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Ward Cove Sediment Remediation Project

Technical Studies:

Field Sampling Plan for the
Phase 2 Investigation

Prepared for

Ketchikan Pulp Company

Ketchikan, Alaska

PTI

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PTI

ENVIRONMENTAL SERVICES

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Ketchikan Pulp Company
7559 North Tongass Highway
Ketchikan, Alaska 99901

PTI Contract CBOW-10-01

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ACRONYMS AND ABBREVIATIONS

AOF	area of focus
AVS	acid-volatile sulfide
CoPC	chemical of potential concern
DRET	dredging elutriate test
EPA	U.S. Environmental Protection Agency
FSP	field sampling plan
HSP	health and safety plan
KPC	Ketchikan Pulp Company
MET	modified elutriate test
NPDES	National Pollutant Discharge Elimination System
PTI	PTI Environmental Services
PSDDA	Puget Sound Dredged Disposal Analysis
PSEP	Puget Sound Estuary Program
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
SEM	simultaneously extracted metals
SOP	standard operating procedure
SQS	sediment quality standard
TCDD	tetrachlorodibenzo- <i>p</i> -dioxin
TEC	toxic equivalent concentration
TIE	toxicity identification evaluation

1. INTRODUCTION

In September 1995, the Ketchikan Pulp Company (KPC) entered into a consent decree with the U.S. Environmental Protection Agency (EPA) to address environmental issues related to KPC's Ketchikan facility located on the shoreline of Ward Cove, Alaska, an embayment in the southern reach of the Tongass Narrows (Figure 1-1). As part of the consent decree, KPC agreed to conduct a Ward Cove sediment remediation project to address sediments in the Cove.

The Ward Cove sediment remediation project is being conducted in two phases. In Phase 1, surface sediments (top 10 cm) were sampled in May and June of 1996 at 28 stations throughout Ward Cove and at 2 stations in a reference area (Moser Bay, Alaska) to characterize the horizontal distribution of chemicals of potential concern (CoPCs) and sediment toxicity throughout the Cove. Ecological and human health evaluations were conducted as part of the Phase 1 investigation to determine the CoPCs and areas of focus (AOFs) that warrant further study in Phase 2. The results of the Phase 1 investigation are presented in PTI (1997b).

This field sampling plan (FSP) describes the fieldwork to be conducted during Phase 2 of the Ward Cove sediment remediation project. Project organization and general project responsibilities are described in Table 1-1. An overview of the Phase 2 study design is presented in Section 2 of this document. Details of the sample collection and analyses to be performed are described in Section 3, *Sediment Sampling*, and Section 4, *Analytical and Testing Methods*, respectively. Sample collection and analysis procedures used in this study follow current guidelines of EPA Region 10, the Puget Sound Estuary Program (PSEP), and the Puget Sound Dredged Disposal Analysis (PSDDA) Program, with modifications made as described in the quality assurance project plan (QAPP). The usability of the data for baseline sediment characterization and the comparability of the data to results of other studies will depend on the implementation of rigorous, standardized quality assurance and quality control (QA/QC) measures. The FSP for the Phase 2 geophysical survey (conducted in May 1997) is provided in Appendix A. The QAPP for the testing laboratories is provided in Appendix B, and the health and safety plan (HSP) is provided in Appendix C. Standard operating procedures (SOPs) are provided in Appendix D and include the following:

- SOP 2—Sample Packaging and Shipping
- SOP 4—Field Documentation
- SOP 5—Sample Custody
- SOP 6B—Preparation of Field Quality Control Samples—Sediment



Source: NOAA (1995)

Figure 1-1. Location of Ward Cove.

TABLE 1-1. PROJECT ORGANIZATION AND RESPONSIBILITIES

Personnel	Responsibilities
<p>KPC Project Manager and Site Coordinator Andy Maloy (907) 228-2391</p>	<p>Overall responsibility for KPC activities. Oversee all program activities to ensure compliance; perform technical oversight and consultation on study design and scope; provide final approval of all necessary actions and adjustments for activities to accomplish project objectives.</p>
<p>EPA Region 10 Project Manager Karen Keeley (206) 553-2141</p>	<p>Oversee all program activities to ensure compliance; perform technical oversight; provide final approval on study design and scope; provide final approval of all necessary actions and adjustments for activities to accomplish project objectives.</p>
<p>PTI Project Manager Lucinda Jacobs (425) 643-9803</p>	<p>Oversee all program activities under KPC direction to ensure appropriate data collection and interpretation; overall responsibility for schedule, budget, and project deliverables for the sediment investigation; provide technical oversight; implement necessary actions and adjustments for activities to accomplish project objectives; main point of contact with the EPA project manager.</p>
<p>PTI Task Manager Scott Becker (425) 643-9803</p>	<p>Provide technical oversight; develop study design and scope for project; provide technical quality assurance assistance on toxicity identification evaluations.</p>
<p>PTI Chief Scientist for Field Operations Jane Sexton (425) 643-9803</p>	<p>Directs mobilization for field activities, documents field activities and observations, and collects and ships samples to the designated laboratories; provide field reports to the KPC project manager, EPA project manager, PTI project manager, and PTI task manager.</p>
<p>PTI Chemical and Engineering Properties Quality Assurance Coordinator Maja Tritt (425) 643-9803</p>	<p>Provide technical quality assurance assistance; review chemical and engineering properties sections of the quality assurance project plan (QAPP); oversee quality assurance activities to ensure compliance with QAPP; track submittal and analysis of samples to the laboratory and ensure delivery of data; monitor field investigations; prepare and submit quality assurance reports on chemical analyses and engineering properties.</p>
<p>PTI Toxicity Testing Quality Assurance Coordinator Jane Sexton (425) 643-9803</p>	<p>Provide technical quality assurance assistance; review toxicity testing sections of the QAPP; oversee quality assurance activities to ensure compliance with QAPP; track submittal and analysis of samples to the laboratory and ensure delivery of data; monitor field investigations; prepare and submit quality assurance reports on toxicity tests.</p>

- SOP 51—Station Positioning
- SOP 71B—Preparation of Reference Materials—Sediment
- SOP 100—Surface Sediment Sampling Using a Modified van Veen Grab Sampler
- SOP 101—Decontamination of Equipment—Sediments
- SOP 102—Preservation and Handling of Samples
- SOP 104—Sediment Coring Procedures Using Slide-Hammer and Gravity Corers
- SOP 130—Geochronological Dating of Sediment Using Pb-210 and Cs-137.

Example field data forms are provided in Appendix E. A detailed description of the toxicity identification evaluations (TIEs) is provided in Appendix F.

2. PHASE 2 STUDY DESIGN

The objectives of the Phase 2 sampling activities are to provide a detailed characterization of the physical features of Ward Cove (i.e., bathymetry, hydrodynamic data, sediment surface and subsurface characteristics), refine the characterization of the horizontal extent of AOFs, characterize bulk chemistry and engineering properties of sediments, provide information on National Pollutant Discharge Elimination System (NPDES) compounds in the sediment, distinguish removal and/or capping areas from no-action areas, and evaluate natural recovery rates for sediment. In accordance with EPA guidance, the Phase 2 sediment sampling effort focuses on areas of the Cove potentially impacted by releases from the KPC facility (i.e., AOFs). The rationale for delineating the spatial extent of AOFs is described in detail in Section 5.3 of PTI (1997b). The elevated chemical concentrations found adjacent to the fish cannery on the south shore of the Cove are not sampled for the Phase 2 field effort (except for NPDES monitoring chemicals; see Section 2.2.2). Several lines of evidence suggest that the elevated concentrations adjacent to the cannery are uniquely associated with the cannery, including the distinctive odor and texture of sediments adjacent to the cannery and the well-defined concentration gradients (PTI 1997a).

The Phase 2 investigation includes the following study elements:

- Geophysical survey
- Surface sediment characterization
- Sediment column characterization
- Sediment accumulation testing.

An overview of these study elements is provided below and in Figure 2-1.

2.1 GEOPHYSICAL SURVEY

A detailed geophysical survey of Ward Cove was conducted in May 1997 prior to the Phase 2 sediment sampling event. The FSP for the geophysical survey is provided in Appendix A. The information collected during the geophysical survey will be reviewed prior to Phase 2 sediment sampling to better identify station locations for sediment column characterization.

In addition to the geophysical data collected in May 1997, hydrodynamic data will be collected during the Phase 2 sediment sampling event. Information on currents, tidal elevations, and salinity/temperature profiles within Ward Cove will be collected to provide data to 1) better assess the potential of sediment transport into Tongass Narrows, 2) improve

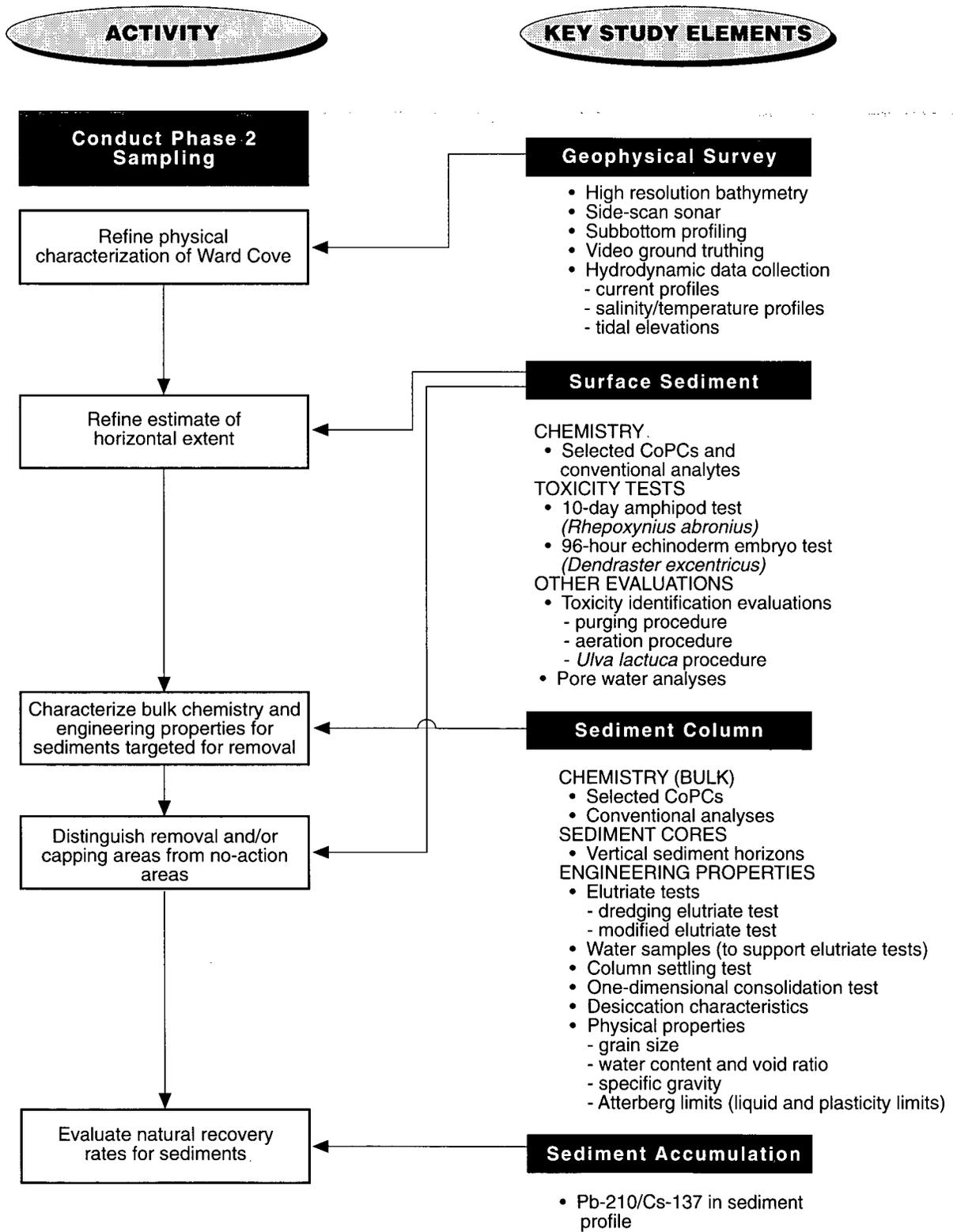


Figure 2-1. Overview of study design for Phase 2 of the Ward Cove sediment remediation project.

present knowledge of water circulation within the Cove, and 3) support the assessment of the potential for natural recovery of sediments. During the Phase 2 sediment sampling event, meters to collect current and salinity/temperature profiles will be placed at five locations in Ward Cove, and a tide gauge will be placed along the southern shoreline of the Cove (Figure 2-2). The five current meter arrays will continuously record current velocities in surface water and in deep water at each location for a period of 1 month. The tide gauge records will be used to interpret current flow data.

2.2 SURFACE SEDIMENT CHARACTERIZATION

The surface sediment characterization will refine the boundaries of the primary and secondary AOFs near the KPC facility identified during Phase 1 (described in PTI [1997b]), fill gaps in the spatial coverage of stations within and adjacent to the AOFs, provide information for NPDES monitoring, evaluate potential cause-and-effect relationships between CoPCs and sediment toxicity, and evaluate chemical composition of intertidal sediments at the mouth of Ward Creek. This information will be used to delineate the areas requiring sediment removal from those areas where sediment will be left in place for capping, natural recovery, or no action.

The characterization of surface sediments in Phase 2 will consist of the following four major components:

- Address data gaps in the spatial coverage of Phase 1 stations
- Evaluate the chemistry and toxicity of surface sediments for NPDES monitoring
- Conduct specialty tests to identify the CoPCs responsible for any observed toxicity in surface sediment
- Evaluate chemical composition of intertidal sediments.

Each of these components is discussed in detail below and summarized in Table 2-1.

