate Health and Safety Officer within 24 hours of the incident, even if employee is not available to review and sign. Employee or employee's doctor must submit a copy of the doctor's report to Corporate Health and Safety Officer within 24 hours of the initial exam and any subsequent exams. For field injuries, submit a copy of the Health and Safety Plan.

Site Incident Report

(Attach additional documentation as necessary)

DATE OF INCIDENT: ____________ TIME OF INCIDENT: ____________

LOCATION OF INCIDENT: ____________

PROJECT NAME: ____________ PROJECT NO.: ____________

TYPE OF INCIDENT* (CHECK THOSE THAT APPLY):

____ "NEAR MISS"
____ VEHICLE ACCIDENT
____ UNDERGROUND PROPERTY DAMAGE
____ FIRE
____ ABOVE-GROUND PROPERTY DAMAGE
____ EVACUATION
____ CHEMICAL EXPOSURE
____ REGULATORY AGENCY INSPECTION OR VIOLATION
____ OTHER (DESCRIBE) ____________

*SUBMIT COPY OF HEALTH AND SAFETY PLAN AND ATTACHMENTS FOR FIELD-RELATED INCIDENTS.

DESCRIPTION OF INCIDENT: ____________

CAUSE OF INCIDENT: ____________

ACTION TAKEN: ____________

FUTURE CORRECTIVE ACTION: ____________

ESTIMATED AMOUNT OF DAMAGE: ____________

INVESTIGATOR NAME	SIGNATURE	DATE
PRINCIPAL-IN-CHARGE	SIGNATURE	DATE

cc: Health and safety manager, corporate health and safety officer, and administration within 24 hours of incident.

ATTACHMENT 2

Daily Tailgate Health and Safety Meeting Form

Daily Tailgate Safety Meeting Form

FIRST DATE OF ACTIVITY: ____________________ TIME: ____________ SITE LOCATIONS: ________________________________

1. ☐ Discussed activities planned for the day
2. ☐ Individual activities are clear to each crew member
3. ☐ Chemical hazards discussed
   a. ☐ Action levels are known and understood
   b. ☐ Frequency and procedures for air monitoring are known and understood
4. ☐ Physical hazards discussed
   a. ☐ Heat stress
   b. ☐ Cold stress
   c. ☐ Slip, trip, and fall hazards
   d. ☐ Drilling operations
   e. ☐ Overhead utilities
   f. ☐ Underground utilities
   g. ☐ Moving and emptying drums
5. ☐ Personal protective equipment (PPE) discussed
   a. ☐ Head protection (hard hat)
   b. ☐ Eye protection (safety glasses must have side shields)
   c. ☐ Hearing protection (at all times drill rig is in operation and when in close proximity to flight line
   d. ☐ Foot protection (steel toes and shanks for work boots)
   e. ☐ Splash (solvent rinse)
   f ☐ Gloves
      i. ☐ Chemical hazard (diluting standards for GC)
      ii. ☐ Environmental conditions (cold)
      iii. ☐ Protection against cross-contamination (disposal after each use)
      iv. ☐ Physical hazard (cut, puncture, and abrasion)
6. ☐ Decon procedures discussed
   a. ☐ Drilling equipment
   b. ☐ Sampling equipment
7. ☐ Emergency procedures discussed
   a. ☐ Route to hospital from site locations(s) above
   b. ☐ Evacuation procedures
   c. ☐ Cellular phone, map to hospital, first aid kit, and eyewash with onsite geologist
8. ☐ Special conditions/procedures
   a. ☐ Escort required
   b. ☐ Locked gates, permits, passes, etc.
9. ☐ Questions/concerns addressed
10. ☐ Other

Meeting attended by (sign and date for each day of work on site; **USE BACK IF ADDITIONAL SPACE IS REQUIRED**):

(Print Name)	(Signature)	(Date)

Meeting conducted by: ________________________________ (Title) ____________________________

ATTACHMENT 3

Personnel Training Certificates

Certificate of Completion

This is to certify that

Brady A. Hanson

has satisfactorily completed
8 hours of refresher training in

Hazardous Waste Operations
And Emergency Response

to comply with the training requirements of
OSHA 29 CFR 1910.120

Certificate Number 10267992

Instructor

ARGUS PACIFIC
TRAINING • CONSULTING

Sep 20, 2007
Date(s) of Training

Annual Refresher Required by: Sep 19, 2008

Argus Pacific, Inc. • 1900 W. Nickerson • Suite 315 • Seattle, Washington • 98119 • (206) 285.3373 • fax (206) 285.3927

safety-kleen.

Certificate of Training

This is to certify that

Brady Hanson

has successfully completed a course of instruction in

HAZWOPER 40 Hour Training (HS 102)

meeting the requirements of OSHA's Hazardous Waste Operations and Emergency Response Standard (HAZWOPER), 29 CFR 1910.120 (p), and related topics.

Class Completion: August 19, 2000

Instructor

August 19, 2000
Date

American Red Cross

Together, we can save a life

This recognizes that

BRADY HANSON

has completed the requirements for

CPR - ADULT

conducted by

RED CROSS OF KING-KITSAP

Date completed **10/19/2007**

The American Red Cross recognizes this certificate as valid for 1 year(s) from completion date.

American Red Cross

Together, we can save a life

This recognizes that

BRADY HANSON

has completed the requirements for

STANDARD FIRST AID

conducted by

RED CROSS OF KING-KITSAP

Date completed **10/19/2007**

The American Red Cross recognizes this certificate as valid for 3 year(s) from completion date.

Certificate of Completion

This is to certify that

Gina S. Catarra

has satisfactorily completed
8 hours of refresher training in

**Hazardous Waste Operations
And Emergency Response**

to comply with the training requirements of
OSHA 29 CFR 1910.120

Certificate Number 10270198

Instructor

ARGUS PACIFIC
TRAINING • CONSULTING

Jan 17, 2008
Date(s) of Training

Annual Refresher Required by: Jan 16, 2009

Argus Pacific, Inc. • 1900 W. Nickerson • Suite 315 • Seattle, Washington • 98119 • (206) 285.3373 • fax (206) 285.3927

Certificate of Completion

This is to certify that

Gina Catarra

has satisfactorily completed

40 hours of training in

Hazardous Waste Operations

in compliance with 29 CFR 1910.120 and WAC 296-62, Part P

THE NORTHWEST'S LEADING TRAINING ORGANIZATION

December 13, 2002

Lynda Hokkanen
Training Coordinator

Prezant

Certificate # 02-4316

Conducted at:

Prezant Associates Seattle, WA

Prezant Associates, Inc. • 330 Sixth Avenue North, Suite 200 • Seattle, Washington 98109 • (206) 281-8858

CPR Training Center, Inc. (888) 881-4277

BUSINESS FIRST AID, UNTIL HELP ARRIVES

Gina Catarra

HAS COMPLETED AN 8 HOUR FIRST AID CLASS INCLUDING ADULT 1 PERSON CPR

INSTRUCTOR L&I# 1916A11913 8-1-09

EXPIRATION DATE

GERAGHTY & MILLER, INC.
Environmental Services

This is to certify that

Bruce A. Carpenter

has completed the

8-Hour Hazardous Waste Operations and Emergency Response

Project Manager Health and Safety Training

as required by OSHA 1910.120 (e) (4)

Bellevue, WA
Location

2/13-14/90
Date

Mary G. Zell
Mary G. Zell
Regional Safety Manager

First National Bank Tower • 900 Massachusetts Street, Suite 600 • Lawrence, Kansas 66044 • (913) 841-7641

Environmental and Occupational Health Associates

This certifies that

Bruce A. Carpenter

has completed the course

Personal Protection on Hazardous Waste Sites

for 40 hours of classroom instruction.

E. A. Taylor
Elizabethe A. Taylor CIH
President

December 12, 1987
Date

Certificate of Completion

This is to certify that

Bruce Carpenter

has satisfactorily completed
8 hours of refresher training in

Hazardous Waste Operations
And Emergency Response

to comply with the training requirements of
OSHA 29 CFR 1910.120

Certificate Number 10268393

Instructor

ARGUS PACIFIC
TRAINING • CONSULTING

Oct 4, 2007
Date(s) of Training

Annual Refresher Required by: Oct 3, 2008

Argus Pacific, Inc. • 1900 W. Nickerson • Suite 315 • Seattle, Washington • 98119 • (206) 285.3373 • fax (206) 285.3927

CPR Training Center, Inc. (888) 881-4277

BUSINESS FIRST AID, UNTIL HELP ARRIVES

Bruce Carpenter

HAS COMPLETED AN 8 HOUR FIRST AID CLASS INCLUDING ADULT 1 PERSON CPR

INSTRUCTOR L&I# J7916A11913

8/23/09

EXPIRATION DATE

Certificate of Completion

This is to certify that

George C. Iftner

has satisfactorily completed
8 hours of refresher training in

**Hazardous Waste Operations
And Emergency Response**

to comply with the training requirements of
OSHA 29 CFR 1910.120

Certificate Number 10267873

Instructor

ARGUS PACIFIC
TRAINING • CONSULTING

Sep 13, 2007
Date(s) of Training
Annual Refresher Required by: Sep 12, 2008

Argus Pacific, Inc. • 1900 W. Nickerson • Suite 315 • Seattle, Washington • 98119 • (206) 285.3373 • fax (206) 285.3927

IESMC, Inc.

Industrial/Environmental Safety Management Consulting, Inc.

P.O. Box 331, Crystal Lake, IL 60039-0331
815-455-1762 Fax: 815-455-1780

Certifies that

George Iftner

has been awarded this certificate for successfully completing

40 Hour Hazardous Incident Response Operations EPA (165.5) Training in accordance with 29 CFR 1910.120 and in Cooperation with the U.S. EPA OFFICE OF EMERGENCY AND REMEDIAL RESPONSE

Conducted on April 19, 1998

Certification #: 0498HW100142

April 19, 1998 2.1 CEU
Date

James C. Meldrum, Founder, CEI

American Red Cross

Together, we can save a life

This recognizes that

GEORGE IFTNER

has completed the requirements for

STANDARD FIRST AID

conducted by

RED CROSS OF KING-KITSAP

Date completed **02/16/2006**

The American Red Cross recognizes this certificate as valid for 3 year(s) from completion date.

American Red Cross

Together, we can save a life

This recognizes that

GEORGE IFTNER

has completed the requirements for

ADULT CPR

conducted by

RED CROSS OF KING-KITSAP

Date completed **02/16/2006**

The American Red Cross recognizes this certificate as valid for 1 year(s) from completion date.

ATTACHMENT 4

Waterborne Vessel Safety Plan

WATERBORNE VESSEL SAFETY PLAN

Prepared for

Washington State Department of Ecology

April 2008

WATERBORNE VESSEL SAFETY PLAN

Prepared for

Washington State Department of Ecology
300 Desmond Drive SE
Lacey, Washington 98503

Prepared by

Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
Telephone: 206/441-9080

April 10, 2008

Contents

A. Introduction

This plan applies to, but is not limited to, field work requiring use of waterborne watercraft, including rafts, canoes, skiffs, or commercial vessels either owned by or subcontracted by Herrera Environmental Consultants Inc. (Herrera). Herrera expects that all employees, for company-approved fieldwork or personal use, will follow safety procedures and regulations set forth in this safety plan.

B. Safety Policy

Herrera's Safety Policy is that health and safety of the staff is of paramount importance. Activities performed under potentially hazardous conditions shall be acknowledged and planned to mitigate personal injury. Herrera's Safety Policy shall apply during approved fieldwork, as well as during pre-approved periods of personal activities when using Herrera-owned watercraft.

C. Person-In-Charge

Fieldwork will be organized and supervised by a Project Manager (PM) or designate. It is the responsibility of the person-in-charge to take all reasonable steps to ensure that:

a. Each participant be informed of the known risks and physical requirements

b. Each participant be shown where the personal floatation devices (PFDs) are stowed

c. Each participant has read this Plan

d. The academic portion of the work is conducted safely

e. It has been determined what safety equipment and clothing is appropriate

f. All company and personal equipment taken into the field is thoroughly checked for safety by a qualified person before it is used

g. Each field trip participant is instructed in safety, the wearing of safety clothing, (e.g., hard hats, safety boots, goggles, etc.), and the safe use of equipment.

D. Checklist

In a generic document such as this, it is impractical to anticipate all situations. The following lists some major items; other items will be dictated by the knowledge or experience of the person-in-charge. Refer to Appendix A for checklist templates.

i. Equipment

All equipment taken for fieldwork must be checked by a qualified person before removal from the office, to ensure that it is in good condition, complete, and safe.

One PFD of proper size that is United States Coast Guard (U.S.C.G.) approved must be kept in an accessible location on board for each person that is present. If the vessel is longer than 16 feet, one additional throwable PFD must be immediately available for use. In a small boat such as a raft, canoe, or kayak, PFDs must be worn at all times.

An electric visual distress signal (VDS), such as a flashlight, must be present if the vessel is 16 feet or longer. A daytime VDS, such as an orange flag 3’ by 3’ with a black square above a black dot, must be present if the vessel is 16 feet or longer.

A U.S. Coast Guard-certified fire extinguisher must be present if there is a fire hazard due to the motor or fuel system of the vessel. It must be portable and have a specific marine-type mounting bracket. Look for “Marine Type USCG” on the label.

If equipment fails during fieldwork, its use must be discontinued and the failure reported to the person-in-charge immediately. This equipment must not be used until satisfactory repairs have been completed.

The responsibility for ensuring equipment is safe is vested in the person-in-charge.

The Boater’s Pre-Departure Checklist (Appendix A) must be completed prior to vessel departure (copy to be incorporated into project file). Additional equipment requirements are provided in Appendix B.

ii. Remote or Hazardous Areas

In the case of fieldwork to be performed in remote or hazardous areas, the person-in-charge should consider:

a. Having at least one participant trained in first aid

b. Having at least one participant trained in CPR

c. Providing a communication link to a central station (at a minimum, whistles provided for each participant)

d. Providing large scale maps of the area providing routes of egress

e. Conducting area-familiarization trips before work has started

f. Having a procedure for contacting local police who will organize a search for missing people

g. Leaving a float plan at the base camp, plus an overall plan with the departmental office lead at Herrera

h. For underwater research, evidence that diver(s) hold current and valid license (refer to Herrera's Manual for Safe Diving)

i. For those who must be equipped with firearms, ensure that they are trained and hold a proficiency certificate

j. Safety and survival tips are provided in Appendix B.

iii. Float Plan

Before leaving for work in the field, a member of the field crew must fill out a Float Plan (Appendix A) describing when and where the event will take place, what vessels will be taken, and who will be present on the field event. A Float Plan should be filled out for work performed on company-owned and rented boats, as well as when services are subcontracted. The Float Plan should be left with their respective department lead in case of an emergency.