2.2.1 Phase 1 Data Gaps

In Phase 2, surface sediments (top 10 cm) will be sampled at 19 stations in Ward Cove and at 2 stations in a reference area (Moser Bay, Alaska). Sediments at 16 of the 19 stations will be sampled to address gaps in the spatial coverage of Phase 1 stations (Figure 2-3). To ensure that Phase 2 results are directly comparable to Phase 1 results, the sampling and analytical methods used in Phase 2 will be the same as those used in Phase 1. Eight of the new Phase 2 stations will be located at the outer boundaries of the primary and secondary AOFs offshore from the KPC facility to confirm the validity of these boundaries. Additionally, eight new stations will be located within the primary and

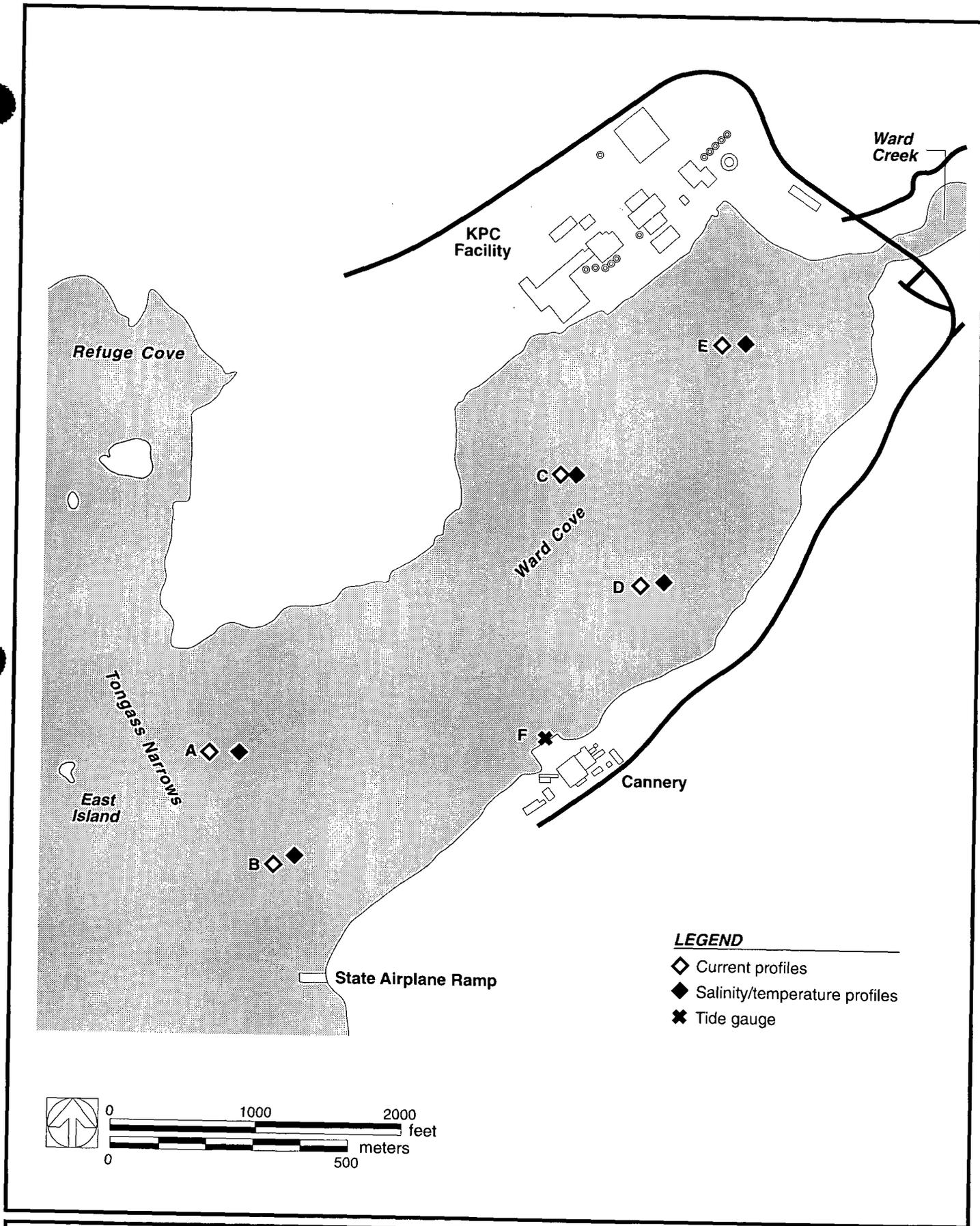


Figure 2-2. Station locations and station identifiers for Phase 2 collection of hydrodynamic data.

TABLE 2-1. SUMMARY OF PHASE 2 STUDY DESIGN

Sampling Component	Number of Stations	Number of Samples per Station	Sampling Interval	Target Analytes or Relevant Measurement
Geophysical Survey				
Bathymetry	Transects	NA	NA	Depth
Side-scan sonar	Transects	NA	NA	Surface sediment features
Video survey	Transects	NA	NA	Surface sediment features
Subbottom profiling	Transects	NA	NA	Subsurface sediment features
Hydrodynamic modeling	1-5 ^a	NA	NA	Current profiles, salinity/temperature profiles, and tidal elevations
Surface Sediment Characterization				
Removal of data gaps	21 ^b	1	0-10 cm	<p><u>Phase 2 Toxicity Tests</u></p> <ul style="list-style-type: none"> ▪ 10-day amphipod test (<i>Rhepoxynius abronius</i>) ▪ 96-hour echinoderm embryo test (<i>Dendraster excentricus</i>) <p><u>Phase 2 CoPCs</u></p> <ul style="list-style-type: none"> ▪ Grain size, total solids, TOC, total ammonia, total sulfide, BOD, COD, and 4-methylphenol
NPDES monitoring	12	1	0-10 cm	<p><u>Toxicity Tests</u></p> <ul style="list-style-type: none"> ▪ 10-day amphipod test (<i>R. abronius</i>) ▪ 96-hour echinoderm embryo test (<i>D. excentricus</i>) <p><u>CoPCs</u></p> <ul style="list-style-type: none"> ▪ Grain size, total solids, TOC, total ammonia, total sulfide, AVS, BOD, COD, arsenic, cadmium, methylmercury, total mercury, zinc, dioxins/furans, phenol, 4-methylphenol, benzoic acid, PAH compounds, and EOX
Specialty tests	3-6 ^c	1	0-10 cm	<ul style="list-style-type: none"> ▪ Toxicity identification evaluations (TIEs) <ul style="list-style-type: none"> - purging procedure - aeration procedure - <i>Ulva lactuca</i> procedure ▪ Pore water analyses (total ammonia, total sulfide, salinity, and pH)
Intertidal area	Transects ^d	1	0-5 cm	<p><u>Phase 1 CoPCs</u></p> <ul style="list-style-type: none"> ▪ Grain size, total solids, TOC, total ammonia, total sulfide, BOD, COD, cadmium, total mercury, zinc, phenol, and 4-methylphenol

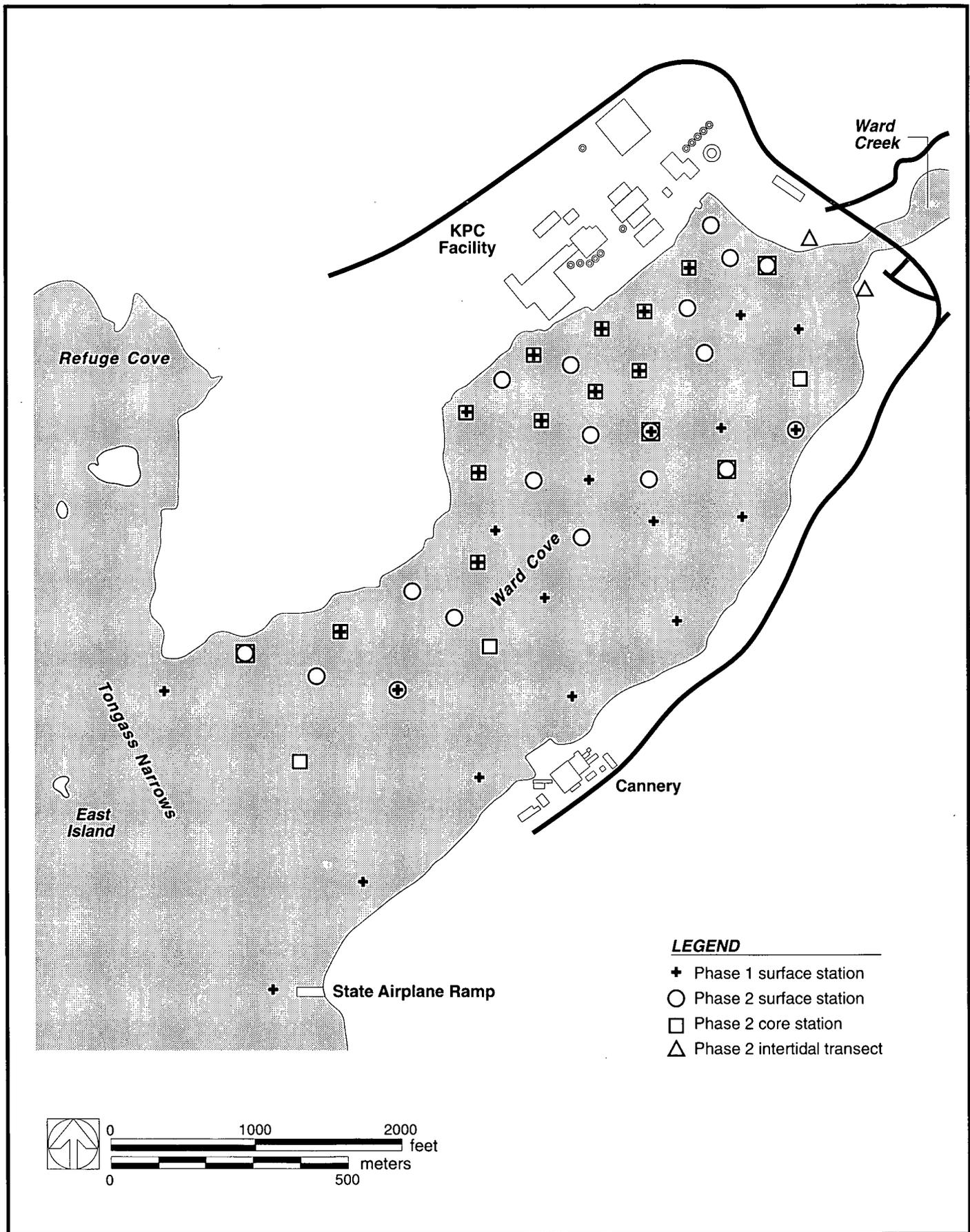


Figure 2-3. Station locations for Phase 1 and 2 sediment study in Ward Cove.

secondary AOFs in relatively large areas that were not sampled in Phase 1. Station 16 (Figure 2-4), which was evaluated in Phase 1, will be resampled to determine whether its inclusion in the primary AOF is accurate. Finally, Stations 19 and 28 (Figure 2-4), which were also evaluated in Phase 1, will be resampled to corroborate anomalous toxicity test results. The two reference stations sampled in Moser Bay in Phase 1 will also be sampled in Phase 2 to provide a comparable basis for statistical comparisons of toxicity results.

Based on the results of Phase 1, the CoPCs and biological indicators used to address data gaps in Phase 2 will be refined in the manner described below.

2.2.1.1 Phase 2 CoPCs for Surface Sediment Characterization

Phase 2 CoPCs will include all Phase 1 conventional analytes (i.e., total organic carbon, total ammonia, total sulfide, biological oxygen demand, and chemical oxygen demand) and 4-methylphenol. These analytes were retained as Phase 2 CoPCs on the basis of the human health and ecological evaluations (PTI 1997b). Sediment grain size distribution and total solids will also be determined to help interpret the Phase 2 data. In addition, a sediment sample from each station will be archived for potential future analysis.

Zinc will not be considered in the Phase 2 surface sediment characterization because it did not exceed its sediment quality standard (SQS) value anywhere in Ward Cove during Phase 1 (see Table 3-2 in PTI [1997b]). Total mercury will not be considered in the surface sediment characterization because it did not exceed its SQS value in Ward Cove during Phase 1, except at one station located immediately offshore from the KPC facility (see Table 3-2 in PTI [1997b]). Cadmium will not be considered in the surface sediment characterization because it exceeded its minimum cleanup level value at only one Phase 1 station (see Table 3-2 in PTI [1997b]) and its SQS value at only six stations. In addition to the generally low observed concentrations of these three divalent metals, the high levels of acid-volatile sulfide (AVS) found in Cove sediments (see Table 3-4 in PTI [1997b]) indicate that it is unlikely that any divalent metals are present in the Cove at toxic levels.

AVS has recently been identified as a factor that can substantially reduce the bioavailability of divalent metals in sediments (Di Toro et al. 1990; Carlson et al. 1991; Di Toro et al. 1992; U.S. EPA 1995). A recent set of papers presented in *Environmental Toxicology and Chemistry* (1996, Volume 15, Number 12) describes much of the most current information on the effects of AVS on metals bioavailability. In short, AVS binds with the metals so that they are not available for uptake by organisms. The primary divalent metals in most sediments are cadmium, copper, lead, nickel, and zinc. Although cobalt, mercury, and silver are divalent metals found in most sediments, their concentrations are usually small relative to the five primary metals (Browner 1996).

Because of the ability of AVS to reduce metals bioavailability, it is important to account for that factor when evaluating the potential toxicity of divalent metals in sediment samples. This effort is accomplished by measuring AVS and the simultaneously extracted

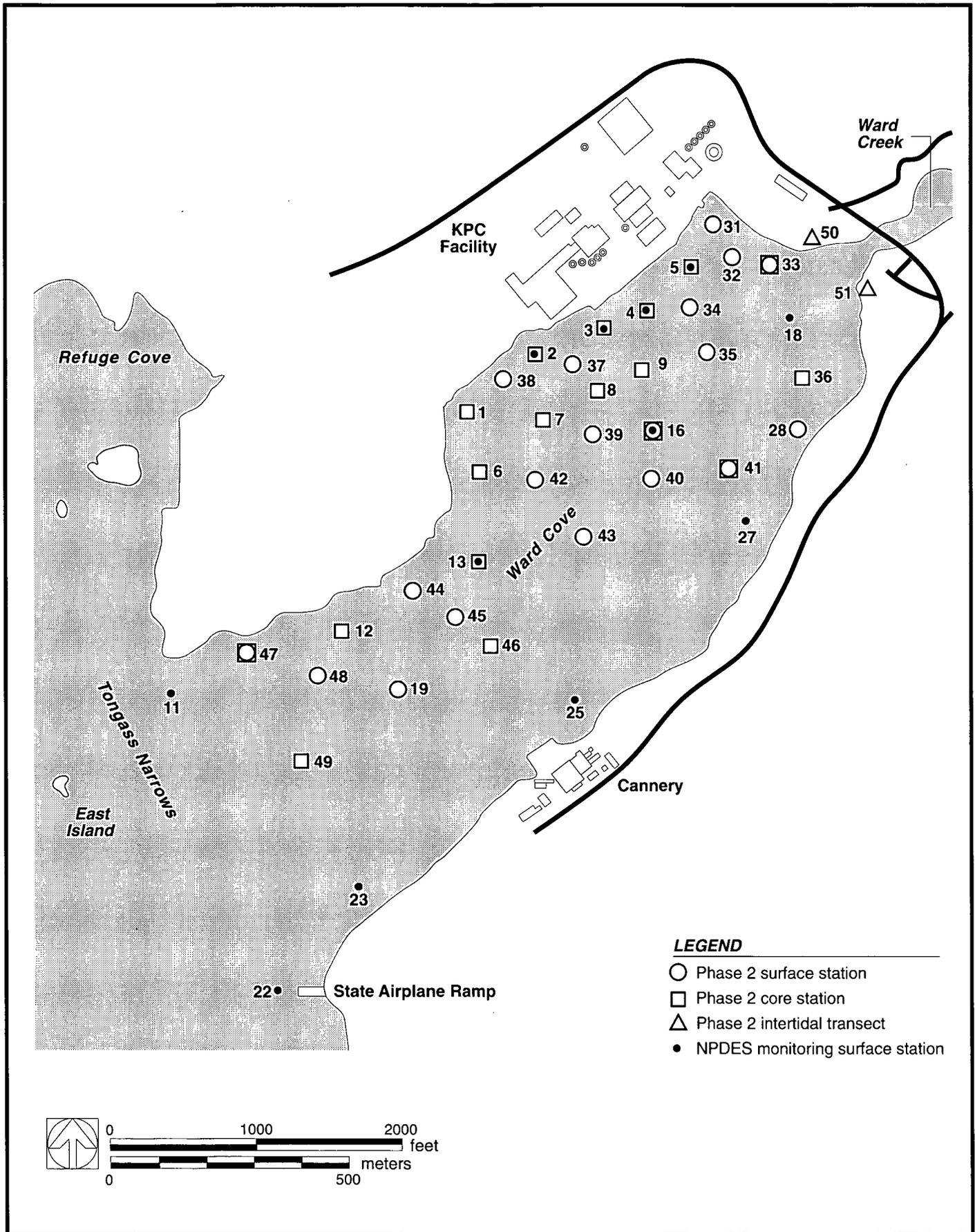


Figure 2-4. Station locations and station numbers for Phase 2 sediment study in Ward Cove.

metals (SEM) in each sample. SEM represents the fraction of metals that are not strongly bound and are therefore available to potentially cause adverse biological effects. Once AVS and SEM are quantified for a sample, they are compared on the basis of molar concentrations by calculating the SEM/AVS ratio. If the ratio is less than 1.0, the quantity of AVS exceeds the quantity of SEM and toxicity is considered unlikely because sufficient AVS exists to bind all of the SEM. If the ratio exceeds 1.0, however, toxicity may be present because there is an insufficient amount of AVS to bind all of the SEM. The presence of toxicity when the SEM/AVS ratio exceeds 1.0 is somewhat uncertain because factors other than AVS may also be present to reduce metals bioavailability.