E. Performance Impairing Substances

The use of substances that can impair performance or judgment and the consumption of alcohol during the working periods of field trips is not approved by the company, under any circumstances.

APPENDIX A

Templates for Float Plan, Pre-Departure, and Standard Checklists

Oakland Bay Sediment Characterization
06-03386-007
Float Plan

Do not file this plan with the Coast Guard. Contact the Herrera office in case of delayed return.

1. Person In Charge

Name ____________ Phone ____________

2. Description of Boat

Name ____________

Registration/ Documentation No. ____________ Lengt h ________

Make ____________ Type ____________

Hull Color ____________ Trim Color ____________

Fuel Capacity ________ Engin e Type ________ No. of Engines ________

Distinguishing Features ____________

3. Operator of Boat

Name ____________ Phone ____________

4. Survival Equipment (check as appropriate)

- ☐ # _____ PFDs
- ☐ Flares
- ☐ Mirror
- ☐ Smoke Signals
- ☐ Flashlight
- ☐ Food
- ☐ Paddles
- ☐ Water
- ☐ Anchor
- ☐ Raft or Dinghy
- ☐ EPIRB
- ☐ Others

5. Marine Radio:

☐ Yes ☐ No

Type ____________ Freqs. ____________

Digital Selective Calling (DSC) ☐ Yes ☐ No

6. Trip Expectations

Depart From ____________

Departure Date ____________ Time ________

Going To ____________

Arrival Date ____________ Time ________

If operator has not arrived/returned by:

Date ____________ Time ________

Call the Coast Guard or local authority at the following number: ____________

7. Vehicle Description

License No. ____________ Make ________

Model ____________ Color ________

Where is Vehicle Parked? ____________

8. Persons on Board

Name:

9. Additional Information

General Vessel Safety Checklist

Each Trip:

- Make sure all exhaust clamps are in place and secure.
- Look for exhaust leaking from the exhaust system components evidenced by rust and/or black streaking, water leaks, or corroded or cracked fittings.
- Inspect rubber exhaust hoses for burned or cracked sections. All rubber hoses should be pliable and free of kinks.
- Confirm that cooling water flows from the exhaust outlet when the engines and generator are started.
- Test the operation of each carbon monoxide detector by pressing the test button.

Do not operate the vessel if any of these problems exist!

At Least Annually:

- Replace exhaust hoses if any evidence of cracking, charring, or deterioration is found.
- Inspect each water pump impeller and inspect the condition of the water pump housing. Replace if worn or cracked (refer to the engine and generator manuals for further information).
- Inspect each of the metallic exhaust components for cracking, rusting, leaking, or looseness. Pay particular attention to the cylinder head, exhaust manifold, and water injection elbow.
- Clean, inspect, and confirm the proper operation of the generator cooling water anti-siphon valve (if equipped).

Regular maintenance and proper operation of the boat are the best defenses against injury from carbon monoxide. To find out more information about how you can prevent carbon monoxide poisoning on recreational boats, contact:

U.S. Coast Guard Infoline
1-800-368-5647
<www.uscgboating.org>

National Marine Manufacturer's Association
312-946-6200
<www.nmma-medialink.com>

Boater's Pre-Departure Checklist

Know your vessel. Before departure, always be sure your vessel is in good working condition and properly equipped for emergencies. Avoid inconvenience and potential danger by taking a few minutes to check the following:

Minimum Federal Required Equipment	**Yes**	**No**
State Registration Documentation		
State Numbering Displayed		
Certificate of Documentation		
Lifejackets (PFDs) – one for each person		
Throwable PFD		
Visual Distress Signals		
Fire Extinguishers (fully charged)		
Proper Ventilation		
Backfire Flame Arrestor		
Sound Producing Device(s)		
Navigation Lights		
Oil Pollution Placard		
Garbage Placard		
Marine Sanitation Device		
Navigation Rules		
Any Additional State Requirements		

Besides meeting the federal requirements, prudent boaters carry additional safety equipment. The following additional items are suggested depending on the size, location, and use of your boat:

Recommended Equipment	**Yes**	**No**	**N/A**
VHF Marine Radio			
Anchor and Tackle			
Chart(s) of Area and Navigation Tools			
Magnetic Compass			
Fenders and Boat Hook			
Mooring Lines and Heaving Line			
Manual Bilge Pump or Bailing Device			
Took Kit			
Spare Parts (fuses, spark plugs, belts, etc.)			
Spare Battery (fully charged)			

Recommended Equipment (continued)	**Yes**	**No**	**N/A**
Spare Propeller			
Extra Fuel and Oil			
Alternate Propulsion (paddles/oar)			
Flashlight and Batteries			
Search Light			
First Aid Kit			
Sunscreen (SPF 30+)			
Mirror			
Food and Water			
Extra Clothing			
AM/FM Radio			
Cellular Phone			
Binoculars			

Safety Checks and Tests	**Yes**	**No**	**N/A**
Test Marine Radio (voice call)			
Test Navigation and Anchor Lights			
Test Steering (free movement)			
Test Tilt/Trim			
Test Bilge Pump			
Check for Any Excessive Water in Bilges			
Check Fuel System for Any Leaks			
Check Engine Fluids			
Ensure Boat Plug is Properly Installed			
Check Electrical System			
Check Galley/Heating Systems			
Check Gauges (i.e., batteries)			
Check Fuel Amount			
Ensure Anchor is Ready for Use			
Check Load of Vessel and Secure Gear from Shifting			
Ensure Passengers Know Emergency Procedures and Equipment Location			
Everyone Put on a Lifejacket to Check for Proper Fitting			
Check the Weather Forecast			
File a Float Plan at Herrera Office			

APPENDIX B

U.S. Coast Guard Equipment Requirements, Navigation Rules, and Safety/Survival Tips

U.S. Coast Guard Equipment Requirements: April 19, 2004

- Search:

- **Safety**
  - **Federal Requirements**
  - MetLife Safety Tips
  - Consumer Advisories
  - Boating Safety Courses
  - U.S. Aids to Navigation
  - Boating Under the Influence
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Federal Requirements and Safety Tips for Recreational Boats

Personal Flotation Devices (PFD)

All recreational boats must carry one wearable PFD (Type I, II, III or Type V PFD) for each person aboard. A Type V PFD provides performance of either a Type I, II, or III PFD (as marked on its label) and must be used according to the label requirements. Any boat 16ft and longer (except canoes and kayaks) must also carry one throwable PFD (Type IV PFD).

PFDs must be

- *Coast Guard approved,*
- *in good and serviceable condition, and*
- *the appropriate size for the intended user.*

Accessibility

- Wearable PFDs must be readily accessible.
- You must be able to put them on in a reasonable amount of time in an emergency (vessel sinking, on fire, etc.).
- They should not be stowed in plastic bags, in locked or closed compartments or have other gear stowed on top of them.
- The best PFD is the one you will wear.
- Though not required, a PFD should be worn at all times when the vessel is underway. A wearable PFD can save your life, but only if you wear it.
- Throwable devices must be immediately available for use.

Inflatable PFDs

- Inflatable PFDs may be more comfortable to wear.
- The best PFD is the one you will wear.
- Inflatable PFDs require the user to pay careful attention to the condition of the device.
- Inflatable PFDs must have a full cylinder and all status indicators on the inflator must be green, or the device is NOT serviceable, and does NOT satisfy the requirement to carry PFDs.
- Coast Guard Approved Inflatable PFD's are authorized for use on recreational boats by person at least 16 years of

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age.

Child PFD Requirements
Some states require that children wear PFDs

- applies to children of specific ages
- applies to certain sizes of boats
- applies to specific boating operations

Check with your state boating safety officials.

Child PFD approvals are based on the child's weight. Check the "User Weight" on the label, or the approval statement that will read something like "Approved for use on recreational boats and uninspected commercial vessels not carrying passengers for hire, by persons weighing __ lbs". They can be marked "less than 30", "30 to 50", "less than 50", or "50 to 90".

PFD requirements for certain boating activities under state laws
The Coast Guard recommends and many states require wearing PFDs:

- For water skiing and other towed activities (use a PFD marked for water skiing).
- While operating personal watercraft (PWC) (use a PFD marked for water skiing or PWC use).
- During white water boating activities.
- While sailboarding (under Federal law, sailboards are not "boats").

Check with your state boating safety officials.

Federal law does not require PFDs on racing shells, rowing sculls, racing canoes, and racing kayaks; state laws vary. Check with your state boating safety officials.

If you are boating in an area under the jurisdiction of the Army Corps of Engineers, or a federal, state, or local park authority, other rules may apply.

PFD Flotation

There are three basic kinds of PFD flotation in the five types of PFDs with the following characteristics:

Inherently Buoyant (primarily Foam)

- The most reliable
- Adult, Youth, Child, and Infant sizes
- For swimmers & non-swimmers
- Wearable & throwable styles

- Some designed for water sports

Minimum Buoyancy		
Wearable Size	**Type**	**Inherent Buoyancy (Foam)**
Adult	I II & III V	22 lb. 15.5 lb. 15.5 to 22 lb.
Youth	II & III V	11 lb. 11 to 15.5 lb.
Child and Infant	II	7 lb.
Throwable: Cushion Ring Buoy	IV	20 lb. 16.5 & 32 lb.

Inflatable

- The most compact
- Sizes only for adults
- Only recommended for swimmers
- Wearable styles only
- Some with the best in-water performance

Minimum Buoyancy		
Wearable Size	**Type**	**Inherent Buoyancy**
Adult	I & II III V	34 lb. 22.5 lb. 22.5 to 34 lb.

Hybrid (Foam & Inflation)

- Reliable
- Adult, Youth, and Child sizes
- For swimmers & non-swimmers
- Wearable styles only
- Some designed for water sports

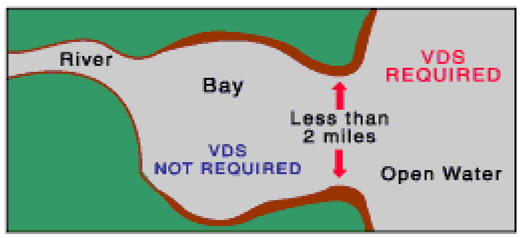
Minimum Buoyancy			
Wearable Size	**Type**	**Inherent Buoyancy**	**Inflated Total Buoyancy**
Adult	II & III V	10 lb 7.5 lb.	22 lb. 22 lb.
Youth	II & III V	9 lb 7.5 lb.	15 lb. 15 lb.
Child	II	7 lb.	12 lb.

Types of PFD's >

Federal Requirements and Safety Tips for Recreational Boats

Visual Distress Signals

All vessels used on coastal waters, the Great Lakes, territorial seas, and those waters connected directly to them, up to a point where a body of water is less than two miles wide, must be equipped with U.S.C.G. Approved visual distress signals. Vessels owned in the United States operating on the high seas must be equiped with U.S.C.G. Approved visual distress signals.



These vessels are not required to carry day signals but must carry night signals when operating from sunset to sunrise:

- Recreational boats less than 16 feet in length
- Boats participating in organized events such as races, regattas, or marine parades.
- Open sailboats less than 26 feet in length not equipped with propulsion machinery.
- Manually propelled boats.

Pyrotechnic Devices
Pyrotechnic Visual Distress Signals must be Coast Guard Approved, in serviceable condition, and readily accessible.

- They are marked with an expiration date. Expired signals may be carried as extra equipment, but can not be counted toward meeting the visual distress signal requirement, since they may be unreliable.
- Launchers manufactured before January 1, 1981, intended for use with approved signals, are not required to be Coast Guard Approved.
- If pyrotechnic devices are selected a minimum of three are required. That is, three signals for day use and three signals for night. Some pyrotechnic signals meet both day and night use requirements.

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- Pyrotechnic devices should be stored in a cool, dry location, if possible.
- A watertight container painted red or orange and prominently marked "DISTRESS SIGNALS" or "FLARES" is recommended.

U.S.C.G. Approved Pyrotechnic Visual Distress Signals and associated devices include:

- Pyrotechnic red flares, hand-held or aerial.
- Pyrotechnic orange smoke, hand-held or floating.
- Launchers for aerial red meteors or parachute flares.

[EACH OF THESE DEVICES HAS A DIFFERENT OPERATING (BURNING) TIME. CHECK THE LABEL TO SEE HOW LONG EACH PYROTECHNIC DEVICE WILL ACTUALLY BE ILLUMINATED. THIS WILL ALLOW YOU TO SELECT A WARNING DEVICE BETTER SUITED TO THE CONDITIONS WHERE YOUR BOAT WILL OPERATE?]

Non-Pyrotechnic Devices
Non-Pyrotechnic Visual Distress Signals must be in serviceable condition, readily accessible, and certified by the manufacturer as complying with U.S.C.G. requirements. They include:

Orange distress flag

- Day signal only.
- Must be at least 3 x 3 feet with a black square and ball on an orange background.
- Must be marked with an indication that it meets Coast Guard requirements in 46 CFR 160.072.
- Most distinctive when attached and waved on a paddle, boathook, or flown from a mast.
- May also be incorporated as part of devices designed to attract attention in an emergency, such as balloons, kites, or floating streamers.

Electric distress light

- Accepted for night use only
- Automatically flashes the international SOS distress signal:
  (... — — — ...)
- Must be marked with an indication that it meets Coast Guard requirements in 46 CFR 161.013.

Under Inland Navigation Rules, a high intensity white light flashing at regular intervals from 50-70 times per minute is considered a distress signal. Such devices do NOT count toward meeting the visual distress signal requirement, however.

Regulations prohibit display of visual distress signals on the water under any circumstances except when assistance is required to prevent immediate or potential danger to persons on board a vessel.

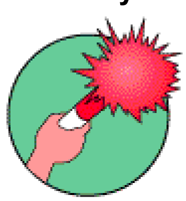
All distress signals have distinct advantages and disadvantages. No single device is ideal under all conditions or suitable for all purposes. Pyrotechnics are universally recognized as excellent distress signals. However, there is potential for injury and property damage if not properly handled. These devices produce a very hot flame and the residue can cause burns and ignite flammable materials.

Pistol launched and hand-held parachute flares and meteors have many characteristics of a firearm and must be handled with caution. In some states they are considered a firearm and prohibited from use.

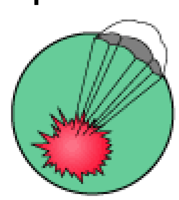
The following are just a few of the variety and combination of devices which can be carried in order to meet the requirements:

- Three hand-held red flares (day and night).
- One hand-held red flare and two parachute flares (day and night).
- One hand-held orange smoke signal, two floating orange smoke signals (day) and one electric distress light (night only).

Pyrotechnic Device Examples



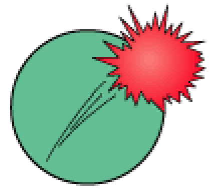
Red Flare
(hand held/day and night)



Parachute Flare
(day and night)

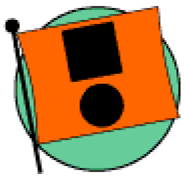
Orange Smoke Signal
(hand held/day only)

Floating Orange Smoke Signal
(day only)

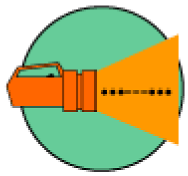


Red Meteor
(day and night)

Non-Pyrotechnic Device Examples



Orange Flag
(day only)



Electric Distress Signals
(night only)

All boaters should be able to signal for help. Boaters must have current dated U.S.C.G. Approved day and night signals for all boats operating on coastal and open bodies of water.

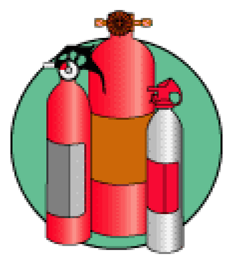
Fire Extinguishers >

Customer Accessibility • Webmaster (Technical Website Issues) • Disclaimer, Privacy & Internet Link Policies

Federal Requirements and Safety Tips for Recreational Boats

Fire Extinguishers

Coast Guard Approved fire extinguishers are required on boats where a fire hazard could be expected from the motors or the fuel system. Extinguishers are classified by a letter and number symbol. The letter indicates the type fire the unit is designed to extinguish (Type B for example are designed to extinguish flammable liquids such as gasoline, oil and grease fires). The number indicates the relative size of the extinguisher. The higher the number, the larger the extinguisher.



Coast Guard approved extinguishers required for boats are hand portable, either B-I or B-II classification and have a specific marine type mounting bracket. It is recommended the extinguishers be mounted in a readily accessible position, away from the areas where a fire could likely start such as the galley or the engine compartment.

Extinguisher markings can be confusing because extinguishers can be approved for several different types of hazards. For instance, an extinguisher marked "Type A, Size II, Type B:C, Size I" is a B-I extinguisher.
Look for the part of the label that says **"Marine Type USCG"**

- Make sure Type B is indicated
- Portable extinguishers will be either size I or II. Size III and larger are too big for use on most recreational boats.

Classes	Foam (Gals)	C02 (lbs)	Dry Chemical (lbs)	Halon (lbs)
B-I(TypeB, SizeI)	1.25	4	2	2.5
B-I(TypeB, Size II)	2.5	15	10	10

Fire Extinguishers are required on boats when any of the following conditions exist:

- Inboard engines are installed.
- There are closed compartments and compartments under

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seats where portable fuel tanks may be stored.
- There are double bottoms not sealed to the hull or which are not completely filled with flotation materials.
- There are closed living spaces.
- There are closed stowage compartments in which combustible or flammable materials are stored.
- There are permanently installed fuel tanks. (Fuel tanks secured so they cannot be moved in case of fire or other emergency are considered permanently installed. There are no gallon capacity limits to determine if a fuel tank is portable. If the weight of a fuel tank is such that persons on board cannot move it, the Coast Guard considers it permanently installed.)

Fire Extinguisher Maintenance
Inspect extinguishers monthly to make sure that:

- Seals and tamper indicators are not broken or missing.
- Pressure gauges or indicators read in the operable range. (Note: CO_2 extinguishers do not have gauges.)
- There is no obvious physical damage, rust, corrosion, leakage or clogged nozzles.
- Weigh extinguishers annually to assure that the minimum weight is as stated on the extinguisher label.

Fire extinguishers that do not satisfy the above requirements or that have been partially emptied must be replaced or taken to a qualified fire extinguisher servicing company for recharge.

Required Number of Fire Extinguishers
The number of fire extinguishers required on a recreational boat are based on the overall length of the boat. The following chart lists the number of extinguishers that are required. In the case where a Coast Guard approved fire extinguishing system is installed for the protection of the engine compartment, the required number of units may be reduced in accordance with the chart.

Minimum number of hand portable fire extinguishers required		
Vessel Length	**No Fixed System**	**With approved Fixed Systems**
Less than 26'	1 B-1	0
26' to less than 40'	2 B-1 or 1 B-II	1 B-I
40' to 65'	3 B-I or 1 B-II and 1 B-1	2 B-1 or 1 B-II

The pressure gauge alone is not an accurate indicator that Halon extinguishers are full. The weight of the units should be checked regularly. It is recommended that portable extinguishers be mounted in a readily accessible position.

Ventilation >

Search:

Safety
- **Federal Requirements**
- MetLife Safety Tips
- Consumer Advisories
- Boating Safety Courses
- U.S. Aids to Navigation
- Boating Under the Influence
- GMDSS Communications

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Federal Requirements and Safety Tips for Recreational Boats

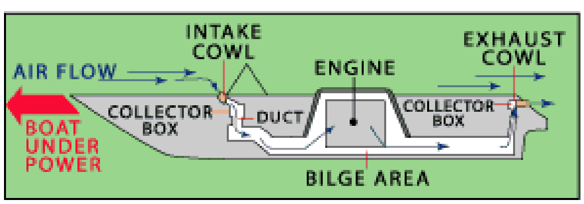
Ventilation

All boats which use gasoline for electrical generation, mechanical power or propulsion are required to be equipped with a ventilation system. A natural ventilation system is required for each compartment in a boat that:

1. contains a permanently installed gasoline engine;
2. has openings between it and a compartment that requires ventilation;
3. contains a permanently installed fuel tank and an electrical component that is not ignition-protected;
4. contains a fuel tank that vents into that compartment (including a portable tank); and
5. contains a non-metallic fuel tank.

A natural ventilation system consists of:

- A supply opening (duct/cowl) from the atmosphere (located on the exterior surface of the boat) or from a ventilated compartment or from a compartment that is open to the atmosphere;
- and an exhaust opening into another ventilated compartment or an exhaust duct to the atmosphere.



All blower motors installed in exhaust ducts must be in working condition of date of manufacture.

Each exhaust opening or exhaust duct must originate in the lower one-third of the compartment. Each supply opening or supply duct and each exhaust opening or duct in a compartment must be above the normal accumulation of bilge water.

A powered ventilation system is required for each compartment in a boat that has a permanently installed gasoline engine with a cranking motor for remote starting.

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A powered ventilation system consists of one or more exhaust blowers. Each intake duct for an exhaust blower must be in the lower one-third of the compartment and above the normal accumulation of bilge water.

For boats built prior to 1980, there was no requirement for a powered ventilation system; however, some boats were equipped with a blower.

The Coast Guard Ventilation Standard, a manufacturer requirement, applies to all boats built on or after August 1, 1980. Some builders began manufacturing boats in compliance with the Ventilation Standard as early as August 1978. If your boat was built on or after August 1, 1978 it might have been equipped with either (1) a natural ventilation system, or (2) both a natural ventilation system and a powered ventilation system. If your boat bears a label containing the words "This boat complies with U.S. Coast Guard safety standards," etc., you can assume that the design of your boat's ventilation system meets applicable regulations.

Manufacturers of boats built after 1980 with remote starters are required to display a label which contains the following information:

Warning:
Gasoline vapors can explode. Before starting engine, operate blower at least 4 minutes and check engine compartment bilge for gasoline vapors.

All owners are responsible for keeping their boat's ventilation systems in operating condition. This means making sure openings are free of obstructions, ducts are not blocked or torn, blowers operate properly, and worn components are replaced with equivalent marine type equipment.

Backfire Flame Arrestor (BFA) >

Search:

Safety
- **Federal Requirements**
- MetLife Safety Tips
- Consumer Advisories
- Boating Safety Courses
- U.S. Aids to Navigation
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Federal Requirements and Safety Tips for Recreational Boats

Backfire Flame Arrestor (BFA)

Gasoline engines installed in a vessel after April 25, 1940, except outboard motors, must be equipped with an acceptable means of backfire flame control. The device must be suitably attached to the air intake with a flame tight connection and is required to be Coast Guard approved or comply with SAE J-1928 or UL 1111 standards and marked accordingly.

Sound Producing Devices >

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Search:

Safety
- Federal Requirements
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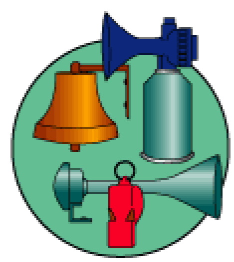
Federal Requirements and Safety Tips for Recreational Boats

Sound Producing Devices

The navigation rules require sound signals to be made under certain circumstances. Meeting, crossing and overtaking situations described in the Navigation Rules section are examples of when sound signals are required. Recreational vessels are also required to sound signals during periods of reduced visibility.

When operating on Inland Waters of the United States, vessels 39.4 feet/12 meters or more in length are required to carry on board a whistle or horn, and a bell.

Note: The requirement to carry a bell on board no longer applies to vessels operating on International Waters.



Signalling Devices

Any vessel less than 39.4 feet/12 meters in length may carry a whistle or horn, or some other means to make an efficient sound signal to signal your intentions and to signal your position in periods of reduced visibility.

Therefore, any vessel less than 39.4 feet/12 meters in length is required to make an efficient sound signal to signal your intentions and to signal your position in periods of reduced visibility.

Navigation Rules >

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Federal Requirements and Safety Tips for Recreational Boats

Navigation Rules

Require vessels to display lights and shapes under certain conditions.

Navigation Lights

Recreational vessels are required to display navigation lights between sunset and sunrise and other periods of reduced visibility (fog, rain, haze, etc.). The U.S. Coast Guard Navigation Rules, International-Inland, specifies lighting requirements for every description of water craft. The information provided is for power-driven and sailing vessels less than 65.5 feet/20 meters in length.

Power-driven Vessels

(Sail Vessel under machinery power is considered a power-driven vessel).

If your power-driven vessel is less than 65.5 feet/20 meters in length, then it must display navigation lights per Figure 1.

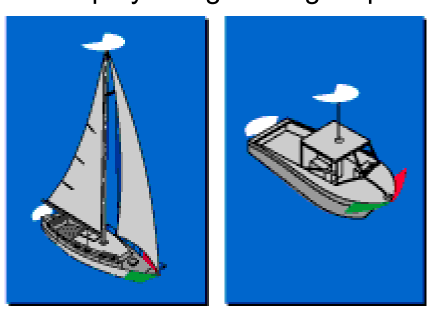

Figure 1

If your power-driven vessel is less than 39.4 feet/12 meters in length, then it may display navigation lights per Figure 2.

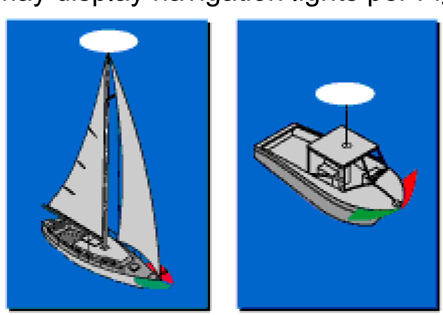

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Figure 2

If your power-driven vessel is less than 23 feet/7 meters in length and its maximum speed cannot exceed 7 knots, then it may display an all-round white light, and if practicable, sidelights instead of the lights prescribed previously. (For International Rules only)

For power-driven vessels less than 39.4 feet/12 meters in length, the masthead or all-round white light must be at least 1 meter above the sidelights.

Sidelights may be a combination light, instead of two separate lights as shown in figures 2 and 5.

Sailing Vessels
If your sailing vessel is less than 65.6 feet/20 meters in length, then it must display navigation lights as shown in Figures 3, 4, or 5.

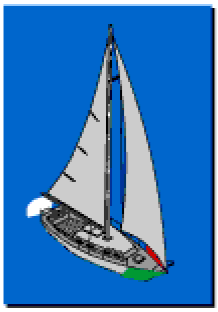

Figure 3

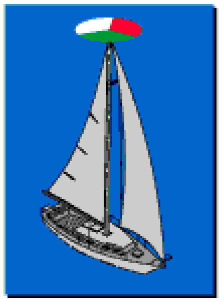

Figure 4

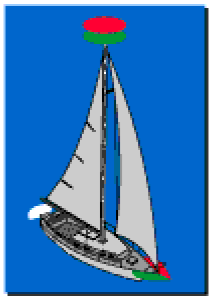

Figure 5

If your vessel is less than 23 feet/7 meters in length, then it should display lights for a sailboat (Figures 3,4,or 5, if practicle). As an option, your vessel may carry an electric torch (flashlight) or lightened lantern that can show a white light in sufficient time to prevent collision. (see Figure 6)

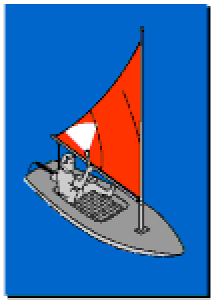

Figure 6

Vessel Under Oars
If your vessel is under oars, then it should display lights for a sailboat (Figures 3 or 4), if

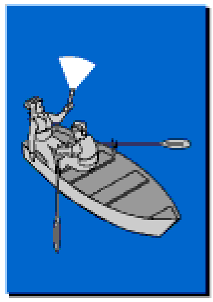
Figure 7

practicle. As an option, your vessel your vessel may carry a flashlight or lighted lantern that can show a white light in sufficient time to prevent collision. (see Figure 7)

Lights and Shapes
To alert other vessels of conditions, which may be hazardous, there are requirements to display lights at night and shapes during the day.