For Ward Cove, a conservative estimate of the molar ratios of SEM and AVS indicates that the maximum SEM/AVS ratios for the 12 NPDES stations at which AVS was measured in Phase 1 range from 0.02 to 0.53, with a mean value of 0.16. The following conservative assumptions were made in estimating the SEM/AVS ratios:

- The total concentration of divalent metals at each of the 12 NPDES stations was estimated by summing the station-specific concentrations of cadmium, total mercury, and zinc determined in Phase 1 with the maximum concentrations of copper, nickel, and lead found in surface sediments throughout Ward Cove in historical studies (i.e., 110 mg/kg for copper, 54 mg/kg for nickel, and 93 mg/kg for lead; PTI 1996). Because copper, nickel, and lead were not measured at the 12 NPDES stations in Phase 1, the maximum historical concentrations were used as very conservative estimates of the concentrations of these three metals at the 12 stations sampled in Phase 1. Because molar concentrations of total mercury were much less than molar concentrations of the five other divalent metals, they had little influence on the station-specific SEM values. However, total mercury concentrations were used to calculate SEM concentrations to provide a more conservative analysis.
- The SEM fraction of each divalent metal was assumed to be 100 percent of the total concentration. Because SEM was not evaluated at the 12 NPDES stations in Phase 1, 100 percent was used as a very conservative estimate of the fraction of the total metal concentrations at each station that was present as SEM and therefore bioavailable.

Phenol will not be considered in the Phase 2 surface sediment characterization because it exceeded its SQS value at only one station located immediately offshore from the KPC facility (see Table 3-2 in PTI [1997b]), indicating that elevated concentrations of this chemical were highly localized.

Dioxins and furans will not be considered in the Phase 2 surface sediment characterization because, when the identified uncertainties in the modeling approach are considered,

exposure modeling results suggest that there are no risks of exposure to CoPCs through the food web for avian and mammalian ecological receptors at Ward Cove. In addition, dioxins and furans were not identified in the human health risk evaluation as a CoPC for human health. However, dioxins and furans will be analyzed in selected archive samples from the Phase 1 sampling effort to provide a more complete picture of dioxin and furan distributions in Ward Cove.

A total of 12 archive sediment samples from the Phase 1 sampling effort will be submitted to the laboratory for dioxin/furan analysis. The stations selected and the reasons for their inclusion are provided below:

- **Stations 1 and 6:** These two stations are located in the vicinity of KPC's former effluent outfall and near Station 7, which had one of the highest levels of tetrachlorodibenzo-*p*-dioxin (TCDD) (expressed as toxic equivalent concentration, or TEC) measured in Ward Cove. Sediment from these stations will be analyzed to better delineate areas of elevated TCDD TECs near the KPC facility and to expand the data set used to derive Ward Cove sediment quality values.
- **Station 12:** This station is located along the north shore of Ward Cove. Analysis of TCDD TECs at this station will provide a better estimate of TCDD TEC distributions toward the mouth of the Cove.
- **Stations 14 and 20:** These stations are located between the area of elevated TCDD TECs adjacent to the KPC facility and the area of elevated TCDD TECs adjacent to the fish cannery. Analysis of sediment from these two stations will be used to better delineate TCDD TECs across the Cove and to expand the data set used to derive Ward Cove sediment quality values.
- **Stations 17, 19, 20, 21, 24, and 26:** Sediment toxicity measured using the toxicity test based on *Rhepoxynius abronius* was not observed at these stations. These stations are particularly useful in developing Ward Cove sediment quality values for TCDD TECs because values are largely driven by no-effects data, which these stations will reflect.
- **Station 30:** This station is a reference station located in Moser Bay. TCDD data from this station will supplement the TCDD data collected in Tongass Narrows to provide a better estimate of TCDD concentrations in areas unaffected by the KPC facility.

2.2.1.2 Phase 2 Biological Indicators

Sediment toxicity in Phase 2 will be assessed for 21 stations using the 10-day amphipod test based on *Rhepoxynius abronius* and the 96-hour echinoderm embryo test based on

Dendraster excentricus. The test methods will be the same as the methods used in Phase 1. These two tests will be used because they were the only toxicity tests that exhibited significant ($P \leq 0.05$) adverse responses to Ward Cove sediments in Phase 1. Use of these two tests as part of a preponderance-of-evidence approach for evaluating sediment toxicity at the Phase 2 stations will therefore provide a conservative assessment that is comparable to the Phase 1 assessment. This comparability will allow the results of Phases 1 and 2 to be combined to provide a complete assessment of sediment toxicity in the AOFs near the KPC facility.

2.2.2 NPDES Monitoring

The Phase 2 sampling will be consolidated with sampling for the 1997 NPDES sediment monitoring program for efficiency and consistency. Surface sediment (top 10 cm) will be collected from 12 stations in Ward Cove, as identified in the sediment monitoring component of the KPC NPDES permit (Figure 2-4). The two reference stations sampled in Moser Bay in Phase 1 will also be sampled for the 1997 NPDES monitoring to provide a comparable basis for statistical comparisons of toxicity results (Figure 2-5). In addition to Phase 1 CoPCs, supplementary analytes will be measured at the 12 NPDES stations to satisfy the requirements of the KPC permit (i.e., AVS, methylmercury, benzoic acid, polycyclic aromatic hydrocarbon compounds, and extractable organic halides) (Table 2-1).

Sediment toxicity tests for the 1997 NPDES sediment monitoring will include the following two tests:

- 10-day amphipod test using *Rhepoxynius abronius*
- 96-hour echinoderm embryo test using the sand dollar *Dendraster excentricus*.

These tests will be used to maintain consistency with the NPDES monitoring requirements.

2.2.3 Specialty Tests to Evaluate Causality

As part of Phase 2, specialty tests will be conducted to evaluate which CoPCs are likely responsible for causing the sediment toxicity observed in the primary AOF near the KPC facility. The study design for these tests is presented in Appendix F. As discussed in PTI (1997b), the only CoPC that correlated strongly with any of the toxicity responses was ammonia, which exhibited a significant ($P \leq 0.05$) negative correlation with survival of *Rhepoxynius abronius*. The potential cause-and-effect relationship between ammonia and sediment toxicity will therefore be a primary focus of the Phase 2 specialty tests.

The Phase 2 specialty tests will include extracted pore water analyses of total ammonia, total sulfide, salinity, and pH and implementation of TIE procedures to assess the degree

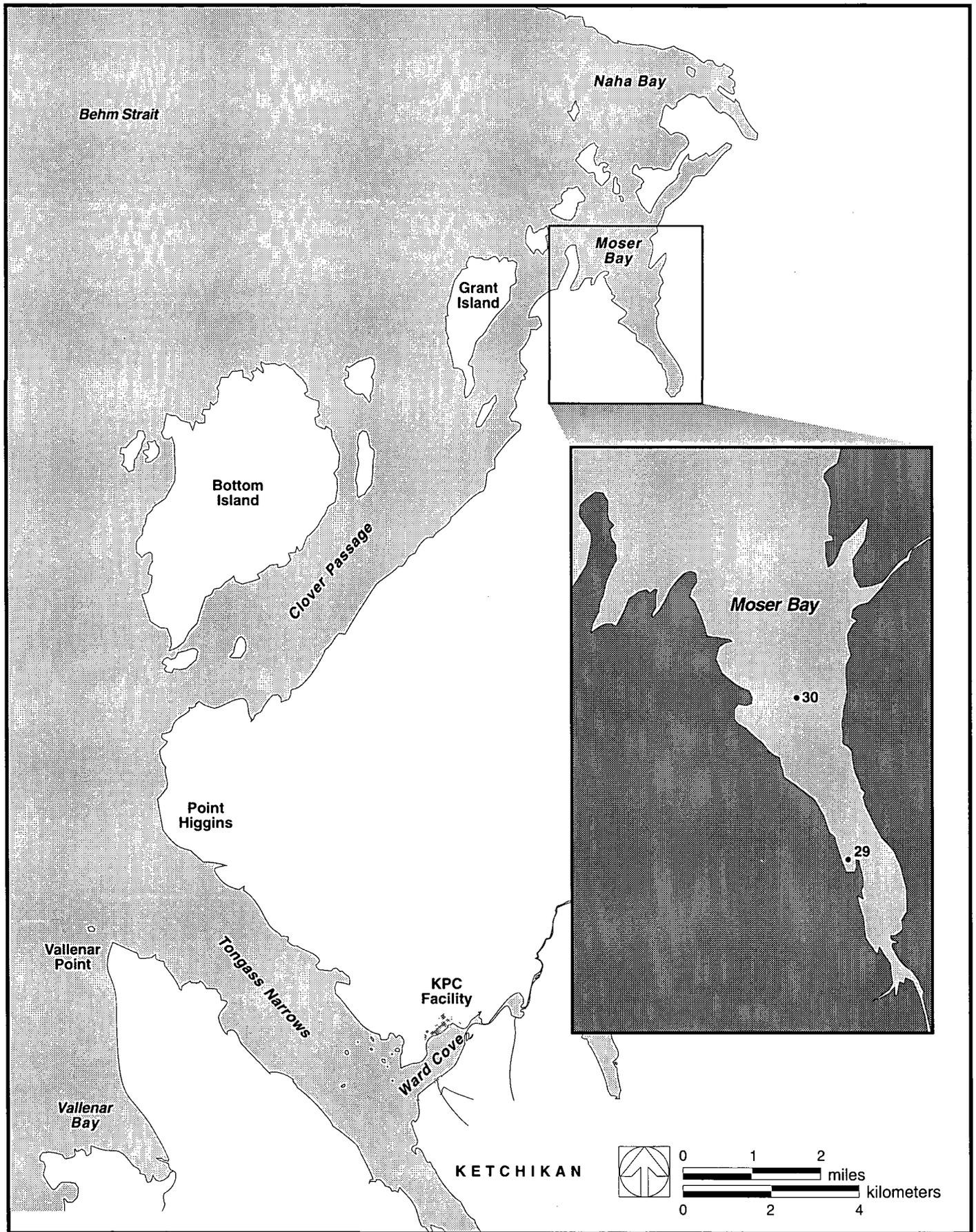


Figure 2-5. Location of reference area stations in Moser Bay for the Phase 2 study.

to which total ammonia and total sulfide are likely responsible for the observed toxicity in sediments from various parts of the AOFs. A considerable amount of work has been done in developing TIE procedures for freshwater sediments (e.g., Ankley et al. 1990; Schubauer-Berigan et al. 1995; Frazier et al. 1996; Whiteman et al. 1996). By contrast, relatively few studies have addressed TIE procedures for estuarine and marine sediments (Ho 1996, pers. comm.; Swartz 1996, pers. comm., U.S. EPA 1996). The TIE procedures used in Phase 2 will therefore be somewhat experimental in nature (see Appendix F). The target test species for TIE testing will be *Rhepoxynius abronius*, *Dendraster excentricus*, and *Ampelisca abdita*. *R. abronius* and *D. excentricus* were the only test species to exhibit significant ($P \leq 0.05$) sediment toxicity in Ward Cove during the Phase 1 investigation. The TIE testing will include exposure of the test organisms to pore water and whole sediments that have been subjected to various manipulations to fractionate the different types of CoPCs.

2.2.4 Intertidal Testing

The chemical composition of intertidal sediments near the mouth of Ward Creek will be evaluated during Phase 2. A composite sample of intertidal sediment (top 5 cm) will be collected from two transects in Ward Cove (Figures 2-3 and 2-4). Each transect will comprise 3–5 stations. Subsamples from each sediment sample will be analyzed for Phase 1 CoPCs (Table 2-1).

2.3 SEDIMENT COLUMN CHARACTERIZATION

The sediment column will be characterized to 1) evaluate the vertical extent of sediment contamination, wood debris, and other distinct sediment horizons, and 2) determine the bulk chemical and physical properties of bulk sediments within the primary AOF near the KPC facility. Major components of the Phase 2 sediment column characterization are summarized in Table 2-1. For Phase 2, sediment cores will be sampled at 18 stations in Ward Cove (Figures 2-3 and 2-4).

2.3.1 Station Locations for Bulk Chemistry Characterization

Characterization of the bulk chemistry of the sediment column will be performed at 18 station locations, as shown in Figures 2-3 and 2-4. The identified stations were all designated as part of the primary or secondary AOFs near the KPC facility during Phase 1, except for Stations 33 and 36, which are located outside of the AOFs near Ward Creek, and Station 49, which has been included in the Phase 2 study to assist with the interpretation of the sediment accumulation study (discussed below). The sediment column characterization data will be used in the remedial alternative analysis and will not be used in standard human health and ecological risk assessments.

Sediment cores in Ward Cove have been previously characterized as part of the study of solids deposition conducted by ENSR (1996). As part of that study, 11 sediment cores were collected, ranging in length from 14 to 70 in. Results from the study were abstracted from ENSR (1996) and were reproduced in Appendix B of PTI (1997b). Three characteristic sediment horizons were identified:

- An upper layer of watery, black, silty organic matter
- A middle zone, primarily in the vicinity of the KPC dock, that consisted primarily of wood debris
- A lower zone of native sediments (i.e., clayey silts and silty clays).

The upper zone and middle zone (when present) reflect the sediment horizons influenced by KPC.

Eighteen sediment cores will be collected during Phase 2. Fourteen of the sediment cores will be located within the primary AOF, one sediment core will be located within the secondary AOF, and three sediment cores will be located outside the AOFs. The equipment and procedures used to collect the cores will be similar to those used to collect cores for the solids deposition study (ENSR 1996). A description of the sediment (e.g., color, texture, presence of wood or shell debris) and distance from the top of the core will be recorded for each sediment core. Representative horizons throughout each core will be composited to create a single sample representing bulk chemical characteristics at each sampling location, unless a visible waste horizon is present (e.g., an ash layer). If a distinctive waste horizon (other than wood debris) is present, a discrete sediment sample will be collected from that horizon for analysis of CoPCs. Representative horizons will be composited from the sediment surface to a depth not to exceed 1 m. Where horizon thickness is greater than 1 m, two samples will be collected. Non-native and native sediments will not be composited. Because of high analytical costs for dioxin and furan analyses, a sediment sample will be collected and composited across discrete horizons from 2–4 contiguous cores (Figure 2-6), which are expected to be similarly impacted. In addition, sediments are already being composited across a vertical horizon at each core station, and thus, compositing across a horizontal area is not inconsistent with the approach to assess representative chemical concentrations for a given area.

To characterize the sediment that will become surface sediment after the dredging, the top 0–1 ft of native sediments will be collected at Stations 2, 16, and 49 (Figure 2-7) and analyzed for Phase 1 CoPCs. In addition, an archive sample of the top 0–1 ft of native sediment will be collected from each of the Phase 2 core stations. These archive samples will be frozen (at -20°C) and held for possible future analysis of Phase 1 CoPCs. The decision of whether to analyze the archive samples will be made after the sediment chemical data from the sediment cores are reviewed.