Anchored Vessels
AT NIGHT: All vessels at anchor must display anchor lights. If your vessel is less than 164 feet/50 meters in length, then its anchor light is an all-round white light visible where it can best be seen from all directions. (Figure 8)

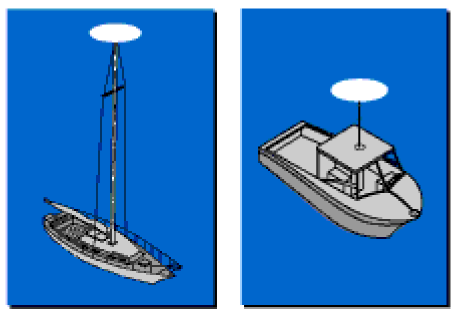
Figure 8

DURING THE DAY: All vessels at anchor must display, forward where it can be best seen, a black ball shape. (See Figure 9)

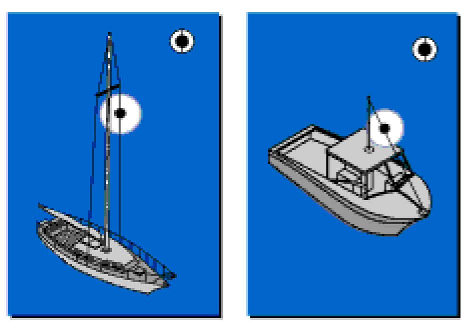
Figure 9

EXCEPTIONS: If your vessel is less than 23 feet/7 meters in length, then it is not required to display an anchor light or shape unless it is anchored in or near a narrow channel, fairway or anchorage, or where other vessels normally navigate.

If your vessel is less than 65.6 feet/20 meters in length, then it is not required to display an anchor light if it is anchored in Inland Waters in a special anchorage designated by the Secretary of

Transportation.

Sailing Vessels Under Power (Machinery)
During the day, vessels under sail also being propelled by machinery, must exhibit forward, where best seen, a black conical shape with the apex pointing down. (Figure 10)

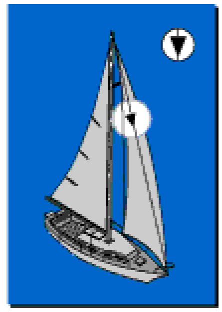

Figure 10

EXCEPTION: If your vessel is less than 39.4 feet/12 meters in length, then it is not required to display the shape in Inland Waters.

REMINDER: If you are operating your sail vessel at night using machinery or sail and machinery, then your vessel must display lights required for a power-driven vessel. (See figures 1 or 2)

Restricted Maneuverability
The Navigation Rules require vessels restricted in their ability to maneuver to display appropriate day shapes or lights. To meet this requirement, if your vessel is engaged in diving activities during the day, then it must exhibit a rigid replica of the international code flag "Alpha" not less than 3.3 feet/ 1 meter in height. If the diving activities are at night, then your vessel must display the navigation lights shown in Figure 11. This requirement does not affect the use of a red and white divers flag, which may be required by State or local law to mark a diver's location. The "A" flag is a navigation signal indicating your vessel's restricted maneuverability and does not pertain to the diver.

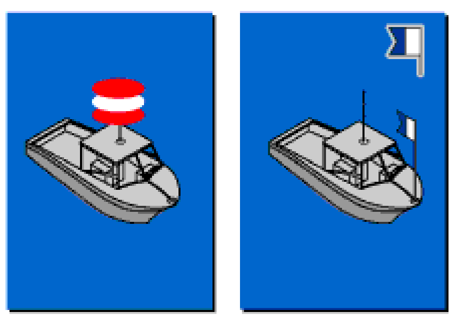

Figure 11

Radio Regulations >

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Federal Requirements and Safety Tips for Recreational Boats

Radio Regulations

Carrying a Radio
Most recreational vessels under 65.6ft/20m in length do not have to carry a marine radio. Any vessel that carries a marine radio must follow the rules of the Federal Communications Commission (FCC).

Radio Licenses
The FCC does not require operators of recreational vessels to carry a radio or to have an individual license to operate VHF marine radios (with or without digital selective calling capability), EPIRBs, or any type of radar. Operators must however follow the procedures and courtesies that are required of licensed operators specified in FCC Rules. You may use the name or registration number of your vessel to identify your ship station.

Users of VHF marine radio equipped with digital selective calling will need to obtain a maritime mobile service identity (MMSI) number from the FCC. It is unlawful to use digital selective calling without obtaining this identity.

Vessels required to be licensed:

1. Vessels that use MF/HF single side-band radio, satellite communications, or telegraphy,
2. Power Driven vessels over 65.6 feet/20 meters in length.
3. Vessels used for commercial purposes including:
   - Vessels documented for commercial use, including commercial fishing vessels.
   - CG inspected vessels carrying more than 6 passengers.
   - Towboats more than 25.7 feet/7.8 meters in length.
   - Vessels of more than 100 tons certified to carry at least 1 passenger.
   - Cargo ships over 300 tons.
4. Any vessel, including a recreational vessel, on an international voyage.

Radio Listening Watch
Vessels not required to carry a radio (e.g. recreational vessels less than 65.6 feet/20 meters in length), but which voluntarily

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carry a radio, must maintain a watch on channel 16 (156.800 MHz) whenever the radio is operating and not being used to communicate. Such vessels may alternatively maintain a watch on VHF channel 9 (156.450 MHz), the boater calling channel.

Distress Call Procedures

1. Make sure radio is on
2. Select Channel 16
3. Press/Hold the transmit button
4. Clearly say: MAYDAY MAYDAY MAYDAY
5. Also give:

- Vessel Name and/or Description
- Position and/or Location
- Nature of Emergency
- Number of People on Board

6. Release transmit button
7. Wait for 10 seconds – If no response Repeat "MAYDAY" Call.

False Distress Alerts
It is unlawful to intentionally transmit a false distress alert, or to unintentionally transmit a false distress alert without taking steps to cancel that alert.

For further information:

FCC —	Toll free telephone: 1-888 CALL FCC World Wide Web: http://www.fcc.gov/wtb/
USCG —	World Wide Web: http://www.navcen.uscg.gov/marcomms/

For a complete listing of VHF Channels and Frequencies visit the USCG Navigation Center web site: www.navcen.uscg.gov

VHF Marine Radio Channels
The chart below contains a partial listing of channels recreational boaters should be familiar with:

Channel	Type of Message and Use
06	**Intership Safety:** Used for ship-to-ship safety messages and search messages and ships and aircraft of the Coast Guard.
09	**Boater Calling:** FCC has established this channel as a supplementary calling channel for recreational boaters in order to relieve congestion on VHF Channel 16.
13, 67	**Navigation Safety (Also known as the Bridge-to-Bridge channel):** Ships greater than 20 meters in length maintain a listening watch on this channel in US waters. This

	channel is available to all ships. Messages must be about ship navigation (i.e. passing or meeting other ships). You must keep your messages short. Your power output must not be more than one watt. This is also the main working channel at most locks and drawbridges. Channel 67 is for lower Mississippi River only.
16	**International Distress, Safety and Calling:** Use this channel to get the attention of another station (calling) or in emergencies. Ships required to carry a radio maintain a listening watch on this channel. USCG and most coast stations also maintain a listening watch on this channel.
21A, 23A, 83A	**U.S. Coast Guard only**
22A	**Coast Guard Liaison and Maritime Safety Information Broadcasts:** Announcements of urgent marine information broadcasts and storm warnings on Channel 16.
24, 25, 26, 27, 28, 84, 85, 85, 87	**Public Correspondence (Marine Operator):** Use these channels to call the marine operator at a public station. By contacting a public coast station, you can make and receive calls from telephones on shore. Except for dis-tress calls, public stations usually charge for this service.
70	**Digital Selective Calling:** Use this channel for distress and safety calling and for general purpose calling using only digital selective calling (DSC) techniques. **Note: The U.S. Coast Guard will not be equipped to respond to DSC distress calls on Channel 70 until 2006—use Channel 16.**

Pollution Regulations >

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Federal Requirements and Safety Tips for Recreational Boats

Pollution Regulations

The Refuse Act of 1899 prohibits throwing, discharging or depositing any refuse matter of any kind (including trash, garbage, oil, and other liquid pollutants into the waters of the United States.

The Federal Water Pollution Control Act prohibits the discharge of oil or hazardous substances which may be harmful into U.S. navigable waters. Vessels 26 feet in length and over must display a placard at least 5 by 8 inches, made of durable material, fixed in a conspicuous place in the machinery spaces, or at the bilge pump control station, stating the following:

Discharge of Oil Prohibited
The Federal Water Pollution Control Act prohibits the discharge of oil or oily waste upon or into any navigable waters of the U.S. The prohibition includes any discharge which causes a film or discoloration of the surface of the water or causes a sludge or emulsion beneath the surface of the water. Violators are subject to substantial civil and/or criminal sanctions including fines and imprisonment.

Regulations issued under the Federal Water Pollution Control Act require all vessels with propulsion machinery to have a capacity to retain oily mixtures on board and be equipped with a fixed or portable means to discharge these oily mixtures to a reception facility. On recreational vessels, a bucket, oil absorbent pads and heavy duty plastic bag, bailer or portable pump are some suitable means that meet the requirement for retention on board until transfering the oily mixture to a reception facility. No person may intentionally drain oil or oily waste from any source into the bilge of any vessel. You must immediately notify the U.S. Coast Guard if your vessel discharges oil or hazardous substances in the water. Call toll-free 800-424-8802 (In Washington, D.C. (202) 267-3675).

Report the following information:

- location
- size
- source
- color
- time observed
- substances

Discharge of Garbage Prohibited

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The Act to Prevent Pollution from Ships (MARPOL ANNEX V) places limitations on the discharge of garbage from vessels. It is illegal to dump plastic trash anywhere in the ocean or navigable waters of the United States. It is also illegal to discharge garbage in the navigable waters of the United States, including inland waters as well as anywhere in the Great Lakes. The discharge of other types of garbage is permitted outside of specific distances offshore as determined by the nature of that garbage.

Garbage Type	Discharge
Plastics – includes synthetic ropes, fishing nets, and plastic bags	Prohibited in all areas
Floating dunnage, lining and packing materials	Prohibited less than 25 miles from nearest land
Food waste, paper, rags, glass, metal, bottles, crockery and similar refuse	Prohibited less than 12 miles from nearest land
Comminuted or ground food waste, paper, rags, glass, etc.	Prohibited less than 3 miles from nearest land

United States vessels of 26 feet or longer must display in a prominent location, a durable placard at least 4 by 9 inches notifying the crew and passengers of the discharge restrictions.

United States oceangoing vessels of 40 feet or longer, which are engaged in commerce or are equipped with a galley and berthing must have a written Waste Management Plan describing the procedures for collecting, processing, storing and discharging garbage, and designate the person who is in charge of carrying out the plan.

Marine Sanitation Devices >

▪ Search:

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Federal Requirements and Safety Tips for Recreational Boats

Marine Sanitation Devices

All recreational boats with installed toilet facilities must have an operable marine sanitation device (MSD) on board. Vessels 65 feet and under may use a Type I, II or III MSD. Vessels over 65 feet must install a Type II or III MSD. *All installed MSDs must be Coast Guard certified.* Coast Guard certified devices are so labeled except for some holding tanks, which are certified by definition under the regulations.

When operating a vessel on a body of water where the discharge of treated or untreated sewage is prohibited the operator must secure the device in a manner which prevents any discharge. Some acceptable methods are: padlocking overboard discharge valves in the closed position, using non releasable wire tie to hold overboard discharge valves in the closed position, closing overboard discharge valves and removing the handle, locking the door, with padlock or keylock, to the space enclosing the toilets (for Type I and Type II only).

Vessel Safety Check (VSC) Program >

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Federal Requirements and Safety Tips for Recreational Boats

Vessel Safety Check (VSC) Program

Introduction
The mission of the Coast Guard Recreational Boating Safety program is to minimize the loss of life, personal injury, property damage and environment impact associated with the use of recreational vessels through preventive means. The VSC program supports one of the program's key goals: to improve the demonstrated knowledge, skills, abilities and behaviors of boaters.

The VSC is not a boarding or law enforcement issue. No citations will be given as a result of this encounter. The boater will be given a copy of the completed evaluations so that the boater may follow some of the suggestions given. Vessels that pass will be able to display the distinctive VSC decal. This does not exempt the boater from law enforcement boarding, but the boater can be prepared to make this a positive encounter.

What is a Vessel Safety Check?
A Vessel Safety Check (VSC) is a FREE check to boaters who wish to be sure that their vessel meets all federal and state equipment requirements. Vessel Examiners performing this service have been trained to look for some of the more common problems, which might occur on vessels or their associated safety equipment. The items checked are:

- Proper Display of Numbers
- Registration/Documentation
- Personal Flotation Devices (PFDs)
- Visual Distress Signals (VDS)
- Fire Extinguishers
- Ventilation
- Backfire Flame Arrestor
- Sound Producing Devices/Bell
- Navigation Lights
- Pollution Placard
- MARPOL Trash Placards
- Marine Sanitation Device
- Navigation Rules
- State and/or Local Requirements
- Overall Vessel Condition

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If the vessel has all the required items (listed above) on board and are in good working order, the vessel examiner will award a VSC decal to affix to the vessel.

Additional Safety Equipment

- Marine Radio
- Dewatering Device & Backup
- Mounted Fire Extinguishers
- Anchor and Line for Area
- First Aid and Person-In-Water Kit (PIW)
  Note: PIW consists of one extra wearable PFD and a throwable type IV PFD with line
- Inland Visual Distress Signals
- Capacity/Certification of Compliance

Note: The above items not required for the award of the Vessel Safety Check decal.

Boating Safety Education
During the Vessel Safety Check, the vessel examiner will discuss with the recreational boater the purpose of specific marine safety equipment, will clarify various federal and state regulations, will discuss certain safety procedures practices, and will answer any boating related questions. Some of the topics discussed are:

- Accident Reporting/Owner Responsibility
- Charts and Aids to Navigation
- Offshore Operations
- Survival Tips
- First Aid
- Float Plans
- Weather and Sea Conditions
- Fueling and Fuel Management
- Boating Checklist
- Availability of Boating Safety Classes

For Further Information
To get your vessel "Safety Checked" or for more information on the Vessel Safety Check program, contact your local U.S. Coast Guard Auxiliary or U.S. Power Squadron member or visit the

Vessel Safety Check web site at www.safetyseal.net.

Remember!

This is a FREE public service provided in the interest of Boating Safety...

Quick Reference Chart >

- Search:
- **Safety**
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  - MetLife Safety Tips
  - Consumer Advisories
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Federal Requirements and Safety Tips for Recreational Boats

Quick Reference Chart

Vessel Length (in feet)				Equipment	Requirement
<16	16<26	26<40	40<65		
X	X	X	X	Certificate of Number (State Registration)	All undocumented vessels equipped with propulsion machinery must be State registered. Certificate of Number must be on board when vessel is in use. Note: some States require all vessels to be registered.
X	X	X	X	State Numbering	**(a)** Plain Block letters/numbers not less than 3 inches in height must be affixed on each side of the forward half of the vessel (Contrasting color to boat exterior). **(b)** State validation sticker must be affixed within six inches of the registration number
	X	X	X	Certificate of Documentation	Applies only to "Documented" vessels: **(a)** Original and current certificate must be on board **(b)** Vessel name/hailing port marked on exterior part of hull -- letters not less than 4 inches in height. **(c)** Official Number permanently affixed on interior structure -- numbers not less than 3 inches in height.

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X	X	X	X	Life Jackets (PFDs)	**(a)** One Type I, II, III, or V wearable PFD for each person on board. (must be USCG approved)
	X	X	X		**(b)** In addition to paragraph (a), must carry One Type IV (throwable) PFD.
X				Visual Distress Signal (VDS)	**(a)** One electric distress light or Three combination (day/night) red flares. Note: only required to be carried on board when operating between sunset and sunrise.
	X	X	X		**(b)** One orange distress flag and One electric distress light - or -Three hand-held or floating orange smoke signals and One electric distress light - or - Three combination (day/night) red flares: hand-held, meteor or parachute type.

Vessel Length (in feet)				**Equipment**	**Requirement**
<16	16<26	26<40	40<65		
X	X			Fire Extinguishers	**(a)** One B-I (when enclosed compartment)
		X			**(b)** One B-II or Two B-I. Note: fixed system equals One B-I
			X		**(c)** One B-II and One B-I or Three B-I. Note: fixed system equals One B-I or Two B-II
X	X	X	X	Ventilation	**(a)** All vessels built after 25 April 1940 that use gasoline as their fuel with enclosed engine and /or fuel tank compartments must have natural ventilation (at least two ducts fitted with cowls). **(b)** In addition to paragraph (a), a vessel built after 31 July 1980 must have rated power exhaust blower.

X	X	X		Sound Producing Devices	**(a)** A vessel 39.4 ft must, at a minimum, have some means of making an "efficient" sound signal - (i.e. handheld air horn, athletic whistle - Human voice/ sound not acceptable).
		X	X		**(b)** A vessel 39.4 ft (12 meters) or greater, must have a sound signaling appliance capable of producing an efficient sound signal, audible for 1/2 mile with a 4 to 6 seconds duration. In addition, must carry on board a bell with a clapper (bell size not less than 7.9 inches - based on the diameter of the mouth)
X	X	X	X	Backfire Flame Arrestor	Required on gasoline engines installed after 25 April 1940, except outboard motors
X	X	X	X	Navigational Lights	Required to be displayed from sunset to sunrise and in or near areas of reduced visibility.
				Oil Pollution Placard	**(a)** Placard must be at least 5 by 8 inches, made of durable material.
		X	X		**(b)** Placard must be posted in the machinery space or at the bilge station.
		X	X	Garbage Placard	**(a)** Placard must be at least 4 by 9 inches, made of durable material.
					(b) Displayed in a conspicuous place notifying all on board the discharge restrictions.
X	X	X	X	Marine Sanitation Device	If installed toilet: Vessel must have an operable MSD TypeI, II, or III.
		X	X	Navigation Rules	The operator of a vessel 39.4 ft (12 meters) or

(Inland Only)	greater must have on board a copy of these rules.

Vessels Operating Offshore >

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Vessels Operating Offshore

If you operate offshore, you should seriously consider carrying additional equipment beyond the minimum federal requirements. This equipment should include appropriate communications gear, an Emergency Position Indicating Radio Beacon (EPIRB), a means of accurately determining your location, and an inflatable life raft. In cold waters, an immersion suit should be carried for everyone on board.

Communications >

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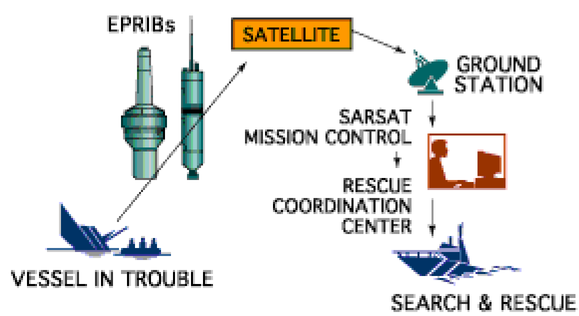
Federal Requirements and Safety Tips for Recreational Boats

Communications

Carry communications gear, marine VHF-FM and/or HF transceiver(s), appropriate to your operating area. Cellular phone coverage is available in many coastal areas. HOWEVER, cellular phones should NOT BE considered a substitute for VHF-FM marine band radios for emergency purposes.

Satellite EPIRBs
Satellite EPIRBs (406 MHz) are designed to quickly and reliably alert rescue forces, indicate an accurate distress position, and guide rescue units to the distress scene, even when all other communications fail.



When activated, the satellite EPIRB transmits a distress signal with a beacon-unique identifying code. The system detects the signal, calculates an accurate distress position, checks the unique identifying code against the EPIRB registration database (vessel and point of contact information supplied by the owner) and routes the distress alert with registration information to the responsible U.S. Coast Guard (or international) Rescue Coordination Center (RCC). 406 MHz EPIRBs with GPS (internal or attached) also provide an immediate GPS position in the information passed to the RCC.

Geostationary satellites make detection almost immediate. If the EPIRB does not have the ability to provide a GPS position, the process to determine a position takes about an hour on average and almost always less than two hours.
Satellite EPIRBs also include a homing beacon and strobe to

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help rescue forces quickly locate the distress scene.

Satellite beacons have significant coverage, alerting timeliness, position accuracy, and signaling advantages over other types of EPIRBs (121.5 MHz). Before purchasing or using an other-than-406MHz EPIRB, be sure you understand its capabilities and limitations.
Mount the EPIRB to float free according to the manufacturer's instructions, if possible. Otherwise, make sure it is readily accessible. Register the EPIRB with NOAA, according to the instructions provided with the beacon. Registration is mandatory, improves response and reduces false alarms.

Inflatable Life Rafts >

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Immersion Suits

Immersion suits will delay the effects of hypothermia in cold water. They should be stored and maintained according to the manufacture's instructions.

Operating Procedures >

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Federal Requirements and Safety Tips for Recreational Boats

Operating Procedures

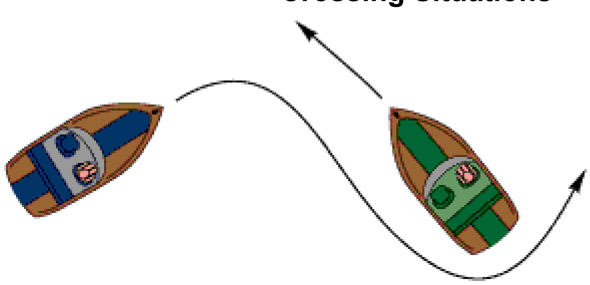
Navigation Rules

The Navigation Rules establish actions to be taken by vessels to avoid collision. The Rules are divided into two parts, INLAND and INTERNATIONAL. Inland Rules apply to vessels operating inside the line of demarcation while International apply outside. Demarcation lines are printed on most navigational charts and are published in the Navigation Rules.

The operator of a vessel 39.4 feet/12 meters or greater is responsible for having on board and maintaining a copy of the Inland navigation rules. The following diagrams describe the whistle signals and action to be taken by vessels in a crossing, meeting or overtaking situation while operating in inland waters. These are basic examples, for further information consult the "NAVIGATION RULES" International Inland (Commandant Instruction M16672.2 Series)

Copies of the rules may be obtained from the Superintendent of Documents, U.S. Government Printing Office, P.O. Box 371954, Pittsburgh, PA 15250-7954 tel. (202) 512-1800

Crossing Situations



Give-way Vessel
...give way 1 short blast
(1 sec.)

Stand-on Vessel
...hold course and speed
1 short blast (1 sec.)

Meeting Head-On or Nearly So Situations

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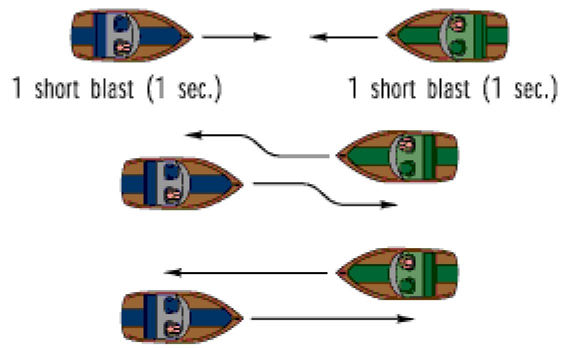
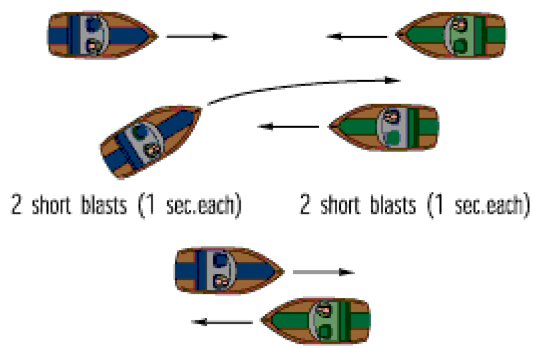


Vessels generally pass portside to portside. However, vessels may pass starboard to starboard if proper signals are given.



Overtaking Situations

[Aids to Navigation >]

Federal Requirements and Safety Tips for Recreational Boats

Aids to Navigation

Aids to Navigation are placed along coasts and navigable waters as guides to mark safe water and to assist mariners in determining their position in relation to land and hidden dangers. Each aid to navigation is used to provide specific information.

Several aids to navigation are usually used together to form a local aid to navigation system that helps the mariner follow natural and improved channels. Such aids to navigation also provide a continuous system of charted marks for coastal piloting. Individual aids to navigation are used to mark landfall from seaward, and to mark isolated dangers.

Lateral markers are buoys or beacons that indicate the port and starboard sides of a route to be followed. Virtually all U.S. lateral marks follow the traditional 3R rule of "red, right, returning". This means, when returning from sea, keep red marks on the right-hand (starboard) side of the vessel.

Mariners must NOT rely on buoys alone for determining their position. Storms and wave action can cause buoys to move.

Lateral Aids >

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Lateral Aids

Lateral aids marking the sides of channels as seen when entering from seaward.

Port Side (Odd Numbers) **Standard Side (Even Numbers)**

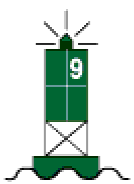


Chart Symbol

Lighted Buoy (Green Light Only)

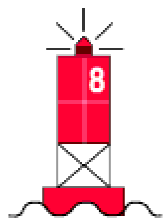
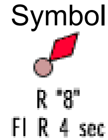


Chart Symbol



Lighted Buoy (Red Light Only)

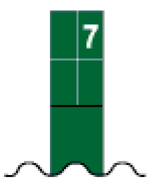


Chart Symbol

Can Light (Unlighted)

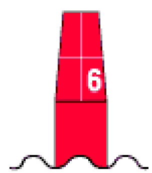
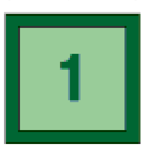


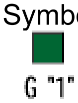
Chart Symbol

Nun Buoy (Unlighted)



Daybreak

Chart Symbol



Daybreak

Chart Symbol

Do not tie up to Aids to Navigation, it is dangerous and illegal.

Safe Water Markers

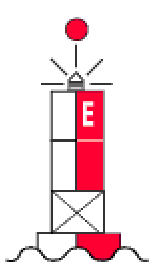
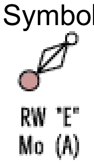


Chart Symbol



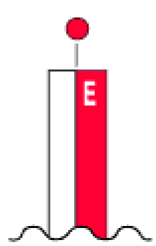


Chart Symbol

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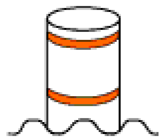
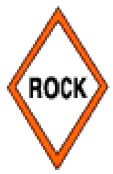
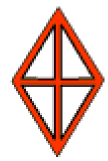
Chart Symbol

Information and Regulatory Markers





Diamond Shape
warns of danger



Diamond Shape with cross
means boats keep out

Circle marks area controlled "as indicated"

For displaying informaion such as directions, distances, locations, ect.

Nautical Charts >

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Nautical Charts

One of the most important tools used by boaters for planning trips and safely navigating waterways are Nautical Charts. Nautical Charts show the nature and shape of the coast, depths of water, general configuration and character of the bottom, prominent landmarks, port facilities, aids to navigation, marine hazards, and other pertinent information. Changes brought about by people and nature require that nautical charts be constantly maintained and updated to aid safe navigation. To meet the needs of the boating public, the National Ocean Service (NOS) produces a variety of nautical charts and chart products. The date of a nautical chart is critical to the boater. Only up-to-date charts should be used for navigation. Nautical charts vary in scale and format. For coastal navigation, for instance, boaters should use the largest chart scale available. Chart updating information can be obtained from "Local Notice to Mariners" published by the U.S. Coast Guard.

NOS nautical charts may be purchased either directly by mail from the NOS Distribution Branch or through an authorized agent. There are more than 1,700 nautical chart agents that sell NOS charts. To obtain a list of the agents near you, request a free catalog.

FAA/National Aeronautical Charting Office
Distribution Division, AVN-530
6303 Ivy Lane, Suite 400
Greenbelt, MD 20770
Telephone: (301) 436-8301 or 1-800-638-8972 U.S. Only
FAX: (301) 436-6829
Email: 9-AMC-chartsales@faa.gov
Website: http://naco.faa.gov/

Safety and Survival Tips >

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U.S. Coast Guard
Safety and Survival Tips:
April 19, 2004

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Safety and Survival Tips

Operator's Responsibilities

Your water fun depends on you, your equipment and other people who, like yourself, enjoy spending leisure time on, in or near the water. Let's take a look at your responsibilities:

- Make sure the boat is in top operating condition and that there are no tripping hazards. The boat should be free of fire hazards and have clean bilges
- Safety equipment, required by law, is on board, maintained in good condition, and you know how to properly use these devices.