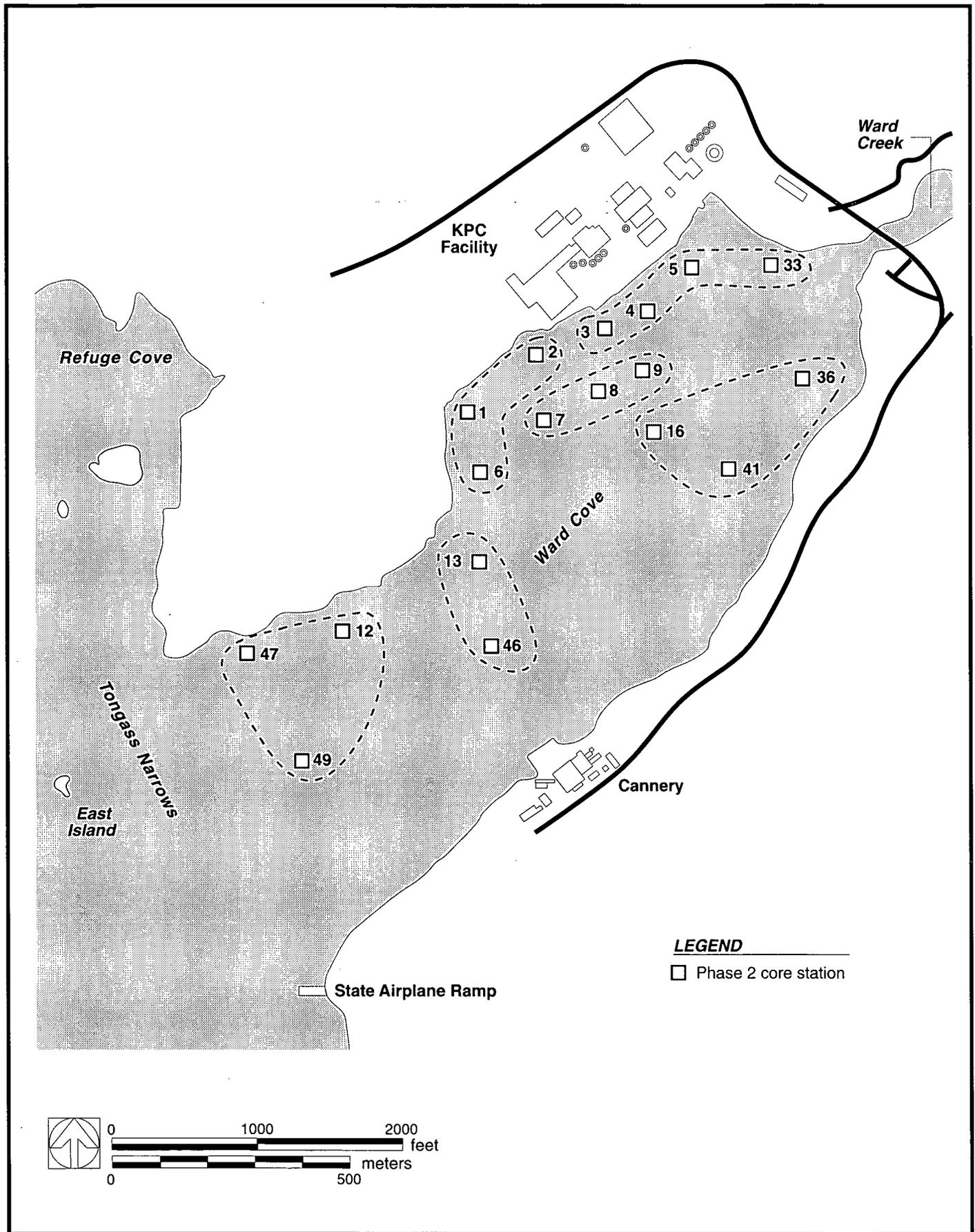


Figure 2-6. Station locations and station numbers for Phase 2 sediment composites for dioxin and furan analyses.

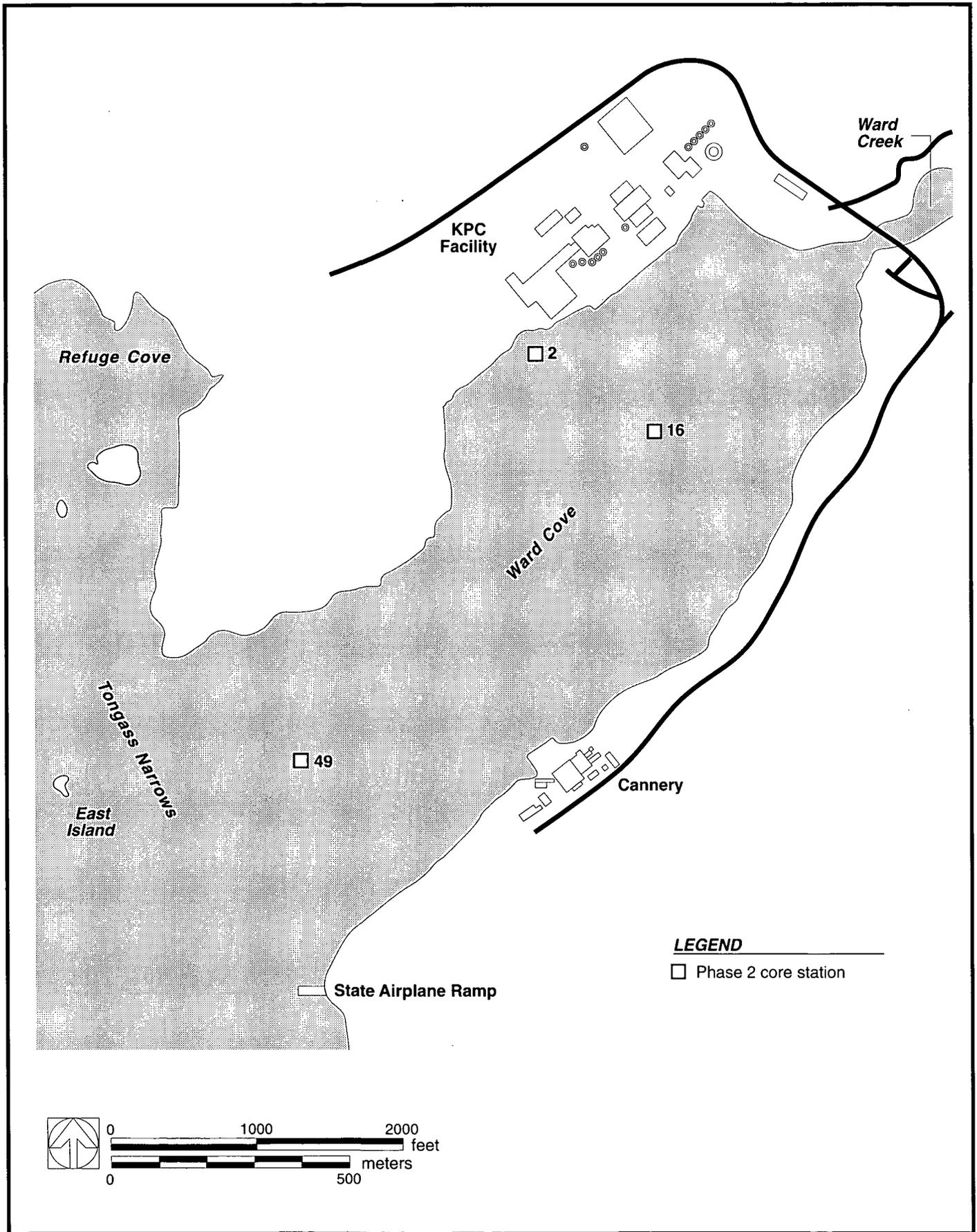


Figure 2-7. Station locations and station numbers for Phase 2 collection of native sediments.

2.3.2 Target Analytes

Target analytes for sediment cores in Phase 2 will include all CoPCs addressed in the Phase 1 investigation (Table 2-1). Although some CoPCs were screened out from the Phase 2 surface sediment characterization effort, it is possible that deeper sediment horizons may have elevated chemical concentrations. For this reason, all of the CoPCs identified for Phase 1 will be analyzed to characterize the bulk chemistry of sediment cores at all 18 stations. In addition, sediment from each sample will be archived for potential future analysis.

2.3.3 Engineering Properties

Engineering tests to be performed on Cove sediments (summarized in Table 2-1) are the following:

- **Elutriate Tests**—Two composite samples from the site will be subjected to dredging elutriate tests (DRET) and modified elutriate tests (MET). Water from the Cove will be collected for use in these tests.
- **Column Settling Tests**—Two composite samples will be subjected to column settling tests. Water from the Cove will also be needed to conduct these tests.
- **Consolidation Tests**—Two composite samples will be subjected to one-dimensional consolidation tests.
- **Desiccation Characteristics**—Two composite samples will be evaluated for desiccation characteristics.
- **Physical Properties**—The following physical properties will be determined in 12 samples:
 - Grain size
 - Water content and void ratio
 - Specific gravity
 - Atterberg limits (liquid and plasticity limits).

The elutriate, column settling, consolidation, and desiccation tests will all be performed on two samples of material considered to be representative of the material to be dredged: one sample representing a composite of core samples from Stations 1 and 7, and one sample representing a composite of core samples from Stations 3 and 5 (Figure 2-8). The compositing of samples for analysis of these properties will be based on PSDDA guidelines. Cores will be composited over a 4-ft depth interval, the interval considered to be

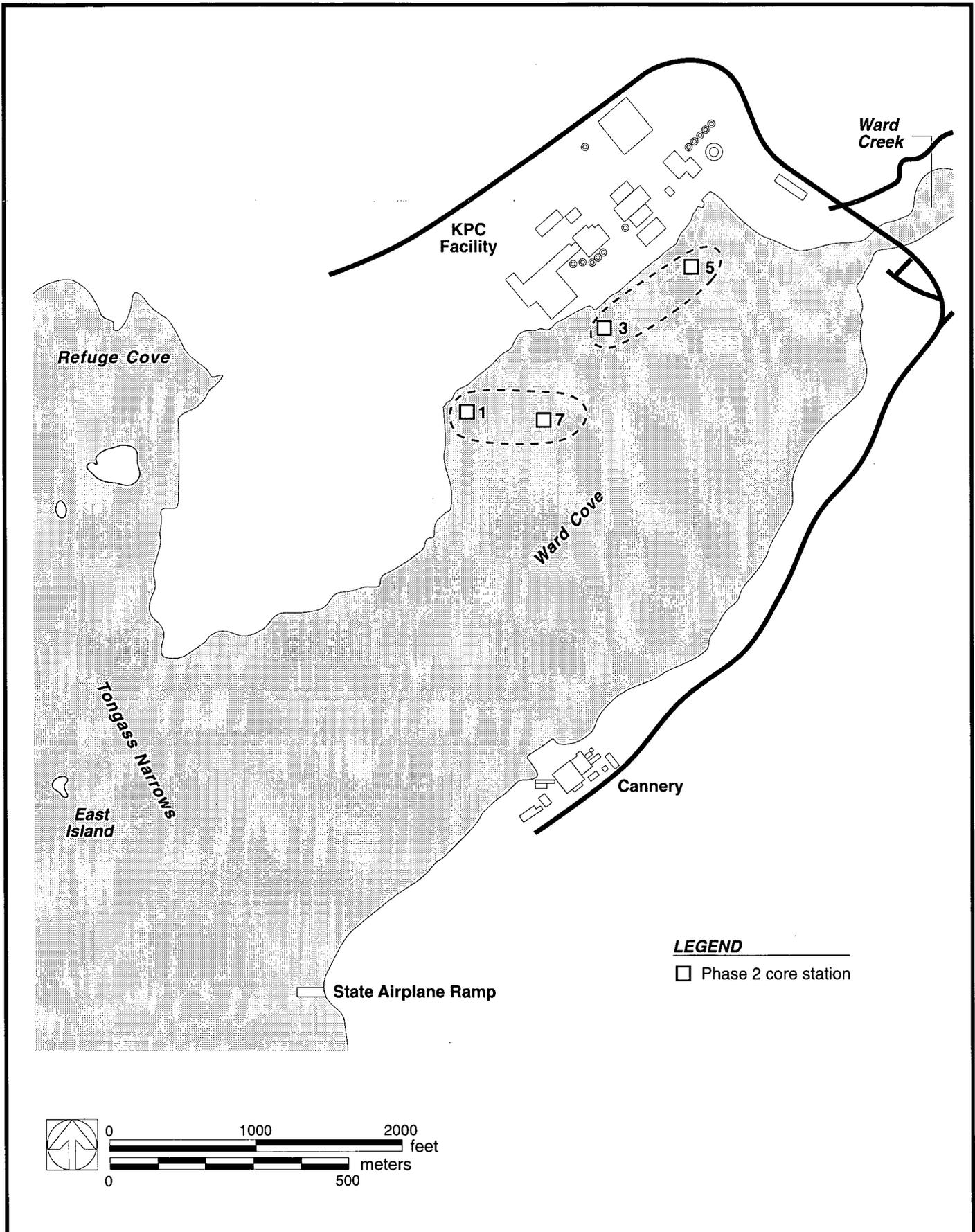


Figure 2-8. Station locations and station numbers for Phase 2 sediment column characterization of engineering properties.

representative of a typical dredge cut. Water samples will be collected near the sediment surface in the vicinity of the core sampling stations.

The elutriate tests (DRET and MET) will be used to evaluate the potential for CoPCs to be released to surface water during dredging, transportation, placement, and dewatering. The elutriate tests that will be performed for the Phase 2 sediment investigation provide a simplified simulation of the dredging and disposal process to determine the concentration of CoPCs in a dredged material slurry. The MET compares total chemical concentrations to dissolved chemical concentrations in a dredged material slurry. Test water and elutriate samples will be analyzed for conventional parameters (total ammonia and total suspended solids), total and dissolved metals (cadmium, mercury, and zinc), and total and dissolved organic compounds (phenol, 4-methylphenol, and dioxin/furans).

The column settling test will be used to analyze the settling characteristics of the sediment. The results of this test will be relevant to the design properties of potential disposal locations. The consolidation tests and desiccation characteristics will be used to evaluate dredged fill and compressible foundation characteristics. The results of these tests will provide information relevant to the selection of the type of dredge required (i.e., hydraulic or mechanical), the disposal site conditions, and the identification of potential capping alternatives.

Physical properties relevant to engineering design will be analyzed on a minimum of one sample for each sediment type visually identified during core sampling. Based on the previous core survey conducted in the Cove (ENSR 1996), approximately 12 samples will be required: three samples from each of the four cores used to characterize engineering properties (Stations 1, 3, 5, and 7; Figure 2-8). The physical tests will also be relevant to the selection of dredging equipment and disposal alternatives.

Two additional engineering tests, the standard penetration test and long-term column leachate testing, may be conducted when a likely subset of preferred remedial alternatives has been identified. The standard penetration test will be needed to support the analysis of design features if a near-shore disposal site is a likely alternative. Long-term column leachate testing is applicable to near-shore and upland disposal alternatives and provides the most relevant, site-specific information once the location and volume of material to be dredged has been identified.

2.4 SEDIMENT ACCUMULATION TESTING

Sediment cores will be collected from two stations (Stations 40 and 49; Figure 2-9) in Ward Cove to characterize the accumulation rates of sediments. Sediment accumulation rates will be used to evaluate the rate at which existing sediments will be buried by newly deposited clean sediments following closure of the KPC facility. This information will be incorporated into natural recovery modeling to predict future sediment conditions in the absence of releases from the KPC facility.