- File a float plan with a relative or friend.
- Have a complete knowledge of the operation and handling characteristics of your boat.
- Know your position and know where you are going.
- Maintain a safe speed at all times to avoid collision.
- Keep an eye out for changing weather conditions, and act accordingly.
- Know and practice the Rules of the Road (Navigation Rules).
- Know and obey Federal and state regulations and waterway markers.
- Maintain a clear, unobstructed view forward at all times. "Scan" the water back and forth; avoid "tunnel" vision. Most boating collisions are caused by inattention.

You are the key to water safety!

Overloading >

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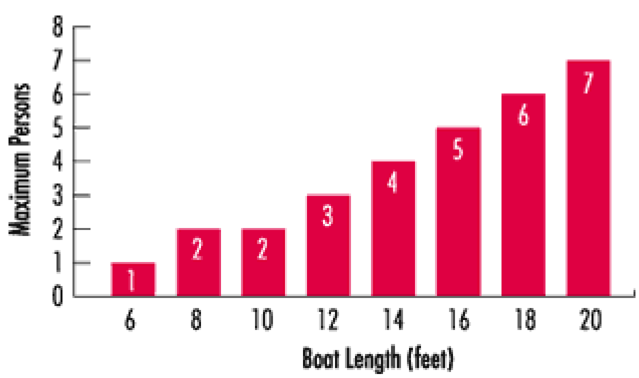
Overloading

Never overload your boat with passengers and cargo beyond its safe carrying capacity. Too many people and/or gear will cause the boat to become unstable. Always balance the load so that the boat maintains proper trim. Here are some things to remember when loading your boat:

- Distribute the load evenly fore and aft and from side to side.
- Keep the load low.
- Keep passengers seated (Do not stand up in a small boat!).
- Fasten gear to prevent shifting.
- Do not exceed the "U.S. Coast Guard Maximum Capacities" information label (commonly called the Capacity Plate).
- If there is no capacity plate, use the following chart as a guide to determine the maximum number of persons you can safely carry in calm weather. (The chart is applicable only to mono-hull boats less than 20ft in length.) A mono-hull is a boat, which makes a single "footprint" in the water when loaded to its rated capacity. For example, a catamaran, trimaran, or a pontoon boat is not a mono-hull boat.



$$\text{Number of People} = \frac{\text{Length of Boat X Boat Width}}{15}$$

Anchoring >

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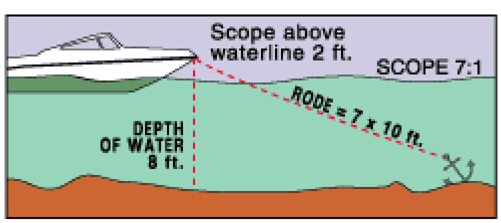
Federal Requirements and Safety Tips for Recreational Boats

Anchoring

Anchoring is done for two principal reasons: first, to stop for fishing, swimming, lunch, or an overnight stay and secondly, to keep you from running aground in bad weather or as a result of engine failure. Anchoring can be a simple task if you follow these guidelines:

- Make sure you have the proper type of anchor (danforth/plow/mushroom).
- A three to six foot length of galvanized chain should be attached to the anchor. The chain will stand up to the abrasion of sand, rock or mud on the bottom much better than a fiber line.
- A suitable length of nylon anchor line should be attached to the end of the chain (this combination is called the "Rode"). The nylon will stretch under heavy strain cushioning the impact of the waves or wind on the boat and the anchor.
- Select an area that offers maximum shelter from wind, current and boat traffic.
- Determine depth of water and type of bottom (preferably sand or mud).
- Calculate amount of anchor line you will need. General rule: 5 to 7 times as much anchor line as the depth of water plus the distance from the water to where the anchor will attach to the bow. For example, if the water depth is 8 feet and it is 2 feet from the top of the water to your bow cleat, you would multiply 10 feet by 5 to 7 to get the amount of anchor line to put out (See diagram below)



- Secure the anchor line to the bow cleat at the point you want it to stop.
- Bring the bow of the vessel into the wind or current.
- When you get to the spot you want to anchor, place the

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engine in neutral.

- When the boat comes to a stop, slowly lower the anchor. Do not throw the anchor over, as it will tend to foul the anchor.
- When all anchor line has been let out, back down on the anchor with engine in idle reverse to help set the anchor.
- When anchor is firmly set, use reference points (landmarks) in relation to the boat to make sure you are not drifting. Check these points frequently.

Do not anchor by the Stern!!
Anchoring a small boat by the stern has caused many to capsize and sink. The transom is usually squared off and has less freeboard than the bow. In a current, the force of the water can pull the stern under. The boat is also vulnerable to swamping by wave action. The weight of a motor, fuel tank, or other gear in the stern increases the risk.

Fueling Precautions >

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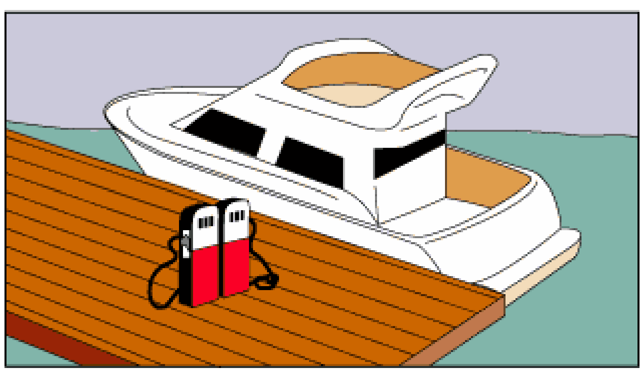
Fueling Precautions

Most fires and explosions happen during or after fueling. To prevent an accident follow these rules:

- Portable tanks should be refueled ashore.
- Close all hatches and other openings before fueling.
- Extinguish all smoking materials.
- Turn off engines, all electrical equipment, radios, stoves and other appliances.
- Remove all passengers.
- Keep the fill nozzle in contact with the tank and wipe up any spilled fuel.
- Open all ports, hatches and doors to ventilate.
- Run the blower for at least four minutes.
- Check the bilges for fuel vapors before starting the engine.
- Do the "sniff test". Sniff around to make sure there is no odor of gasoline anywhere in the boat.



Do not start the engine until all traces of fuel vapors are eliminated!!

Fuel Management
Practice the "One-Third Rule" by using:

- One-third of the fuel going out
- One-third to get back
- One-third in reserve

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Float Plan >

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Federal Requirements and Safety Tips for Recreational Boats

Float Plan

Play it safe, keep a stack of float plan forms on hand. Leave a copy with a friend, relative or local marina before heading out on the water. In case of an emergency, pertinent information will be right at their fingertips to enable them to contact the local marine police or Coast Guard with necessary details. A word of caution—in case you're delayed, and it's not an emergency, inform those with your float plan, and be sure to notify them when you return so the float plan can be "closed out" and an unnecessary and costly search avoided. An example of a float plan is provided here as a PDF.

Propeller Blades Warning >

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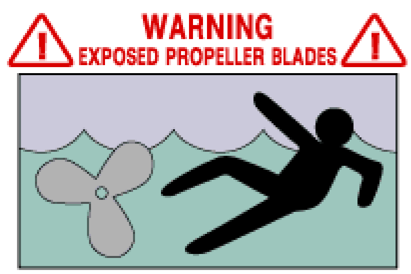
Federal Requirements and Safety Tips for Recreational Boats

SAFETY TIP

Propeller Blades Warning

Never forget the danger to persons in the water that boat propellers can inflict. Statistics indicate that most propeller injuries and fatalities involve open motorboats 16 to less than 26 feet in length and are due to operator inattention, inexperience, and carelessness. Remember to shut off your engines when approaching swimmers. When engines are running, alert swimmers to stay clear of the stern. Propeller guards are not suitable for all types of boats. Therefore, the best and safest course of action to take when people are in the water near your boat—Shut off your engines!



People in the water can be severely injured or killed!

Weather >

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SAFETY TIP

Weather

You should never leave the dock without first checking the local weather forecast. You can get the weather information from the TV, radio, local newspaper, on-line, or from one of the weather channels on your VHF radio.

At certain times of the year weather can change rapidly and you should continually keep a "weather eye" out. While you are out in a boat here are a few signs you can look for that indicate an approaching weather change:

- Weather changes generally come for the west. Scan the sky with your weather eye, especially to the west.
- Watch for cloud build up, especially rapid vertically rising clouds.
- Sudden drop in temperature.
- Sudden change in wind direction and/or speed.
- If you have a barometer on your boat, check it every 2 to 3 hours. A rising barometer indicates fair weather and a rise in wind velocity; a falling barometer indicates stormy or rainy weather.

What To Do in Severe Weather

- Reduce speed, but keep just enough power to maintain headway.
- Put on your PFDs.
- Turn on running lights.
- Head for nearest shore that is safe to approach, if possible.
- Head bow of boat into the waves at about a 45-degree angle.
- Keep bilges free of water.
- Seat passengers on bottom of boat near centerline.
- If your engine fails, trail a sea anchor on a line from the bow to keep the boat headed into the waves. A bucket will work as a sea anchor in an emergency.
- Anchor the boat if necessary

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SAFETY TIP Small Boats and Water Activities

Many hunters and anglers do not think of themselves as boaters, but use small semi v-hull vessels, flat bottom jon-boats or canoes to pursue their sports. These boats tend to be unstable and easily capsize. Capsizings, sinkings, and falls overboard from small boats account for 70% of boating fatalities and these facts mean you must have a greater awareness of the boat's limitations and the skill and knowledge to overcome them.

Standing in a small boat raises the center of gravity, often to the point of capsizing. Standing for any reason or even changing position in a small boat can be dangerous, as is sitting on the gunwales or seat backs or on a pedestal seat while underway. A wave or sudden turn may cause a fall overboard or capsizing because of the raised center of gravity.

Staying Afloat >

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Staying Afloat

It is common belief that someone dressed in heavy clothing or waders will sink immediately if they fall overboard. This is not true. Air trapped in clothing provides considerable flotation, and bending the knees will trap air in waders, providing additional flotation. To stay afloat follow these rules:

- Remain calm, do not thrash about or try to remove clothing or footwear. This leads to exhaustion and increases the loss of air that keeps you afloat.
- Keep your PFD on.
- Keep your knees bent.
- Float on your back and paddle slowly to safety.

Cold Water Survival >

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SAFETY TIP Cold Water Survival

Sudden immersion in cold water can induce rapid, uncontrolled breathing, cardiac arrest, and other physical body conditions, which can result in drowning. Always wearing a PFD will help you survive in rapid immersion situations. In other situations where you must enter the water, here are a few things to follow:

- Wear a PFD.
- Button up your clothing.
- Cover your head if possible and enter the water slowly.
- Keep your head out of the water if at all possible.
- Assume the Heat Escape Lessening Posture (H.E.L.P.) position.

Hypothermia >

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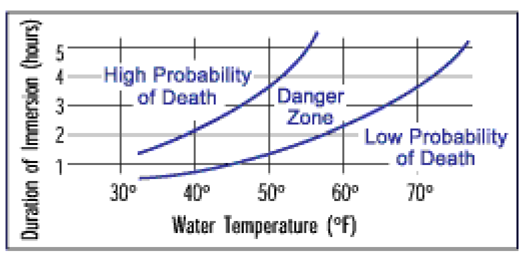
Federal Requirements and Safety Tips for Recreational Boats

Hypothermia

Immersion in water speeds the loss of body heat and can lead to hypothermia. Hypothermia is the abnormal lowering of internal body temperature. If your boat capsizes it will likely float on or just below the surface. Outboard powered vessels built after 1978 are designed to support you even if full of water or capsized. To reduce the effects of hypothermia get in or on the boat. Try to get as much of your body out of the water as possible. If you can't get in the boat a PFD will enable you to keep your head out of the water. This is very important because about 50% of body heat loss is from the head.

It may be possible to revive a drowning victim who has been under water for considerable time and shows no signs of life. Numerous documented cases exist where victims have been resuscitated with no apparent harmful effects after long immersions. Start CPR immediately and get the victim to a hospital as quickly as possible.



The Danger Zone indicates where safety precautions and appropriate behavior (adopting H.E.L.P.) can increase your chances of survival when immersed in cold water.

Carbon Monoxide >

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Carbon Monoxide Hazards on Recreational Boats

The Facts
Carbon Monoxide can be a "silent killer" on houseboats and other recreational vessels. Each year, boaters are injured or killed by carbon monoxide. Virtually all of the poisonings are preventable.

Carbon monoxide is a by-product of combustion of carbon based material such as gasoline, propane, charcoal or wood. Common sources aboard boats include main and auxiliary engines, generators, cooking ranges, space heaters, and water heaters. (Note: Cold and poorly tuned engines produce more carbon monoxide than warm properly tuned engines).

Carbon monoxide can collect within a boat in a variety of ways. Exhaust leaks (the leading cause of death by carbon monoxide) can allow carbon monoxide to migrate throughout the boat and into enclosed areas. Even properly vented exhaust can re-enter a boat if it's moored too close to a dock or another boat, or if the exhaust is pushed back by prevailing winds. Exhaust can re-enter boats when cruising under certain conditions – the station wagon effect – especially with canvas in place. Exhaust can also collect in enclosed spaces near the stern swim platform.

What To Do?

- Schedule regular engine and exhaust system maintenance inspections by experienced and trained mechanics.
- Be aware that dangerous concentrations of carbon monoxide can accumulate when a boat, generator or other fueled device is operated while the boat is at a pier, seawall or alongside another boat. Do not run engines or equipment for extended periods of time under these conditions or without continuous monitoring.
- Keep forward facing hatches open to allow fresh air circulation in accommodation spaces, even in inclement weather.
- Keep people clear of the rear deck area and swim platform of the boat while either the generator or engines

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are running. Always monitor the swimming area.

- Do not confuse carbon monoxide poisoning with seasickness or intoxication. If someone on board complains of irritated eyes, headaches, nausea, weakness or dizziness, immediately move the person to fresh air, investigate the cause and take corrective action. Seek medical attention, if necessary.
- Install a carbon monoxide detector in each accommodation space on your boat. Check the detectors periodically to be sure they are functioning properly.

Checklist >

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Checklist

Each Trip:

- Make sure all exhaust clamps are in place and secure.
- Look for exhaust leaking from the exhaust system components evidenced by rust and /or black streaking, water leaks, or corroded or cracked fittings.
- Inspect rubber exhaust hoses for burned or cracked sections. All rubber hoses should be pliable and free of kinks.
- Confirm that cooling water flows from the exhaust outlet when the engines and generator are started.
- Listen for any change in exhaust sound that could indicate a failure of an exhaust component.
- Test the operation of each carbon monoxide detector by pressing the test button.

Do not operate the vessel if any of these problems exist!

At Least Annually:
(Performed by a qualified marine technician)

- Replace exhaust hoses if any evidence of cracking, charring or deterioration is found.
- Inspect each water pump impeller and inspect the condition of the water pump housing. Replace if worn or cracked (refer to the engine and generator manuals for further information).
- Inspect each of the metallic exhaust components for cracking, rusting, leaking or looseness. Pay particular attention to the cylinder head, exhaust manifold, and water injection elbow.
- Clean, inspect and confirm the proper operation of the generator cooling water anti-siphon valve (if equipped).

Regular maintenance and proper operation of the boat are the best defenses against injury from carbon

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monoxide...

To find out more information about how you can prevent carbon monoxide poisoning on recreational boats, contact:

U.S. Coast Guard Infoline
1-800-368-5647
www.uscgboating.org

National Marine Manufacturers Association
312-946-6200
www.nmma-medialink.com

Download a printable pdf of the checklist.

Pre-Departure Checklist >

Federal Requirements and Safety Tips for Recreational Boats

Boater's Pre-Departure Checklist

Know your vessel. Before departure, always be sure your vessel is in good working condition and properly equipped for emergencies. Avoid inconvenience and potential danger by taking a few minutes to check the following:

Minimum Federal Required Equipment	**Yes**	**No**
State Registration Documentation		
State Numbering Displayed		
Certificate of Documentation		
Lifejackets (PFDs) - one for each person		
Throwable PFD		
Visual Distress Signals		
Fire Extinguishers (fully charged)		
Proper Ventilation		
Backfire Flame Arrestor		
Sound Producing Device(s)		
Navigation lights		
Oil Pollution Placard		
Garbage Placard		
Marine Sanitation Device		
Navigation rules		
Any Additional State Requirements		

Besides meeting the federal requirements, prudent boaters carry additional safety equipment. The following additional items are suggested depending on the size, location and use of your boat:

Recommended Equipment	**Yes**	**No**	**N/A**
VHF Marine Radio			
Anchor and Tackle			
Chart(s) of Area & Navigation Tools			
Magnetic Compass			
Fenders and Boat Hook			

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Mooring Lines and Heaving line
Manual Bilge Pump or Bailing Device
Tool Kit
Spare Parts (fuses, spark plugs, belts, etc)
Spare Battery (fully charged)
Spare Propeller
Extra Fuel & Oil
Alternate Propulsion (paddles/oar)
Flashlight & Batteries
Search Light
First Aid Kit
Sunscreen (SPF 30+)
Mirror
Food and Water
Extra Clothing
AM - FM Radio
Cellular Phone
Binoculars

Safety Checks and Tests	**Yes**	**No**	**N/A**
Test Marine Radio (voice call)			
Test Navigation and Anchor Lights			
Test Steering (free movement)			
Test Tilt / Trim			
Test Bilge Pump			
Check for any excessive water in bilges			
Check Fuel System for any leaks			
Check Engine Fluids			
Ensure Boat Plug is properly installed			
Check Electrical System			
Check Galley / Heating Systems			
Check Gauges (i.e. batteries)			
Check Fuel Amount			
Ensure Anchor is ready for use			
Check load of vessel and secure gear from shifting			
Ensure passengers know Emergency Procedures and Equipment Location			
Everyone put on a Lifejacket to check for proper fitting.			
Check the Weather Forecast			
File a Float Plan with family or friend			

Download a printable pdf of the pre-departure checklist.

Be Safe on the Water >

Search:

- **Safety**
  - **Federal Requirements**
  - MetLife Safety Tips
  - Consumer Advisories
  - Boating Safety Courses
  - U.S. Aids to Navigation
  - Boating Under the Influence
  - GMDSS Communications
- Regulations
- Recalls & Safety Defects
- News
- Statistics
- Glossary
- FAQs
- Links
- Grants

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- Site Map

Federal Requirements and Safety Tips for Recreational Boats

Be Safe on the Water

Know the navigation rules, observe the courtesies of safe boating and
KNOW . . .

your	**B**oat
the	**E**quipment
the	**S**afety devices and wear PFDs
about	**A**lcohol and other distress stressors
about	**F**irst aid and emergency procedures
your	**E**nvironment, area and weather

. . . . . BEFORE YOU GO!

Boating Safety is no accident. To build sound knowledge, proficiency and confidence, the keys to safe boating, take a boating safety course.

For more information on boating safety and boating courses, contact your State Boating Agency, Coast Guard Auxiliary, US Power Squadron, Coast Guard District or call the Boating Safety Infoline (1-800-368-5647).

Take Time to Reflect on Safety
Safe Boating Begins Here . . .
with You!

Conversion Table (Metric/US) >

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Federal Requirements and Safety Tips for Recreational Boats

Conversion of Metric to U.S. Units

Metric Measure	Feet in Decimals	Feet and Inches
50.0 Meters (M)	164.0 ft.	164' 1/2"
20.0 M	65.6 ft.	65' 7 1/2"
12.0 M	39.4 ft.	39' 4 1/2"
10.0 M	32.8 ft.	32' 9 3/4"
8.0 M	26.3 ft.	26' 3"
7.0 M	23.0 ft.	22' 11 1/2"
6.0 M	19.7 ft.	19' 8 1/4"
5.0 M	16.4 ft.	16' 4 3/4"
4.0 M	13.1 ft.	13' 1 1/2"
2.5 M	8.2 ft.	8' 2 1/2"
1.0 M	3.3 ft.	3' 3 1/3"

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APPENDIX C

Washington Administrative Code (WAC) Boating Statutes

WAC 352-60-030 Personal flotation devices required. No person shall operate or permit the operation of a vessel on the waters of the state unless the vessel has on board United States Coast Guard approved personal flotation devices as follows:

(1) Vessels less than sixteen feet (4.9 meters) in length, and canoes and kayaks of any length, must have one Type I, II, or III PFD of the proper size for each person on board.

(2) Vessels sixteen feet (4.9 meters) or more in length, except a canoe or kayak, must have one Type I, II, or III wearable PFD of the proper size for each person on board and, in addition, one Type IV throwable PFD.

(3) Alternate PFD requirement. A United States Coast Guard approved Type V PFD may be carried in lieu of any required PFD under this section if it is approved for the activity in which the vessel is engaged in and used in compliance with requirements on the approval label.

(4) Stowage and condition. All personal flotation devices required by this section shall be readily accessible to all persons on board and be in good and serviceable condition. All devices shall be approved by the United States Coast Guard and marked in compliance with Coast Guard standards.

(5) Exemptions. Racing shells, rowing sculls and racing kayaks are exempt from the requirements of this section provided they are manually propelled, recognized by a national or international racing association and designed solely for competitive racing.

[Statutory Authority: RCW 43.51.400, 88.12.065, 88.12.125, 88.12.245 and chapter 33, CFR Part 175.15. 94-16-027, § 352-60-030, filed 7/25/94, effective 8/25/94. Statutory Authority: RCW 43.51.400. 84-11-057 (Order 79), § 352-60-030, filed 5/18/84.]

WAC 352-60-040 Visual distress signals. (1) Application. The requirements for this section apply to coastal waters.

(2) No person shall operate or permit the operation of a vessel unless visual distress signals are carried on board under the following conditions:

(a) For vessels sixteen feet (4.9 meters) or more in length, devices suitable for day use and devices suitable for night use, or devices suitable for both day and night use must be carried on board.

(b) For vessels less than sixteen feet (4.9 meters) in length, visual distress signals for night use must be carried on board when operating between sunset and sunrise.

(3) Visual distress signals accepted. Any of the following signals as specified in Title 46, Code of Federal Regulations, Part 160, when carried in the number required, can be used to meet the requirements of this section:

(a) An electric distress light meeting the standards of Chapter 46, Code of Federal Regulations, Part 161.013. One is required to meet the night only requirement.

(b) An orange flag meeting the standards of Chapter 46, Code of Federal Regulations, Part 160.072. One is required to meet the day only requirement.

(c) Pyrotechnics meeting the standards noted in the table below:

Distress Signal Description	USCG Approval Number	Use	Number Required
Hand-Held Red Flare Signals	160.021	Day and Night	3
Floating Orange Smoke Signals	160.022	Day Only	3
Parachute Red Flare Signals	160.024	Day and Night	3
Hand-Held Rocket Propelled Parachute Red Flare Signals	160.036	Day and Night	3
Hand-Held Orange Smoke Signals	160.037	Day Only	3
Floating Orange Smoke Signals	160.057	Day Only	3
Red Aerial Pyrotechnic Flares	160.066	Day and Night	3

(4) Marking and stowage. Visual distress signals required by this section must be legibly marked with the United States Coast Guard approval number and must be readily accessible.

(5) Condition and expiration date. Visual distress signals required by this section must be in serviceable condition, and if marked with an expiration date, shall not be expired.

(6) Launchers. Any vessel that carries a visual distress signal required by this section where a launcher is necessary to activate the signal, must also have on board a launcher approved by the United States Coast Guard.

(7) Prohibited use. No person in a vessel shall display a visual distress signal on the waters of Washington state under any circumstance except a situation where assistance is needed because of immediate or potential danger to the persons on board.

(8) Exceptions. The following vessels, when operating between sunset and sunrise, must carry visual distress signals that meet the requirements of this section and are suitable for night use:

(a) A vessel competing in any organized marine parade, regatta, race or similar authorized event;

(b) A vessel being manually propelled; or

(c) A sailing vessel of completely open construction, less than twenty-six feet (7.9 meters) in length, and not equipped with propulsion machinery.

(9) Any combination of signal devices selected from the types noted in subsection (3)(a), (b) and (c) of this section, when carried in the number required, may be used to meet both day and night requirements. Examples - the combination of two hand-held red flares (160.021), and one parachute red flare (160.024 or 160.036) meets both day and night requirements. Three hand-held orange smoke (160.037) with one electric distress light (161.013) meet both day and night requirements.

[Statutory Authority: RCW 43.51.400, 88.12.065, 88.12.125, 88.12.245 and chapter 33, CFR Part 175.15. 94-16-027, § 352-60-040, filed 7/25/94, effective 8/25/94. Statutory Authority: RCW 43.51.400. 84-11-057 (Order 79), § 352-60-040, filed 5/18/84.]

RCW 79A.60.130
Muffler or underwater exhaust system required -- Exemptions -- Enforcement -- Penalty.

(1) All motor-propelled vessels shall be equipped and maintained with an effective muffler that is in good working order and in constant use. For the purpose of this section, an effective muffler or underwater exhaust system does not produce sound levels in excess of ninety decibels when subjected to a stationary sound level test that shall be prescribed by rules adopted by the commission, as of July 25, 1993, and for engines manufactured on or after January 1, 1994, a noise level of eighty-eight decibels when subjected to a stationary sound level test that shall be prescribed by rules adopted by the commission.

(2) A vessel that does not meet the requirements of subsection (1) of this section shall not be operated on the waters of this state.

(3) No person may operate a vessel on waters of the state in such a manner as to exceed a noise level of seventy-five decibels measured from any point on the shoreline of the body of water on which the vessel is being operated that shall be specified by rules adopted by the commission, as of July 25, 1993. Such measurement shall not preclude a stationary sound level test that shall be prescribed by rules adopted by the commission.

(4) This section does not apply to: (a) A vessel tuning up, testing for, or participating in official trials for speed records or a sanctioned race conducted pursuant to a permit issued by an appropriate governmental agency; or (b) a vessel being operated by a vessel or marine engine manufacturer for the purpose of testing or development. Nothing in this subsection prevents local governments from adopting ordinances to control the frequency, duration, and location of vessel testing, tune-up, and racing.

(5) Any officer authorized to enforce this section who has reason to believe that a vessel is not in compliance with the noise levels established in this section may direct the operator of the vessel to submit the vessel to an on-site test to measure noise level, with the officer on board if the officer chooses, and the operator shall comply with such request. If the vessel exceeds the decibel levels established in this section, the officer may direct the operator to take immediate and reasonable measures to correct the violation.

(6) Any officer who conducts vessel sound level tests as provided in this section shall be qualified in vessel noise testing. Qualifications shall include but may not be limited to the ability to select the appropriate measurement site and the calibration and use of noise testing equipment.

(7) A person shall not remove, alter, or otherwise modify in any way a muffler or muffler system in a manner that will prevent it from being operated in accordance with this chapter.

(8) A person shall not manufacture, sell, or offer for sale any vessel that is not equipped with a muffler or muffler system that does not comply with this chapter. This subsection shall not apply to power vessels designed, manufactured, and sold for the sole purpose of competing in racing events and for no other purpose. Any such exemption or exception shall be documented in any and every sale agreement and shall be formally acknowledged by signature on the part of both the buyer and the seller. Copies of the agreement shall be maintained by both parties. A copy shall be kept on board whenever the vessel is operated.

(9) Except as provided in RCW 79A.60.020, a violation of this section is an infraction under chapter 7.84 RCW.

(10) Vessels that are equipped with an engine modified to increase performance beyond the engine manufacturer's stock configuration shall have an exhaust system that complies with the standards in this section after January 1, 1994. Until that date, operators or owners, or both, of such vessels with engines that are out of compliance shall be issued a warning and be given educational materials about types of muffling systems available to muffle noise from such high performance engines.

(11) Nothing in this section preempts a local government from exercising any power that it possesses under the laws or Constitution of the state of Washington to adopt more stringent regulations.

[2000 c 11 § 97; 1993 c 244 § 39. Formerly RCW 88.12.085.]

NOTES:

Intent -- 1993 c 244: See note following RCW 79A.60.010.

RCW 79A.60.180
Loading or powering vessel beyond safe operating ability -- Penalties.

(1) A person shall not load or permit to be loaded a vessel with passengers or cargo beyond its safe carrying ability or carry passengers or cargo in an unsafe manner taking into consideration weather and other existing operating conditions.

(2) A person shall not operate or permit to be operated a vessel equipped with a motor or other propulsion machinery of a power beyond the vessel's ability to operate safely, taking into consideration the vessel's type, use, and construction, the weather conditions, and other existing operating conditions.