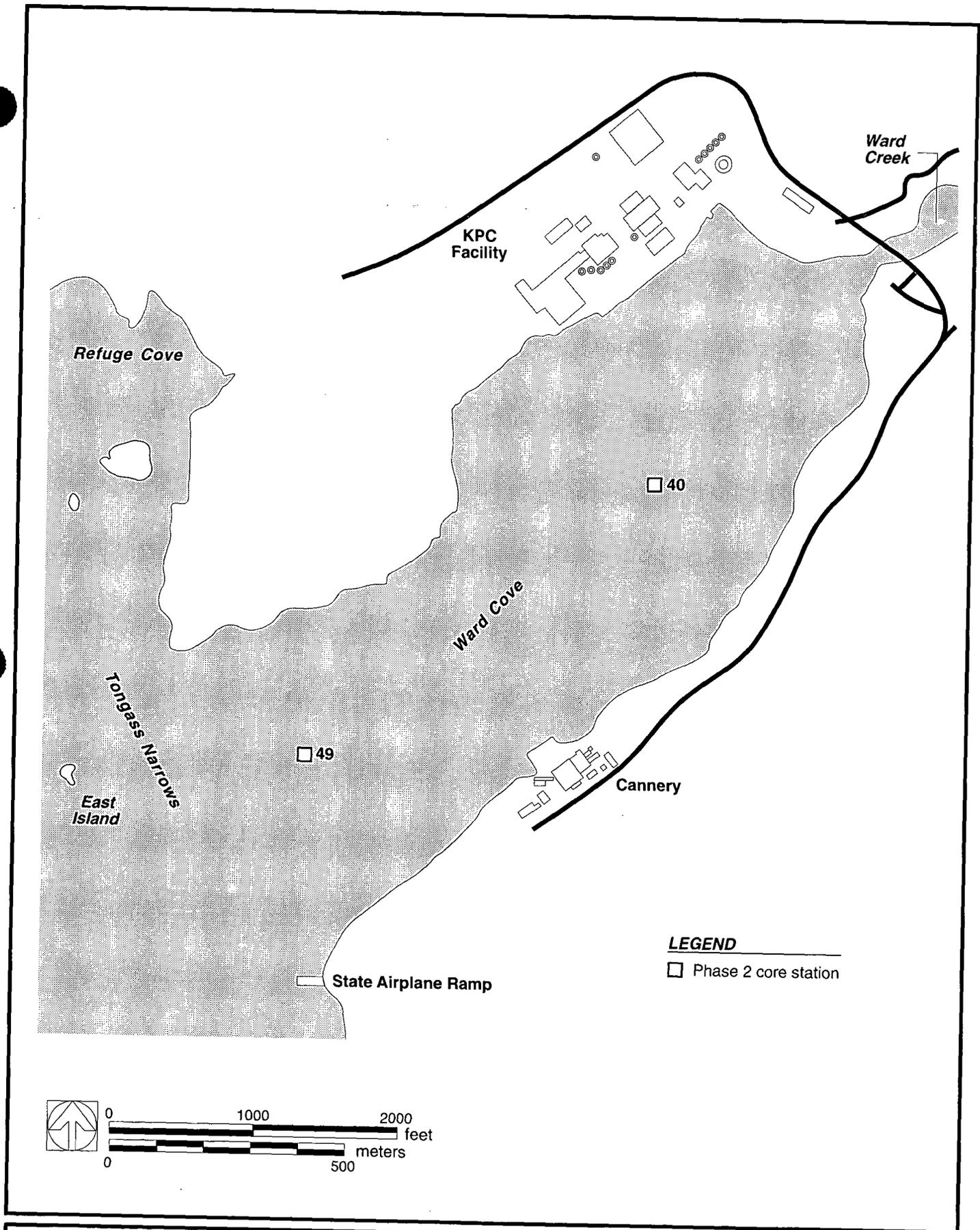


Figure 2-9. Station locations and station numbers for Phase 2 sediment accumulation study in Ward Cove.

Stations for sediment accumulation will be positioned outside of the area of influence of the historical and current outfalls from the KPC facility and outside the influence of the fish cannery (Figure 2-9). Sediment cores of approximately 60–80 cm in length will be collected. Depth horizons of 2 cm will be extruded from the core to provide a high resolution characterization of the depth distribution of key variables. Lead-210 and cesium-137 will be analyzed at multiple depths throughout the core to determine 1) the rate at which lead-210 decreases below the surface mixed layer, and 2) the depth horizon of the cesium-137 maximum. The analysis will be conducted in a tiered fashion to determine if cores are suitable for lead-210 evaluation before the detailed analyses are conducted. Sediments can be dated on the basis of lead-210 measurements by relating the time scale of lead-210 decay (22-year half-life) to the sediment depth over which a comparable decrease in lead-210 activity occurs (Carpenter et al. 1985). Sediments can be dated on the basis of the cesium-137 measurements because the worldwide subsurface maximum in cesium-137 can be related to the period of nuclear testing, with the peak corresponding to 1963 and the first appearance corresponding to 1955.

3. SEDIMENT SAMPLING

Detailed procedures for sample collection, handling, and shipping are described in this section. Procedures are included for the following tasks:

- Documenting the locations of stations and establishing sample identifiers
- Collecting and compositing sediment samples
- Processing samples to ensure proper subsampling of each matrix
- Cleaning equipment, work surfaces, and sampling implements prior to commencing sampling and between stations
- Completing standard forms to document the collection effort and field conditions.

The anticipated schedule of sample collection and safety considerations are also discussed in this section.

3.1 STATION LOCATIONS AND SAMPLE TYPES

Sediment samples will be collected from 39 stations in Ward Cove and from 2 intertidal transects at the mouth of Ward Creek, following field procedures that are consistent with PSEP protocols (PSEP 1986a,b, 1989a,b). The proposed station locations are shown in Figure 2-4. In addition, surface sediment samples will be collected from two stations at a nearby reference area (i.e., Moser Bay) (Figure 2-5).

The number and type of sediment samples to be collected during Phase 2 are summarized below:

- **Surface Sediment Samples**—A composite sample of surface sediment (0–10 cm sediment horizon) will be collected from 19 stations in Ward Cove for the Phase 2 investigation, from an additional 6 stations for NPDES monitoring, and from 2 reference stations in Moser Bay. A field duplicate sample for chemistry analyses will be collected from two of the stations in Ward Cove. Subsamples from each sediment sample will be analyzed for selected organic compounds and conventional parameters and subjected to two sediment toxicity tests (Table 3-1). Specialized tests (i.e., TIEs) will also be performed on surface sediment

TABLE 3-1. SUMMARY OF ANALYTES AT EACH STATION

Station	Surface, Core, or Transect	NPDES Number ^a	Conventional Variables							Metals					
			Grain Size	Total Solids	TOC	Total Ammonia	Total Sulfide	AVS	BOD	COD	Arsenic	Cadmium	Methyl-mercury	Total Mercury	Zinc
Ward Cove															
1	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
2	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
	Surface	43	X	X	X	X	X	X	X	X	X	X	X	X	X
3	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
	Surface	40	X	X	X	X	X	X	X	X	X	X	X	X	X
4	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
	Surface	39	X	X	X	X	X	X	X	X	X	X	X	X	X
5	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
	Surface	41	X	X	X	X	X	X	X	X	X	X	X	X	X
6	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
7	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
8	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
9	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
11	Surface	48	X	X	X	X	X	X	X	X	X	X	X	X	X
12	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
13	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
	Surface	46	X	X	X	X	X	X	X	X	X	X	X	X	X
16	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
	Surface	44	X	X	X	X	X	X	X	X	X	X	X	X	X
17 ^a	Surface		X	X	X	X	X	--	--	--	--	--	--	--	--
18	Surface	42	X	X	X	X	X	X	X	X	X	X	X	X	X
19	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
22	Surface	51	X	X	X	X	X	X	X	X	X	X	X	X	X
23	Surface	49	X	X	X	X	X	X	X	X	X	X	X	X	X
25	Surface	47	X	X	X	X	X	X	X	X	X	X	X	X	X
27	Surface	45	X	X	X	X	X	X	X	X	X	X	X	X	X
28	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
31	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
32	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
33	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
34	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
35	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
36	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
37	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
38	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
39	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
40	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
41	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
42	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
43	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
44	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
45	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
46	Core		X	X	X	X	X	--	X	X	--	X	--	X	X

3-2

TABLE 3-1. (cont.)

Station	Surface, Core, or Transect	NPDES Number ^a	Conventional Variables							Metals					
			Grain Size	Total Solids	TOC	Total Ammonia	Total Sulfide	AVS	BOD	COD	Arsenic	Cadmium	Methyl-mercury	Total Mercury	Zinc
47	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
48	Surface		X	X	X	X	X	--	X	X	--	--	--	--	--
49	Core		X	X	X	X	X	--	X	X	--	X	--	X	X
Intertidal															
50	Transect		X	X	X	X	X	--	X	X	--	X	--	X	X
51	Transect		X	X	X	X	X	--	X	X	--	X	--	X	X
Moser Bay															
29	Surface		X	X	X	X	X	X	X	X	X	X	X	X	X
30	Surface		X	X	X	X	X	X	X	X	X	X	X	X	X

TABLE 3-1. (cont.)

Station	Surface, Core, or Transect	NPDES Number ^a	Organic Compounds						Toxicity Tests		Specialty Tests ^c		
			Dioxins/ Furans ^b	Phenol	4-Methyl- phenol	Benzoic Acid	PAH Compounds	EOX	Pb-210 Cs-137	10-Day Amphipod	96-Hour Echinoderm	TIE	Pore Water Analyses
Ward Cove													
1	Core		X ¹	X	X	--	--	--	--	--	--	--	--
2	Core		X ¹	X	X	--	--	--	--	--	--	--	--
	Surface	43	X	X	X	X	X	X	--	X	X	--	--
3	Core		X ²	X	X	--	--	--	--	--	--	--	--
	Surface	40	X	X	X	X	X	X	--	X	X	--	--
4	Core		X ²	X	X	--	--	--	--	--	--	--	--
	Surface	39	X	X	X	X	X	X	--	X	X	--	--
5	Core		X ²	X	X	--	--	--	--	--	--	--	--
	Surface	41	X	X	X	X	X	X	--	X	X	--	--
6	Core		X ¹	X	X	--	--	--	--	--	--	--	--
7	Core		X ³	X	X	--	--	--	--	--	--	X	X
8	Core		X ³	X	X	--	--	--	--	--	--	--	--
9	Core		X ³	X	X	--	--	--	--	--	--	--	--
11	Surface	48	X	X	X	X	X	X	--	X	X	--	--
12	Core		X ⁴	X	X	--	--	--	--	--	--	X	X
13	Core		X ⁵	X	X	--	--	--	--	--	--	--	--
	Surface	46	X	X	X	X	X	X	--	X	X	--	--
16	Core		X ⁶	X	X	--	--	--	--	--	--	--	--
	Surface	44	X	X	X	X	X	X	--	X	X	X	X
17 ^o	Surface		--	--	--	--	--	--	--	--	--	X	X
18	Surface	42	X	X	X	X	X	X	--	X	X	--	--
19	Surface		--	--	X	--	--	--	--	X	X	--	--
22	Surface	51	X	X	X	X	X	X	--	X	X	--	--
23	Surface	49	X	X	X	X	X	X	--	X	X	--	--
25	Surface	47	X	X	X	X	X	X	--	X	X	--	--
27	Surface	45	X	X	X	X	X	X	--	X	X	--	--
28	Surface		--	--	X	--	--	--	--	X	X	--	--
31	Surface		--	--	X	--	--	--	--	X	X	--	--
32	Surface		--	--	X	--	--	--	--	X	X	--	--
33	Core		X ²	X	X	--	--	--	--	--	--	--	--
	Surface		--	--	X	--	--	--	--	X	X	--	--
34	Surface		--	--	X	--	--	--	--	X	X	X	X
35	Surface		--	--	X	--	--	--	--	X	X	--	--
36	Core		X ⁶	X	X	--	--	--	--	--	--	--	--
37	Surface		--	--	X	--	--	--	--	X	X	--	--
38	Surface		--	--	X	--	--	--	--	X	X	--	--
39	Surface		--	--	X	--	--	--	--	X	X	--	--
40	Surface		--	--	X	--	--	--	X ^h	X	X	--	--
41	Core		X ⁶	X	X	--	--	--	--	--	--	--	--
	Surface		--	--	X	--	--	--	--	X	X	--	--
42	Surface		--	--	X	--	--	--	--	X	X	--	--
43	Surface		--	--	X	--	--	--	--	X	X	--	--
44	Surface		--	--	X	--	--	--	--	X	X	X	X
45	Surface		--	--	X	--	--	--	--	X	X	--	--
46	Core		X ⁵	X	X	--	--	--	--	--	--	--	--

3-4

TABLE 3-1. (cont.)

Station	Surface, Core, or Transect	NPDES Number ^a	Organic Compounds						Toxicity Tests		Specialty Tests ^c		
			Dioxins/ Furans ^b	Phenol	4-Methyl- phenol	Benzoic Acid	PAH Compounds	EOX	Pb-210 Cs-137	10-Day Amphipod	96-Hour Echinoderm	TIE	Pore Water Analyses
47	Core		X ⁴	X	X	--	--	--	--	--	--	--	--
	Surface		--	--	X	--	--	--	--	X	X	--	--
48	Surface		--	--	X	--	--	--	--	X	X	--	--
49	Core		X ⁴	X	X	--	--	--	X	--	--	--	--
Intertidal													
50	Transect		--	X	X	--	--	--	--	--	--	--	--
51	Transect		--	X	X	--	--	--	--	--	--	--	--
Moser Bay													
29	Surface		X	X	X	X	X	X	--	X	X	--	--
30	Surface		X	X	X	X	X	X	--	X	X	--	--

TABLE 3-1. (cont.)

Station	Surface, Core, or Transect	NPDES Number ^a	Engineering Tests			Native Sediments ^e	Archive Sample ^f
			MET ^b	DRET ^b	Other ^d		
Ward Cove							
1	Core		X ¹	X ¹	X ¹	A	--
2	Core		--	--	--	X	--
	Surface	43	--	--	--	--	A
3	Core		X ²	X ²	X ²	A	--
	Surface	40	--	--	--	--	A
4	Core		--	--	--	A	--
	Surface	39	--	--	--	--	A
5	Core		X ²	X ²	X ²	A	--
	Surface	41	--	--	--	--	A
6	Core		--	--	--	A	--
7	Core		X ¹	X ¹	X ¹	A	--
8	Core		--	--	--	A	--
9	Core		--	--	--	A	--
11	Surface	48	--	--	--	--	A
12	Core		--	--	--	A	--
13	Core		--	--	--	A	--
	Surface	46	--	--	--	--	A
16	Core		--	--	--	X	--
	Surface	44	--	--	--	--	A
17 ^g	Surface		--	--	--	--	A
18	Surface	42	--	--	--	--	A
19	Surface		--	--	--	--	A
22	Surface	51	--	--	--	--	A
23	Surface	49	--	--	--	--	A
25	Surface	47	--	--	--	--	A
27	Surface	45	--	--	--	--	A
28	Surface		--	--	--	--	A
31	Surface		--	--	--	--	A
32	Surface		--	--	--	--	A
33	Core		--	--	--	A	--
	Surface		--	--	--	--	A
34	Surface		--	--	--	--	A
35	Surface		--	--	--	--	A
36	Core		--	--	--	A	--
37	Surface		--	--	--	--	A
38	Surface		--	--	--	--	A
39	Surface		--	--	--	--	A
40	Surface		--	--	--	--	A
41	Core		--	--	--	A	--
	Surface		--	--	--	--	A
42	Surface		--	--	--	--	A
43	Surface		--	--	--	--	A
44	Surface		--	--	--	--	A
45	Surface		--	--	--	--	A
46	Core		--	--	--	A	--

TABLE 3-1. (cont.)

Station	Surface, Core, or Transect	NPDES Number ^a	Engineering Tests			Native Sediments ^e	Archive Sample ^f
			MET ^b	DRET ^b	Other ^d		
47	Core		--	--	--	A	--
	Surface		--	--	--	--	A
48	Surface		--	--	--	--	A
49	Core		--	--	--	X	--
Intertidal							
50	Transect		--	--	--	--	A
51	Transect		--	--	--	--	A
Moser Bay							
29	Surface		--	--	--	--	A
30	Surface		--	--	--	--	A

- Note:**
- - analyte will not be measured
 - X - analyte will be measured
 - A - sample will be archived for possible future analysis
 - AVS - acid-volatile sulfide
 - BOD - biological oxygen demand
 - COD - chemical oxygen demand
 - DRET - dredging elutriate test
 - EOX - extractable organic halide
 - MET - modified elutriate test
 - NPDES - National Pollutant Discharge Elimination System
 - PAH - polycyclic aromatic hydrocarbon
 - TIE - toxicity identification evaluation
 - TOC - total organic carbon

^a Corresponding station identified in KPC's NPDES permit.

^b Superscript numerals indicate which cores will be composited into a single sample (see Figures 2-6 and 2-8). Water for elutriate preparation will also be collected at these stations.

^c The six stations indicated on this table for specialty tests are candidate stations. The final selection of stations for these tests will be made prior to the Phase 2 sampling event and will be based on the results of the preliminary testing in May. If a core station is selected for specialty tests, then the surface sediment (top 10 cm) at that station will also be collected and analyzed for Phase 2 chemicals of potential concern.

^d Other engineering properties tests are as follows: column settling, one-dimensional consolidation, desiccation characteristics, and physical properties, including grain size, water content and void ratio, specific gravity, and Atterberg limits (liquid and plasticity limits).

^e Native sediments are defined as sediments that existed in the cove prior to the deposition of material potentially affected by KPC.

^f If enough sediment is present at a specific sediment horizon in a sediment core, then an archive sample will be collected. This determination will be made in the field during the Phase 2 sampling event.

^g Only specialty tests (and associated conventional variables) will be performed at this Phase 1 station.

^h A core sample will be collected at this station and analyzed for only Pb-210, Cs-137, grain size, and total solids.

samples collected from Ward Cove (i.e., 3–6 stations; see Figure F-4 in Appendix F).

- **Subsurface Sediment Samples**—Subsurface sediment (see details provided in Section 2.3.1) will be collected from 18 stations in Ward Cove (Figure 2-4). Based on the stratigraphy of the sediment column, a determination will be made in the field on the exact number of samples that will be collected from each sediment core. A field duplicate sample for chemistry analyses will be collected from one of the stations in Ward Cove. Subsamples from each sediment sample will be analyzed for selected organic compounds, metals, and conventional parameters (Table 3-1) for sediment column characterization. Dioxins and furans will be analyzed on composite sediment samples collected at selected stations (Figure 2-6). Engineering properties of the sediment and sediment accumulation rates (i.e., lead-210 and cesium-137) will also be tested at selected stations (Figures 2-8 and 2-9, respectively). To characterize the sediment that will become surface sediment after the dredging, the top 0–1 ft of native sediments will be collected at Stations 2, 16, and 49 (Figure 2-7) and analyzed for Phase 1 CoPCs. In addition, an archive sample of the top 0–1 ft of native sediment will be collected from each of the Phase 2 core stations.
- **Intertidal Sediment Samples**—Two composite samples of intertidal sediment (0–5 cm sediment horizon) will be collected from two transects (respectively) near the mouth of Ward Creek in Ward Cove (Figure 2-4). A field duplicate sample for chemistry analyses will be collected from one of the intertidal transects. Each transect will comprise 3–5 stations. Photographs will be taken of each intertidal transect. The station locations will be noted on a map. Subsamples from each sediment sample will be analyzed for selected organic compounds, metals, and conventional parameters (Table 3-1).
- **Water Samples**—Water samples for elutriate testing will be collected approximately 1 m above the sediment surface at each of the stations selected for analysis of engineering properties (Figure 2-8).
- **Archive Samples**—Subsamples from all stations will be archived for possible future chemical analyses.

Hydrodynamic data will also be collected at selected locations in Ward Cove during the Phase 2 sediment sampling event. Current meters equipped with salinity/temperature probes will be deployed at five locations in Ward Cove, and a tide gauge will be placed along the southern shoreline of the Cove (Figure 2-2).

**TABLE 3-2. PHASE 1 STATION LOCATIONS FOR SEDIMENTS
 THAT WERE SAMPLED IN WARD COVE AND MOSER BAY
 IN 1996 AND THAT WILL BE RESAMPLED IN 1997**

Station	Location	
	Easting	Northing
Ward Cove		
1	327050.34	6143138.21
2	327128.50	6143222.78
3	327292.25	6143326.34
4	327403.45	6143360.43
5	327496.24	6143460.56
6	327035.35	6142998.51
7	327175.53	6143088.76
8	327290.75	6143162.32
9	327392.31	6143236.20
11	326348.09	6142505.78
12	326735.20	6142651.17
13	327042.57	6142786.97
16	327425.42	6143083.20
18	327744.55	6143318.45
19	326860.63	6142508.12
22	326568.66	6141844.09
23	326772.52	6142075.62
25	327245.13	6142499.94
27	327615.01	6142903.46
28	327742.16	6143100.56
Moser Bay		
29	332566	6158216
30	332436	6158872

3.2 VESSEL OPERATION AND NAVIGATION

The specific sampling vessel that will be used during the field effort will be identified by the selected contractor, in consultation with KPC. The vessel operator will be thoroughly familiar with accurate deployment and retrieval of the sampling gear. Vessel positioning will be achieved with a differential global positioning system integrated with Hypack navigation software capable of locating the survey vessel with an absolute accuracy of ± 2 m and a repeatable accuracy of ± 1 m. Differential corrections will be obtained from the U.S. Coast Guard beacon on Annette Island. The positioning system used for this sampling effort will provide latitude and longitude coordinates for the station locations. Repositioning at Phase 1 stations will be based on these coordinates (Table 3-2). Water depth will be noted, and all sample locations will be documented.

The specific personnel to be used during the field effort will be identified by the selected contractor. During the sampling cruise, the sampling team will consist of a vessel operator, a chief scientist, and two or three crew members. The chief scientist will be responsible for all decisions concerning sample collection. If a significant deviation from this FSP needs to be considered because of conditions encountered during sampling (e.g., repositioning of a station location), the chief scientist will notify the PTI Environmental Services (PTI) project manager, the KPC project manager, and the EPA project manager.

3.3 SAMPLE IDENTIFIERS

Sample identifiers will be established before field sampling begins and assigned to each sample as it is collected. Sample identifiers consist of codes designed to fulfill three purposes: 1) to identify related samples (i.e., replicates) to ensure proper data analysis and interpretation, 2) to obscure the relationships between samples so that laboratory analysis will be unbiased by presumptive similarities between samples, and 3) to track individual sample containers to ensure that the laboratory receives all of the material associated with a single sample. To accomplish these purposes, each container is assigned a sample identifier, a sample number, and a tag number. These codes and their uses are described below:

- **Sample Identifier**—A system of sample identifiers will be established by the environmental consultant before samples are collected. The sample identifiers may contain codes that identify the type of sample, related field replicates, station locations, and other sample information and will conform to any database requirements, such as length and format. The sample identifiers are entered into the field logs and database for use during data interpretation. To prevent laboratory personnel from associating related samples, sample identifiers will not be used to identify samples on the sample jars or on any forms that are provided to the laboratories with the samples.

- **Sample Number**—The sample number is an arbitrary number assigned to each sediment sample collected. All subsamples of a composited field sample will have the same sample number. Each field replicate of a given type will have a different sample number, and the sample numbers of related field replicates will not necessarily have any shared content. The sample number appears on the sample containers, the chain-of-custody forms, and the sample analysis request forms.
- **Tag Number**—A different sample tag number is attached to each sample container. If the amount of material (i.e., everything associated with a single sample number) is too large for a single container, each container will have the same sample number and a different sample tag. A sample will also be split between containers if a different preservation technique is used for each container (i.e., because different analyses will be conducted). The sample tag number will appear on the chain-of-custody and sample analysis request forms. Tag numbers are used by laboratories only to confirm that they have received all of the containers that were filled and shipped. Data are reported by sample number.

Sample numbers will be assigned sequentially in the field; sample tags will be preprinted with tag numbers.

3.4 SAMPLING PROCEDURES

In this section, procedures are described for collecting sediments using a grab sampler, gravity corer, and hand-held grab sampler (i.e., stainless-steel spoons). Sample collection and handling methods (including criteria for judging the acceptability of samples) are described in greater detail in the following sections.

3.4.1 Surface Sediment Sample Collection

Surface sediment samples (0–10 cm sediment horizon) will be collected for analysis of chemical concentrations, physical characteristics, and toxicity tests at 25 stations in Ward Cove (19 Phase 2 stations and an additional 6 NPDES monitoring stations) and at 2 reference stations in Moser Bay. Although the target sediment horizon is 0–10 cm, shallower horizons may be collected at selected stations if the target horizon cannot be sampled after repeated attempts.

Surface sediment samples will be collected using a 0.06-m² stainless-steel van Veen grab sampler in accordance with standard methods used by PSEP (1986a,b; 1989a,b). Before sampling begins at a station, the van Veen grab sampler and all other sampling equipment will be scrubbed with Alconox[®], rinsed with site seawater, rinsed with acetone and then hexane, air-dried, and rinsed with site seawater. The acetone and hexane rinsates will be collected in a container, and the small volume collected will be allowed to evaporate.

After a sediment sample is retrieved and judged to be acceptable (see discussion below), the overlying water will be siphoned off and the upper 10 cm of sediment will be collected in accordance with PSEP (1986a) guidelines. Stainless-steel spatulas and spoons will be used to collect the sediment. A stainless-steel ruler will be used to ensure that the sampling criterion for adequate penetration depth is met and that the correct amount (i.e., 10 cm) of sediment has been removed. Sediment touching the sides of the grab sampler will not be collected.

At each sampling station, a minimum of three grab samples will be collected. The surface (top 10 cm) sediment will be collected from each grab sample, and the three samples will be composited to achieve a sample more representative of average surface sediment characteristics at that station. The sediment grab samples at each station will be composited in a stainless-steel bowl and covered with aluminum foil until a sufficient volume of sediment is collected. Sediment in the bowl will then be mixed using a large stainless-steel spoon to achieve a uniform texture and color before subsamples are taken and transferred to pre-cleaned glass containers with Teflon[®]-lined lids.

Material collected in the grab sampler will be evaluated for acceptability according to whether the following criteria are met:

- The sampler is not overfilled
- Overlying water is present
- The overlying water is not excessively turbid
- The sediment surface is relatively undisturbed
- A sediment penetration depth of at least 11 cm is attained.

The chief scientist will evaluate all samples collected. If a sample fails to meet the above criteria, it could be rejected and discarded away from the station. However, if the only limitation in the sample acceptability is the penetration depth, the sample will be retained in a separate container in the event that the target sediment horizon of 0–10 cm cannot be sampled.

If surface sediment cannot be collected with a van Veen grab sampler, as may be the case if a large quantity of large wood debris is present, sediment samples may be collected by divers using hand-held corers. To collect cores by hand, the divers will push a short, 10-cm diameter coring tube into the sediment to a distance of at least 15 cm. The top of the tube will be capped, and the bottom will be excavated by hand. The coring tube will be gently removed and capped at the bottom. Aboard the sampling vessel, the sediment will be extruded upward from the coring tube using PVC pipes pressed against the bottom of a rubber stopper inserted into the tube's lower end; the overlying water will be allowed to slowly drain over the top of the tube. When the sediment surface reaches the top of the

tube, a sample transfer container (open at both ends) will be placed over the top of the tube, and the sediment will be extruded upward into the sample container. When the sediment surface is 10 cm from the top of the sample container, the container will be slid away from the coring tube, thereby slicing the top 10 cm off the sediment core. The sediment will be transferred to a stainless-steel bowl for compositing and subsampling.

3.4.2 Subsurface Sediment Sampling

Subsurface sediment samples will be collected from 18 stations in Ward Cove with a gravity corer. For coring stations where the sediment is relatively hard (i.e., near-shore zones), either hand-held diver cores, a vibrocorer, or an impact corer may be used to obtain adequate penetration if the gravity corer gives unacceptable penetration. Polyethylene core liners will be used in the corer. Prior to sampling, all core liners will be washed in sequence with a standard detergent (e.g., Alconox[®]) and then hexane, rinsed with distilled/deionized water, and then air-dried. During storage and transport, core liners will be capped at both ends to prevent contamination.

While the corer is being lowered in the water column, its position will be monitored with sonar. When the inlet of the corer is approximately 2 m above the sediment, the lowering of the corer will be stopped, the boat location will be confirmed, and the angle of the hydrowire will be determined. When the angle of the hydrowire is less than 5 degrees, the corer will be lowered into the sediment at a rate of 30 cm/s or less. If the weather is windy, the lowering rate will be increased to maintain at least a 10:1 ratio between the vertical speed of the corer and the horizontal drift speed of the boat. Cable will be released through the winch until there is slack in the line. If the boat drifts significantly (e.g., because of windy conditions), slack in the line will be permitted only briefly to prevent pulling the corer out at an angle. A video camera may be used to better position the coring device (i.e., to avoid areas covered by wood debris).

The corer will be retrieved at a controlled rate to minimize agitation of the core. Retrieval will be stopped as soon as the top of the corer reaches the water surface. A plug will then be inserted in the bottom end of the corer using an extension arm to prevent the core from slipping out when the corer is raised out of the water. The corer will be brought onboard the sampling vessel and immediately stabilized to prevent it from tipping or falling. Care will be taken at all times to keep the corer in a vertical position.

Once the corer is secured onboard the sampling vessel, the polyethylene liner that contains the sample will be removed from the corer barrel and inspected. Each core will be evaluated for acceptability according to whether the following criteria are met:

- At least 5 cm of overlying water is present
- The overlying water is not excessively turbid

- The sediment surface is relatively undisturbed
- The planned penetration depth of the corer was achieved.

If the corer penetrates too far into the sediment (i.e., less than 5 cm of overlying water is present), the weight of the corer or the time that the hydrowire is allowed to stay slack will be reduced.

The chief scientist will evaluate the acceptability of all sediment cores collected. If a sediment core fails to meet any of the above criteria, it will be rejected and discarded away from the station at a later time. Rejected cores will be extruded immediately to minimize the period of contact with the core liner. Liners that contained a rejected core will be used again only at the same station, after washing with site water to remove adhering sediments. If the specified penetration depth is not achieved after three or more attempts, the chief scientist may decide to relocate the station slightly. If the slight relocation of the station does not improve the penetration depth, the station may be temporarily abandoned and the contractor's project manager will be notified. The final decision as to how to treat temporarily abandoned stations will be made after consultation with the KPC project manager and the EPA project manager.

All acceptable cores will be kept in an upright position and at 4°C onboard the sampling vessel. The acceptable cores will be removed from the sampling vessel as soon as possible after the time of collection, and the cores will be transferred to the onshore field laboratory where the sediment samples will be collected. At the field laboratory, each core tube will be clamped in an upright position and the overlying water in the sample tube will be siphoned off of the sediment surface. The core will then be laid horizontally, the core liner will be split, and the top section of the core liner will be removed. All acceptable cores will be photographed next to a meter stick using 35-mm color print film. Acceptable cores will then be inspected for physical characteristics that may alter the sectioning pattern.

For most sediment cores, the depth of interest in the sediment is the depth at which the pulp mill compounds are above background concentrations. Therefore, core samples will be collected and analyzed from the top down to the first stratum that is at background (i.e., native sediments). Representative horizons throughout each core to a depth not to exceed 3 ft will be composited to create a single sample representing bulk chemical characteristics at each sampling location. Where horizon thickness is greater than 3 ft, two composite samples will be collected. If a waste horizon is present (e.g., an ash layer), a discrete sediment sample will be collected from that horizon for analysis of CoPCs.

To characterize the sediment that will become surface sediment after any proposed dredging, the top 0–1 ft of native sediments will be collected for analysis at the stations shown in Figure 2-8. An archive sample of the top 0–1 ft of native sediments will be collected at all of the other Phase 2 subsurface sediment stations. A sediment sample will

also be collected for analysis and composited across discrete horizons from the stations shown in Figure 2-6 and analyzed for dioxins and furans.

If sample compositing is required, each core section will be placed in a separate stainless-steel bowl and covered with aluminum foil until all remaining sections have been sampled. The sediment from each core section will then be mixed with large stainless-steel spoons or a stainless-steel paddle to achieve a uniform texture and color. The homogenized sediment will be subsampled and transferred to sample containers.

Immediately after they are filled, all sample containers will be placed on ice in a cooler or in a refrigerator designated for sediment samples. Samples will be stored at 4°C. Sufficient headspace will be left in containers that are to be frozen (i.e., archive samples) to accommodate expansion during freezing. Chain-of-custody and sample analysis request forms will be completed and signed by the chief scientist at the end of each day and shipped with the samples to the analytical laboratories.