(3) A violation of subsection (1) or (2) of this section is an infraction punishable as provided under chapter 7.84 RCW except as provided under RCW 79A.60.020 or where the overloading or overpowering is reasonably advisable to effect a rescue or for some similar emergency purpose.

(4) If it appears reasonably certain to any law enforcement officer that a person is operating a vessel clearly loaded or powered beyond its safe operating ability and in the judgment of that officer the operation creates an especially hazardous condition, the officer may direct the operator to take immediate and reasonable steps necessary for the safety of the individuals on board the vessel, including directing the operator to return to shore or a mooring and to remain there until the situation creating the hazard is corrected or ended. Failure to follow the direction of an officer under this subsection is a misdemeanor punishable as provided under RCW 9.92.030.

[2000 c 11 § 100; 1993 c 244 § 16. Formerly RCW 88.12.135.]

NOTES:

Intent -- 1993 c 244: See note following RCW 79A.60.010.

RCW 79A.60.200
Duty of operator involved in collision, accident, or other casualty -- Immunity from liability of persons rendering assistance -- Penalties.

(1) The operator of a vessel involved in a collision, accident, or other casualty, to the extent the operator can do so without serious danger to the operator's own vessel or persons aboard, shall render all practical and necessary assistance to persons affected by the collision, accident, or casualty to save them from danger caused by the incident. Under no circumstances may the rendering of assistance or other compliance with this section be evidence of the liability of such operator for the collision, accident, or casualty. The operator shall also give all pertinent accident information, as specified by rule by the commission, to the law enforcement agency having jurisdiction: PROVIDED, That this requirement shall not apply to operators of vessels when they are participating in an organized competitive event authorized or otherwise permitted by the appropriate agency having jurisdiction and authority to authorize such events. These duties are in addition to any duties otherwise imposed by law. Except as provided for in RCW 79A.60.020 and subsection (3) of this section, a violation of this subsection is a civil infraction punishable under RCW 7.84.100.

(2) Any person who complies with subsection (1) of this section or who gratuitously and in good faith renders assistance at the scene of a vessel collision, accident, or other casualty, without objection of the person assisted, shall not be held liable for any civil damages as a result of the rendering of assistance or for any act or omission in providing or arranging salvage, towage, medical treatment, or other assistance, where the assisting person acts as any reasonably prudent person would have acted under the same or similar circumstances.

(3) An operator of a vessel is guilty of a class C felony and is punishable pursuant to RCW 9A.20.021 if the operator: (a) Is involved in a collision that results in injury to a person; (b) knew or reasonably should have known that a person was injured in the collision; and (c) leaves the scene of the collision without rendering all practical and necessary assistance to the injured person as required pursuant to subsection (1) of this section, under circumstances in which the operator could have rendered assistance without serious danger to the operator's own vessel or persons aboard. This subsection (3) does not apply to vessels involved in commerce, including but not limited to tugs, barges, cargo vessels, commercial passenger vessels, fishing vessels, and processing vessels.

[2000 c 11 § 102; 1996 c 36 § 1; 1993 c 244 § 18; 1984 c 183 § 1; 1983 2nd ex.s. c 3 § 48. Formerly RCW 88.12.155, 88.12.130, and 88.02.080.]

NOTES:

Intent -- 1993 c 244: See note following RCW 79A.60.010.

RCW 79A.60.210
Casualty and accident reports -- Confidentiality -- Use as evidence.

(1) All reports made to the commission pursuant to RCW 79A.60.200 and 79A.05.310 shall be without prejudice to the person who makes the report and shall be for the confidential usage of governmental agencies, except as follows:

(a) Statistical information which shall be made public;

(b) The names and addresses of the operator and owner and the registration number or name of the vessel as documented which was involved in an accident or casualty and the names and addresses of any witnesses which, if reported, shall be disclosed upon written request to any person involved in a reportable accident, or, for a reportable casualty, to any member of a decedent's family or the personal representatives of the family.

(2) A report made to the commission pursuant to RCW 79A.60.200 and 79A.05.310 or copy thereof shall not be used in any trial, civil or criminal, arising out of an accident or casualty, except that solely to prove a compliance or failure to comply with the report requirements of RCW 79A.60.200 and 79A.05.310, a certified statement which indicates that a report has or has not been made to the commission shall be provided upon demand to any court or upon written request to any person who has or claims to have made a report.

[1999 c 249 § 1502; 1984 c 183 § 3. Formerly RCW 88.12.165, 88.12.140, and 43.51.402.]

NOTES:

Severability -- 1999 c 249: See note following RCW 79A.05.010.

RCW 79A.60.220
Boating accident reports by local government agencies -- Investigation -- Report of coroner.

Law enforcement authorities, fire departments, or search and rescue units of any city or county government shall provide to the commission a report, prepared by the local government agency regarding any boating accident occurring within their jurisdiction resulting in a death or injury requiring hospitalization. Such report shall be provided to the commission within ten days of the occurrence of the accident. The results of any investigation of the accident conducted by the city or county governmental agency shall be included in the report provided to the commission. At the earliest opportunity, but in no case more than forty-eight hours after becoming aware of an accident, the agency shall notify the commission of the accident. The commission shall have authority to investigate any boating accident. The results of any investigation conducted by the commission shall be made available to the local government for further processing. This provision does not eliminate the requirement for a boating accident report by the operator required under RCW 79A.60.200.

The report of a county coroner, or any public official assuming the functions of a coroner, concerning the death of any person resulting from a boating accident, shall be submitted to the commission within one week of completion. Information in such report may be, together with information in other such reports, incorporated into the state boating accident report provided for in RCW 79A.05.310(4), and shall be for the confidential usage of governmental agencies as provided in RCW 79A.60.210.

[1999 c 249 § 1503; 1987 c 427 § 1. Formerly RCW 88.12.175, 88.12.150, and 43.51.403.]

NOTES:

Severability -- 1999 c 249: See note following RCW 79A.05.010.

Boating accidents and boating safety services -- Study -- Report -- 1987 c 427: "The parks and recreation commission shall conduct a study of boating accidents and boating safety services in Washington including a review of how the local option tax for funding of boating safety enforcement is used. Further the parks and recreation commission shall develop recommendations to address identified problems and report these recommendations to the legislature by January 2, 1988." [1987 c 427 § 4.]

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APPENDIX D

Sample Station Coordinate and Property Ownership Information

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Sample ID	Latitude	Longitude	Description	Location	DNR Provided Owner Information	Mason County Parcel Records Owner Name	Mason County Parcel Records Tideland Parcel No.
Shelton Harbor							
SH-1	47.21335280510	-123.08389258400	sediment	Shelton Marina	Simpson Timber Co.	unknown	320208888888
SH-2	47.21357972570	-123.08752080000	sediment	Marine Railway	M. Reid et al.	unknown	320208888888
SH-3	47.21253760410	-123.09011602700	sediment	Harbor, near Shelton Creek outfall	Peninsula Rwy. Co.	unknown	320208888888
SH-4	47.21269848820	-123.09164275000	sediment	Simpson outfalls	Peninsula Rwy. Co.	unknown	320208888888
SH-5	47.21152314180	-123.09183896200	sediment	Simpson outfalls	Peninsula Rwy. Co.	unknown	320208888888
SH-6	47.21015870000	-123.09201501400	sediment	Simpson outfall, north of Goldsborough Creek	Peninsula Rwy. Co.	Peninsula Rwy. Co.	320204100800
SH-7	47.21087563100	-123.09074755900	sediment	300 ft east offshore	Peninsula Rwy. Co.	unknown	320208888888
SH-8	47.21078230520	-123.08918135700	sediment	600 ft east offshore	Peninsula Rwy. Co.	unknown	320208888888
SH-9	47.21067696370	-123.08561299000	sediment	Inner harbor	Peninsula Rwy. Co.	Peninsula Rwy. Co.	320204100800
SH-10	47.21157022410	-123.08325541700	sediment	Inner harbor	Peninsula Rwy. Co.	unknown	320208888888
SH-11	47.20798213810	-123.09421152300	sediment	North of former sawmill 4	W. Kneeland (1910)	unknown	320208888888
SH-12	47.20727984060	-123.09407152500	sediment	Offshore of former sawmill 4	W. Kneeland (1910)	unknown	320208888888
SH-13	47.20653792370	-123.09282144400	sediment	Offshore south of former sawmill 4, Rayonier lab, and Manke yard	Peninsula Rwy. Co.	unknown	320208888888
SH-14	47.20874883010	-123.08079300400	sediment	Inner harbor	Peninsula Rwy. Co.	unknown	320208888888
SH-15	47.21010206870	-123.07724672900	sediment	Oakland Bay next to Shelton Harbor	DNR	DNR	320202222222
SH-16	47.21346494700	-123.07812388200	sediment	Oakland Bay next to Shelton Harbor	DNR	DNR	320202222222
SH-17	47.21135179380	-123.08636737000	sediment core	Inner harbor	Peninsula Rwy. Co.	unknown	320208888888
SH-18	47.20869813890	-123.09411367800	wood waste	Offshore from sawmill 3	Peninsula Rwy. Co.	unknown	320208888888
SH-19	47.20791603560	-123.09244722500	wood waste	Inner harbor	Peninsula Rwy. Co.	unknown	320208888888
SH-20	47.20689092220	-123.09058218800	wood waste	Inner harbor, north of Manke sort yard	Peninsula Rwy. Co.	unknown	320208888888
SH-21	47.20875570080	-123.08971317000	wood waste	Inner harbor	Peninsula Rwy. Co.	unknown	320208888888
SH-22	47.20801499490	-123.08681786600	wood waste	Inner harbor	Peninsula Rwy. Co.	unknown	320208888888
SH-23	47.20828690170	-123.08447926700	wood waste	Inner harbor	Peninsula Rwy. Co.	unknown	320208888888
SH-24	47.20655790280	-123.08445670000	wood waste	Offshore from City of Shelton property	Peninsula Rwy. Co.	unknown	320208888888
SH-25	47.20699266070	-123.08098855600	wood waste	Offshore from City of Shelton property	Peninsula Rwy. Co.	unknown	320208888888
SH-26	47.21160568320	-123.08995585900	wood waste	Inner harbor	Peninsula Rwy. Co.	unknown	320208888888
SH-27	47.21217461540	-123.08789514200	wood waste	Inner harbor	Peninsula Rwy. Co.	unknown	320208888888
SH-28	47.21042296660	-123.08198493700	wood waste	Inner harbor	Peninsula Rwy. Co.	Peninsula Rwy. Co.	320204100800
SH-29	47.21188452180	-123.07812156100	wood waste	Oakland Bay next to Shelton Harbor	DNR	DNR	320202222222
SH-30	47.21433878030	-123.08403291100	wood waste	Shelton Marina	Port of Shelton	Port of Shelton	320205706006
Hammersley Inlet							
HI-1	47.20348900360	-123.06213733300	sediment	Offshore from Walker Park	DNR	DNR	320212222222
HI-2	47.20583578390	-123.06266993200	sediment	Offshore from Miller Point	T. Chapman et al./Foss Co.	DNR	320218888888
HI-3	47.20655209380	-123.07260575100	sediment	East of Eagle Point, north of private residences	DNR	unknown	320218888888
HI-4	47.20854138690	-123.06717714300	sediment	Hammersley Inlet	DNR	DNR	320212222222
HI-5	47.20907894270	-123.07380145300	sediment	Existing WWTP outfall	DNR	DNR	320212222222
HI-6	47.21233048460	-123.07102386900	sediment	Offshore from Munson Point	Nathan Gardner	DNR	320212222222
HI-7	47.21440288350	-123.07698850100	sediment	Oakland Bay	DNR	DNR	320202222222

Sample ID	Latitude	Longitude	Description	Location	DNR Provided Owner Information	Mason County Parcel Records Owner Name	Mason County Parcel Records Tideland Parcel No.
Oakland Bay							
OB-1	47.21864411600	-123.07924708000	sediment	Offshore from bulk fuel facilities	Oakland Shellfish Co./Clam Acres/Gretchen Matzen/DNR	unknown	320178888888
OB-2	47.21927956040	-123.07394810500	sediment	Oakland Bay	DNR	DNR	320162222222
OB-3	47.21792790110	-123.07010388000	sediment	Oakland Bay	DNR	DNR	320162222222
OB-4	47.22478829900	-123.07051045900	sediment	Oakland Bay	DNR	DNR	320162222222
OB-5	47.22488318740	-123.06255986500	sediment	Oakland Bay	DNR	DNR	320162222222
OB-6	47.22245017080	-123.05407662200	sediment	Oakland Bay	DNR	DNR	320152222222
OB-7	47.22723912780	-123.04334754500	sediment	Chapman Cove	M. McDonald/J. O'Neill	Taylor United Inc.	320151080160
OB-8	47.22345089410	-123.03393635800	sediment	Chapman Cove	Rayonier Inc./A. Swanson (oys. trks)	DNR	320142222222
OB-9	47.23156670560	-123.05594129600	sediment	Oakland Bay	DNR	DNR	320092222222
OB-10	47.23761782030	-123.04958556400	sediment	Oakland Bay	DNR	DNR	320102222222
OB-11	47.24800529420	-123.03196349300	sediment	North Oakland Bay	DNR	DNR	320022222222
OB-12	47.25071093550	-123.03991970500	sediment	North of Bayshore Point	Reserve No. 2/Taylor United Inc.	WDFW	320032222222
OB-13	47.25315052750	-123.03276208400	sediment	North Oakland Bay, offshore from Moran property	Rayonier Inc./F. Stabenfeldt	Taylor United Inc.	320020081150
OB-14	47.25595172310	-123.02083075800	sediment	North Oakland Bay	Rayonier Inc./F. Stabenfeldt	Taylor United Inc.	320020081150
OB-15	47.22253605390	-123.06268961000	sediment core	Oakland Bay		WDFW	320162222222
OB-16	47.23933354220	-123.04826168500	sediment core	Water area south of Bayshore Point	Reserve "B"	DNR	320102222222
OB-17	47.21584383170	-123.08189269800	wood waste	Oakland Bay, north of Shelton Marina	Simpson Timber Co./Taylor Resources Inc./Manke Family Resources	unknown	320178888888
OB-18	47.21567167290	-123.06917348300	wood waste	Oakland Bay north of Munson Point	DNR	DNR	320162222222
OB-19	47.22642273820	-123.05275550400	wood waste	Oakland Bay near Chapman Cove	DNR	DNR	320152222222

Sample coordinates are in NAD 83.

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