3.4.3 Intertidal Sediment Sample Collection

Surface sediment samples (0–5 cm sediment horizon) will be collected for analysis of chemical concentrations and physical characteristics at two intertidal transects at the mouth of Ward Cove (Figures 2-3 and 2-4). Each transect will comprise 3–5 stations. Surface sediment samples will be collected using stainless-steel spatulas and spoons in accordance with standard methods used by PSEP (1986a,b; 1989a,b). A stainless-steel ruler will be used to ensure that the sampling criterion for adequate penetration depth is met and that the correct amount (i.e., 5 cm) of sediment has been removed. Before sampling begins at a station, all sampling equipment will be scrubbed with Alconox[®], rinsed with distilled water, rinsed with acetone and then hexane, air-dried, and rinsed with distilled water. The acetone and hexane rinsates will be collected in a container, and the small volume collected will be allowed to evaporate.

The surface (top 5 cm) sediment will be collected from each station along the transect (i.e., 3–5 stations), and the sediment from each station will be composited to achieve a sample more representative of average surface sediment characteristics in the intertidal area. The sediment samples collected at each station will be composited in a stainless-steel bowl and covered with aluminum foil until a sufficient volume of sediment is collected. Sediment in the bowl will then be mixed with a large stainless-steel spoon to achieve a uniform texture and color before subsamples are taken and transferred to pre-cleaned glass containers with Teflon[®]-lined lids. Immediately after they are filled, all sample containers will be placed on ice in a cooler at 4°C. For those subsamples that will be frozen (i.e., archive samples), sufficient headspace will be left in each jar to accommodate expansion during freezing. Photographs will be taken of each intertidal transect. The station locations will be noted on a map. Chain-of-custody and sample analysis request forms will be completed and signed by the chief scientist at the end of each day and shipped with the samples to the analytical laboratories.

3.4.4 Water Sample Collection

Water samples will be collected for use in the tests that determine the engineering properties of the sediments proposed for dredging. Approximately 130 L of water will be collected at approximately 1 m above the sediment surface at each of the stations selected for analysis of engineering properties (Figure 2-8). Water samples will be collected using either a peristaltic pump with Teflon[®] tubing or a water-bottle sampler (e.g., Niskin, Go-Flo) in accordance with standard methods used by PSEP (1991). The water-bottle sampler will consist of a cylindrical tube with stoppers at each end and a closing device that is activated by a messenger or an electrical signal. The water-bottle sampler will sample a discrete parcel of water at the designated depth (i.e., 1 m above the sediment surface). The water-bottle sampler will be attached directly to a hydrographic wire or cable and lowered to the desired sampling depth.

Prior to deployment, the stoppers of the water-bottle samplers will be cocked open on the sampling vessel. It is critical that the interior of the sampler and the stoppers remain free from contamination. Care will be taken by all members of the sampling team to avoid touching the insides of the sampler and stoppers. The interior of each water-bottle sampler will be washed periodically with 10-percent hydrochloric acid.

After cocking, the sampler is lowered to the designated depth (i.e., 1 m above the sediment surface). As it is being lowered through the water column, the sampler will be left open at both ends so that water is not trapped within the device. Once the sampler reaches the desired depth, it will be allowed to equilibrate with ambient conditions for 2-3 minutes before being closed. After equilibration, the closing device will be activated by a messenger or electrical signal. Once the water-bottle sampler is brought onboard the sampling vessel, the stoppers will be checked for complete seals. If a stopper is not properly sealed, then the water sample will be rejected and a new water sample will be collected.

Immediately after they are filled, all sample containers will be placed on ice in a cooler at 4°C. Chain-of-custody and sample analysis request forms will be completed and signed by the chief scientist at the end of each day and shipped with the samples to the analytical laboratories.

3.4.5 Sample Handling

All sample containers will be provided by the laboratory and prepared in accordance with PSEP guidelines (PSEP 1986a) prior to field operations. Sample containers will be kept closed and in a cooler until use. As they are collected, samples will be fully labeled, recorded in the field notebook along with other pertinent collection data, and returned to coolers as soon as possible. Immediately after they are filled, all sample containers will be placed on ice in a cooler at 4°C. For those subsamples that will be frozen (i.e., archive

samples), sufficient headspace will be left in each jar to accommodate expansion during freezing.

Sediment and water samples for all chemical analyses will be shipped on ice (4°C) to the testing laboratories and will be stored at 4°C until analysis and final disposition of the samples. All field samples, except archived chemical samples, will be analyzed as soon as possible after receipt at the laboratory. Maximum sample holding times are stipulated in Table 3-3 and in the QAPP (Appendix B). Archived sediment samples will be placed at an angle to minimize breakage and will be placed in an outer plastic bag to avoid cross contamination should breakage occur. The archived samples for possible future chemical analyses will be held frozen at the laboratory pending a decision to begin analyses within the specified holding time for frozen samples.

Chain-of-custody and sample analysis request forms will be completed and signed at the end of the day and shipped with the samples to the analytical laboratories. Samples will be shipped or sent by courier to arrive at the participating laboratories within 3–5 days of sample collection.

Samples shipped or sent by courier will be packed in bubble-wrap plastic to prevent breakage, and chain-of-custody seals will be placed across the cooler lids. Chain-of-custody forms will be enclosed in the coolers with the samples and will be signed at the laboratory upon receipt. A copy of the signed form will be returned to the field sampling contractor and filed in the project file. Sample packaging and shipping requirements are described in SOP 2, *Sample Packaging and Shipping* (Appendix D).

3.5 DOCUMENTATION

The integrity of each sample from the time of collection to the point of data reporting must be maintained throughout the study. Proper record-keeping and chain-of-custody procedures will be implemented to allow samples to be traced from collection to final disposition. Various logs and forms required to adequately identify and catalog station and sample information include the following:

- **Station/Sample Log**—Each gear deployment event will be recorded on a station/sample log sheet. One or more station/sample log sheets will be completed for each station sampled. The station name, date, gear, cast number, depth, and location coordinates will be recorded on each log sheet. Penetration depth, sediment type, sediment color, and sediment odor will also be recorded for sediment samples. The sample type, sample identifier, sample number, and sample tag number will also be recorded on the station/sample log sheet.
- **Chain-of-Custody Form**—The sample and tag numbers of each sample container will be recorded on a chain-of-custody form. The chain-of-custody form will also identify the sample collection date and time,

TABLE 3-3. SAMPLE PRESERVATION AND HANDLING PROCEDURES

Analyte	Approximate Laboratory Subsample	Container	Preservation and Handling	Maximum Holding Time (from date of collection)
Sediment				
Toxicity Tests				
Amphipod mortality (<i>R. abronius</i>)	1.25 L	2 × 1-L glass jar, Teflon®-lined lid	Store in dark; 4°C	14 days
Echinoderm abnormality (<i>D. excentricus</i>)	200 g	1-L glass jar; Teflon®-lined lid	Store in dark; 4°C	14 days
Conventional Analyses				
Total ammonia	20 g	Wide-mouth, high-density polyethylene jar	4°C (do not freeze)	7 days
Total organic carbon	1 g	Wide-mouth, high-density polyethylene jar	4°C or freeze	28 days 6 months
Total sulfide	10 g	125-mL wide-mouth, high-density polyethylene jar	No headspace; 4°C (do not freeze)	14 days
Acid-volatile sulfide	10 g	125-mL wide-mouth, high-density polyethylene jar	No headspace; 4°C (do not freeze)	14 days
Biological oxygen demand	1–5 g	Wide-mouth, high-density polyethylene jar	No headspace; 4°C	7 days
Chemical oxygen demand	0.5–2 g	Wide-mouth, high-density polyethylene jar	4°C	7 days
Grain size	250 g	Wide-mouth, high-density polyethylene jar	4°C (do not freeze)	180 days
Total solids	10 g	Wide-mouth, high-density polyethylene jar	4°C	180 days
Metals				
Methylmercury	1 g	Wide-mouth, high-density polyethylene jar	4°C	28 days ^a
Total mercury	0.2 g	Wide-mouth, high-density polyethylene jar	4°C	28 days ^a
Arsenic, cadmium, zinc	1 g	Wide-mouth, high-density polyethylene jar	4°C	180 days

TABLE 3-3. (cont.)

Analyte	Approximate Laboratory Subsample	Container	Preservation and Handling	Maximum Holding Time (from date of collection)
Organic Compounds				
Phenol, 4-methylphenol, PAHs, benzoic acid	10-30 g	Wide-mouth glass jar; Teflon®-lined lid	4°C	14 days to extraction ^{b,c}
Dioxin and furan congeners	10-30 g	Wide-mouth glass jar; Teflon®-lined lid	4°C; store in dark	30 days to extraction ^{b,d}
Extractable organic halides	1-5 g	Wide-mouth glass jar; Teflon®-lined lid	4°C; store in dark	28 days
Radionuclides/Sediment Accumulation Testing				
Cesium-137	2 g	Wide-mouth, high-density polyethylene jar	4°C or freeze	1 year
Lead-210	5 g	Wide-mouth, high-density polyethylene jar	4°C or freeze	1 year
Sediment and Water for Engineering Properties Tests				
MET				
Sediment	3,000 g wet weight ^e	4 × 1-L glass bottle, Teflon®-lined lid or 2 × 1-gal plastic container with Teflon® bag	4°C (do not freeze)	14 days
Water	20 L	20 × 1-L glass bottle, Teflon®-lined lid or 6 × 1-gal plastic container with Teflon® bag	4°C (do not freeze)	14 days
DRET				
Sediment	200 g wet weight ^f	1 × 1-L glass bottle, Teflon®-lined lid or 1 × 1-gal plastic container with Teflon® bag	4°C (do not freeze)	14 days
Water	20 L	20 × 1-L glass bottle, Teflon®-lined lid or 6 × 1-gal plastic container with Teflon® bag	4°C (do not freeze)	14 days
Column Settling Tests				
Sediment	20 L	6 × 1-gal plastic container	4°C (do not freeze)	180 days
Water	80 L	24 × 1-gal plastic container	4°C (do not freeze)	180 days
Sediment for Consolidation Tests	1 L	1 × 1-gal plastic container	4°C (do not freeze)	180 days

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TABLE 3-3. (cont.)

Analyte	Approximate Laboratory Subsample	Container	Preservation and Handling	Maximum Holding Time (from date of collection)
Sediment for Desiccation Characteristics	1 L	1 × 1-gal plastic container	4°C (do not freeze)	180 days
Sediment for Physical Properties (grain size, water content, void ratio, specific gravity, and Atterberg limits)	225 g wet weight	8 oz glass jar, Teflon®-lined lid or 8 oz high-density polyethylene jar	4°C (do not freeze)	180 days
Sediment for Pore Water Extraction	1 L ^a	1-L glass jar, Teflon®-lined lid	4°C	5 days
Extracted Pore Water				
Ammonia	25 mL	High-density polyethylene bottle	Add H ₂ SO ₄ to pH <2; 4°C	28 days
Total sulfide	100 mL	125-mL glass VOA vial	Add 0.5 mL zinc acetate, NaOH to pH >9; 4°C	5 days
Salinity and pH	25 mL	High-density polyethylene bottle	4°C	48 hours
Sediment Elutriate				
Conventional Analyses				
Total ammonia	25 mL	High-density polyethylene bottle	Add H ₂ SO ₄ to pH <2; 4°C	28 days
Total suspended solids	250 mL	High-density polyethylene bottle	Add H ₂ SO ₄ to pH <2; 4°C	7 days
Metals				
Cadmium, zinc (total and dissolved)	400 mL	High-density polyethylene bottle	Add HNO ₃ to pH <2	6 months
Total mercury (total and dissolved)	200 mL	High-density polyethylene bottle	Add HNO ₃ to pH <2	28 days
Organic Compounds				
Phenol, 4-methylphenol (total and dissolved)	1 L	1-L amber glass jar, Teflon®-lined lid	4°C; store in dark	7 days ^c
Dioxin and furan congeners (total and dissolved)	1 L	1-L amber glass jar, Teflon®-lined lid	4°C; store in dark	30 days ^d

Footnotes on next page.

TABLE 3-3. (cont.)

Note: Sample requirements for toxicity identification evaluation tests using *Rhepoxynius abronius*, *Dendraster excentricus*, and *Ampelisca abdita* will be determined when details of these procedures are established.

- DRET - dredging elutriate test
- MET - modified elutriate test
- PAH - polycyclic aromatic hydrocarbon

- ^a Samples for total mercury will maintain their integrity for several years if stored frozen (Bloom 1995, pers. comm.) and may be archived at -20°C for up to 1 year for this project.
- ^b Samples may be archived in the freezer (-20°C) for up to 1 year (PSEP 1989).
- ^c Extracts must be analyzed within 40 days of extraction.
- ^d Analysis must be completed within 45 days of extraction.
- ^e A total of 2.5 L of sediment should be provided to the laboratory. Approximately 600 g dry weight will be required to complete the MET.
- ^f A total of 250 L of sediment should be provided to the laboratory. Approximately 10 g wet weight will be required to complete the DRET.
- ^g A sediment volume of 1 L is expected to yield at least 200 mL of pore water. Final sample size requirements will be determined during the preliminary sampling in May.

the type of sample, the project, and the chief scientist. The chain-of-custody form will be sent to the laboratory along with the sample. Chain-of-custody forms will be completed in triplicate with one copy retained by the chief scientist.

- **Sample Analysis Request Form**—Each set of samples sent to a laboratory will be accompanied by a sample analysis request form. The sample analysis request form will identify samples by sample number and sample tag. For each sample tag, the sample analysis request form will identify the preservative or other sample pretreatment applied and the analyses to be conducted by referencing a list of specific analytes or the statement of work for the laboratory. One copy of this form will be retained by the chief scientist, and the original form will accompany the shipment. A combined chain-of-custody and sample analysis request form may be used.
- **Sample Label and Custody Seal**—A sample label will be completed for each sample. Sample containers will be labeled at the time of sampling with the following information: sample number, site name, sampling date and time, sampling personnel, preservative (if appropriate), and tag number. A custody seal will be placed across the lid of the cooler prior to shipping.

At the time of sampling, the sample number and analysis code for each sediment subsample will be recorded in the field logbook. At the end of each day and prior to shipping or storage, chain-of-custody entries will be made for all samples. Finally, information on the labels will be checked against field logbook entries, and samples will be re-counted.

The chief scientist is responsible for properly completing all forms. Station and sample logs must be completed at the time the observations are made. Chain-of-custody and sample analysis request forms will be completed and signed before the end of each sampling day and before the samples are removed from the vessel or pass from the control of the chief scientist. Chain-of-custody forms will be signed at each additional point of transfer of samples between the field and the laboratory and within the laboratory. Copies of all forms will be retained by the field sampling contractor.

A bound, waterproof field notebook with consecutively numbered pages will also be completed for this sampling event. All daily field activities will be documented in indelible ink in this notebook. At a minimum, PTI's chief scientist will record the following information in the daily notebook:

- Date and time of entry (24-hour clock)
- Project name and location
- Project number

- Time and duration of daily sampling activities
- Weather conditions
- Variations, if any, from specified sampling protocols and reasons for deviations
- Name of person making entries and other field personnel
- Onsite visitors, if any
- Specific information on each type of sampling activity (e.g., surface sediment sampling or subsurface sediment coring).

Appendix E contains examples of the various logs and forms that are used to record information at each sampling location. Any changes in the sampling procedures described in this FSP will be documented in the field notebook.

3.6 SAMPLING SCHEDULE

Sampling for Phase 2 is anticipated to begin on July 21, 1997, pending approval of this FSP by EPA. In the interim, sampling equipment and sampling personnel will be mobilized. Sampling is estimated to require 15–20 days at the site (depending on the difficulty of obtaining adequate sediment samples at all stations) and 1 day at the reference area (i.e., Moser Bay). The sequence of sample collection will be arranged to maximize efficiency while minimizing potential cross-sample contamination. For example, efforts will be made to sample adjacent stations as a group, but stations that may have high levels of CoPCs will not be sampled immediately prior to stations at which CoPC concentrations are likely to be low. The actual sequence in which the stations will be visited will be determined in the field by the chief scientist.

3.7 SAMPLING SAFETY

Safety hazards are associated with the equipment and supplies that will be used, as well as with the general rigors of work on the water. The HSP is provided in Appendix C; its purpose is to identify potential hazards, institute procedures for minimizing those hazards, document the proper responses in case of accident and injury, and make this information known to all shipboard personnel. Before sampling begins, a health and safety briefing will be held onboard the sampling vessel.

To ensure safe and efficient shipboard operations, the chief scientist will be designated the safety officer responsible for all shipboard operations, including evaluating hazardous conditions, ensuring compliance with safety precautions, and suspending shipboard operations if necessary. A halt to or suspension of operations can also be dictated by the vessel operator.

3.7.1 Hazards

Hazards encountered during sampling are generally classified as either chemical or physical. Chemical hazards are primarily associated with the materials used to clean sampling gear. Physical hazards are associated with the gear and conditions of work on the water.

3.7.1.1 Chemical Hazards

Stations to be sampled during the survey are not expected to contain concentrations of chemicals (including natural sulfides) that pose a hazard to human health. If excessive odor, nonaqueous liquids, or organic enrichment is observed during field operations, the sampling plan will be reassessed. Precautionary steps may include artificially ventilating the rear deck, instituting suitable protective measures for the crew, or relocating or eliminating the sampling station.

Acetone and hexane will be used to clean the sampling equipment. Both are clear, colorless, volatile solvents with strong odors. Acetone and hexane will be used only on the open deck, and personnel must wear protective gloves when handling these liquids.

Material safety data sheets for acetone and hexane are included in the HSP (Appendix C).

3.7.1.2 Physical Hazards

Gear deployment and retrieval present hazards because of the weight of the sampling gear, its suspension above the deck, and the risk of entanglement or accidental or premature release or closure. While gear deployment hazards are expected to be minimal, there are physical hazards associated with the van Veen sampler and the gravity corer.

During sampling gear retrieval, at least one crew member will watch for the sampling gear to appear and alert the winch operator. Failure to observe the sampling gear and stop the winch can break the cable, loosen the sampling gear, and possibly injure personnel with falling gear or the end of the broken cable. The winch drum, the blocks, and the area between the sampling gear and the rail, deck, or other large equipment present significant pinching and crushing hazards. Personnel will be instructed to keep their hands, feet, and clothing clear of these points.

Lines, hoses, hatch covers, and mud on the deck present tripping, slipping, and falling hazards. Every crew member will be instructed to keep the working surface of the deck clear and clean by coiling hoses and lines and rinsing accumulations of mud from the deck. In addition, all crew members will remain aware of hatch cover positions and other gear at all times.

A drowning hazard exists for shipboard personnel working on the water primarily from tripping (discussed above) or excessively rough weather. Flotation vests will be worn by all personnel on deck. The vessel is also equipped with throwable life rings, and each crew member will be briefed on the use and storage location of these rings.

Fatigue presents a hazard when working on the water and can be compounded by the motion of the vessel, exposure, or hypothermia. Personnel will monitor their own conditions and capabilities and are responsible for taking appropriate measures to relieve fatigue or exposure. The chief scientist may also direct any member of the crew to cease working.

3.7.2 Safe Work Practices

Precautions for handling chemicals include wearing gloves, restricting use to the deck, storing and dispensing them from narrow-mouth bottles or squirt bottles, and exercising care in use. Solvent rinsate from sampling gear will be collected in a container so excess solvent is not spilled on the deck. The sea condition and presence of wakes or other disturbances will be noted to avoid spillage.

All crew members will wear hard hats when working on the rear deck. Work gloves will be available but not required (impermeable gloves are required when using acetone or hexane). Flotation vests will be worn by all personnel on deck.

During gear deployment and retrieval, personnel should pay close attention to the position of the gear, the motion of the boat, obstructions on the deck that could impede their mobility, and actual or potential fouling of the gear. Hands and feet must never be placed underneath sampling gear.

Weather conditions will be monitored by the chief scientist and vessel operator. The vessel is supplied with emergency flotation equipment and fire extinguishers. Food and shelter (the vessel's cabin) will be provided for the sampling crew. Each crew member will be required to bring clothing appropriate for the weather to minimize the hazards of exposure and hypothermia.

3.7.3 Emergency Planning

If an emergency or accident occurs during sampling, the chief scientist and vessel operator will determine the appropriate response. They will assess the severity of the incident and, if appropriate, contact emergency assistance. The vessel operator is responsible for moving the boat into position to receive emergency aid, if necessary. A basic first-aid kit will be kept onboard to treat minor cuts or scrapes. All field personnel have received first-aid and CPR training. All accidents must be reported to the chief scientist and will be recorded in the cruise log. Contact information for local emergency services, hospitals,

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and ambulance services will be onboard the vessel in a location known to and accessible to all personnel. Emergency contact information is provided in the HSP (Appendix C).

4. ANALYTICAL AND TESTING METHODS

Analytical and testing procedures will be completed in accordance with requirements specified in the selected methods.

4.1 CHEMICAL ANALYSES

Procedures for each chemical analysis are summarized in the QAPP (PTI 1996) and the QAPP addendum (Appendix B). Samples will be analyzed in accordance with PSEP (PSEP 1986b, 1989a,b), EPA SW-846 (U.S. EPA 1986), or other EPA-approved or recommended methods when available. Analyses will include all associated QA/QC procedures recommended in each method.

For sediment samples, the laboratory shall assume that the entire sample submitted for analysis is representative material. To avoid substance losses, any overlying water in sediment samples received from the field will be mixed into the sample before removal of a subsample for analysis.

4.2 TOXICITY TESTS

Procedures for each toxicity test are summarized in the QAPP (PTI 1996) and the QAPP addendum (Appendix B). Samples will be tested in accordance with PSEP (1995), as modified by PSDDA, and testing will include all associated QA/QC procedures recommended in each test method.

For sediment samples, the laboratory shall assume that the entire sample submitted for analysis is representative material. To avoid substance losses, any overlying water in sediment samples received from the field will be mixed into the sample before removal of a subsample for analysis.

4.3 TOXICITY IDENTIFICATION EVALUATIONS

Procedures for TIEs are discussed in Appendix F. Samples will be evaluated based on relatively new and somewhat experimental techniques (e.g., Schubauer-Berigan et al. 1995; Frazier et al. 1996; Whiteman et al. 1996; U.S. EPA 1996; Ho et al. 1997).

For sediment samples, the laboratory shall assume that the entire sample submitted for analysis is representative material. To avoid substance losses, any overlying water in

sediment samples received from the field will be mixed into the sample before removal of a subsample for analysis.

4.4 ENGINEERING PROPERTIES

Procedures for analysis of engineering properties are summarized in the QAPP (PTI 1996) and the QAPP addendum (Appendix B). Samples will be analyzed in accordance with the MET (Palermo 1986) and the DRET (DiGiano et al. 1995) or other EPA-approved or recommended methods when available. Analyses will include all associated QA/QC procedures recommended in each method. In addition, several complementary tests will be performed to evaluate the dredgability of the sediments and the location and identification of available disposal placement areas. These analyses are summarized in the QAPP addendum (Appendix B).

4.5 SEDIMENT ACCUMULATION TESTING

Radiological analyses for Phase 2 sediment samples will be completed in accordance with SOPs provided by the selected testing laboratory. Lead-210 analysis will be performed using alpha spectrometry of the polonium-210 decay product. Cesium-137 analyses will be performed on dried sediment samples using direct gamma spectrometry.

5. DATA ANALYSIS AND REPORTING

5.1 DATA ANALYSIS

Laboratory results will be evaluated by comparing chemical concentrations among sampling stations and with available sediment criteria and guidelines. The results of chemical analyses for all samples will be summarized in tables or figures.

5.2 DATA REPORTING

The results of the sampling program and data analyses will be provided in the draft technical studies report. Original laboratory results will be provided in appendices to the final report. An electronic version of all Phase 2 data will be provided to EPA Region 10.

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Appendix A

**Geophysical Survey Field
Sampling Plan**

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ACRONYMS AND ABBREVIATIONS

DGPS	differential global positioning system
FSP	field sampling plan
HSP	health and safety plan
KPC	Ketchikan Pulp Company
UTM	Universal Transverse Mercator

INTRODUCTION

The Ketchikan Pulp Company's (KPC) pulp mill is located in Ketchikan, Alaska, on Ward Cove, an embayment in the southern reach of the Tongass Narrows (Figure A-1). Ward Cove is a coastal valley bounded by Slide Ridge to the north and Ward Mountain to the south. The shoreline of Ward Cove on the south boundary of the site is steep. Ward Cove is approximately 1 mile long, has a maximum width of 0.5 mile, and connects to Tongass Narrows to the west. Ward Creek, located just east of the site boundary, is the primary source of freshwater to the Cove. The lower reaches of Ward Creek are tidally influenced, with water levels varying at least 8–20 ft. Waters are expected to be brackish to saline depending on tide levels and flow conditions in the upper portions of Ward Creek.

This field sampling plan (FSP) describes the geophysical survey that will be conducted during Phase 2 of the Ward Cove sediment remediation project. The primary objective of the geophysical survey is to provide a detailed characterization of the physical features of Ward Cove. The bathymetric data will be used to guide the location of stations in the Phase 2 sediment investigation. Information on water depth, shoreline configuration, and slope stability is also critical to the evaluation of sediment remedial alternatives. More detailed information on water depth and surface sediment characteristics will provide an enhanced perspective on the kinds of benthic habitats found in Ward Cove. The bathymetric survey will be developed and interpreted as an extension of previous surveys of log debris (ENSR 1995) and solids deposition (ENSR 1996).



Figure A-1. Location of Ward Cove and area to be included in geophysical survey.

GEOPHYSICAL SURVEY

The geophysical survey will include simultaneous measurement of four kinds of information: precision bathymetry (i.e., depth distributions), physical characteristics of surface sediments (i.e., side-scan sonar), subbottom profiling, and video ground-truthing.

PRECISION BATHYMETRY

The precision bathymetric survey will provide a detailed map of the depth distributions throughout Ward Cove. The bathymetric data will be acquired using a Reson Seabat 9001 multibeam bathymetric sonar system or equivalent. This system acquires 60 soundings across a 90-degree swath for full bottom coverage of approximately twice the water depth in a single pass. The multibeam system will be integrated with a TSS Model 540 heave-roll-pitch sensor, a KVH digital compass, and the differential global positioning system (DGPS) navigation system using Hypack software.

Before the bathymetric survey is conducted, a patch test will be conducted to confirm alignment angles of the motion reference sensors and the multibeam sonar head. A bar check will be conducted to confirm the static draft of the sonar head at the beginning and end of the survey. To determine sound velocity of the water column, velocity profiles will be conducted at a minimum of twice per day. These profiles will be used in post-processing of the multibeam data to account for ray path bending and correct slant range measurements as a result of velocity changes in the water column relative to the input velocity used during the survey.

Bathymetric data will be collected by traversing along the bathymetric contours parallel to the shoreline or whatever orientation is most advantageous for acquiring multibeam data and for avoiding obstructions such as log rafts. The spacing between adjacent transects is a function of water depth and will vary depending on the swath width obtained on the previous transect. In general, the spacing will be approximately 180 percent of the water depth (20 percent overlap). Cross ties will be obtained at a 400-m line spacing as a quality assurance check of tidal and motion sensor data.

A navigation fix mark will be posted on the geophysical analog records at 20-second intervals. The digital depth information will be recorded on a magnetic hard drive along with the navigation and vessel motion data. Vertical control for the survey will be obtained from a digital water-level (i.e., tide) gauge installed in Ward Cove. This information will be merged with the bathymetric data to produce the final bathymetric charts. All depths will be reduced to the project datum and will be plotted as elevations.

The planned survey track lines will be computed and plotted prior to the start of the survey. During the survey, preplotted track lines and a left/right cross track indicator will be displayed on a video monitor to assist the vessel captain in navigating the desired course. In addition, the preplots and the "track lines made good" will be plotted on a plotter. During the survey, the vessel position will be acquired using DGPS and projected in real time to Universal Transverse Mercator (UTM) coordinates using Hypack software with an accuracy of approximately 1 m. All of the navigation and digitized bathymetric data will be recorded on hard drive and backed up to 150 megabyte Bernoulli disks for later processing and editing. This information will be used to produce maps and charts of the bathymetry of Ward Cove.

SIDE-SCAN SONAR

The side-scan sonar survey will provide a detailed acoustic image of the bottom of Ward Cove. The display is a variable density image produced by varying the color or grey scale on the sonogram or record. The images generated with this system will be equivalent to an aerial photograph of the bottom of the Cove. Surface features that can be detected and mapped include lateral variations in physical characteristics of the sediment, fiber mats, wood debris, rock outcrops, and unusual bathymetric features, such as depressions, areas of submarine slides, and zones of biogenic gas often associated with organic debris. Fine-grained sediments, such as silt or clay, will produce a uniform, low amplitude (light grey) pattern. Fiber mats will also produce a low amplitude image; however, they will also have a texture associated with the image. If biogenic gas is present, the image will be higher in amplitude and much darker. Larger objects (e.g., logs and boulders) will produce high amplitude returns (i.e., dark images) and may have a dark shadow. The lateral dimension of these objects and the height of the object above the sea floor will be displayed on the sonogram. However, the results of the side-scan sonar survey may be confounded by the presence of biogenic gas and other debris.

Each transect will cover a swath width of 50–150 m, depending on water depth. The side-scan sonar data will be collected concurrently with the precision bathymetric survey using an EG&G Model 260 side-scan sonar, or equivalent. In addition to the transects run for the bathymetric survey, a minimum of two additional transects will be run parallel to the entire shoreline of the Cove at depths less than 3–4 m to measure the surface features of the shallow areas that could not be surveyed by the onshore-offshore transects (i.e., because of restrictions related to the draft of the survey vessel).

To corroborate the side-scan sonar data, a number of sediment samples may be collected from representative areas of the Cove using a van Veen grab sampler. Sediment samples will be collected in accordance with the methods stipulated in PTI (1996). The locations of these samples will be determined on the basis of preliminary field analysis of the side-scan sonar data. The following criteria will be used to select the sampling locations:

- Variations in the intensity of the sonar records (i.e., indicative of changes in lithology or grain size)
- The presence of coherent patterns (i.e., fiber mats, areas of bark debris, sandwaves, mudwaves, and drag marks)
- The presence of features with sharp outlines that produce acoustic shadows (i.e., evidence of cultural debris [e.g., automobiles, refrigerators], logs, or rocks).

SUBBOTTOM PROFILING

Subbottom profiling will be performed to map the subsurface sediment characteristics (e.g., mud layers) of Ward Cove. The subbottom data will be collected using a Datasonics Model 5000 or Applied Acoustic Engineers Geopulse subbottom profiling system. The subbottom profiler used for this investigation will be capable of subsurface penetration depths that range from approximately 10 to 100 m. However, if large concentrations of organic material or biogenic gas are present in the sediment, then the subsurface penetration may be limited to less than 1 m.

In principal, the subbottom profiling system is similar to the ecosounder used for precision bathymetry. However, the subbottom system transmits a greater amount of acoustic energy to penetrate the bottom of the Cove, allowing the collection of information on subsurface sediments. All subbottom profiling data will be collected in conjunction with the precision bathymetric and side-scan sonar data.

The use of two subbottom profiling systems, having different frequencies, provides a qualitative means of characterizing subsurface sediments. The Datasonics 5/12 kHz transducer will provide improved resolution for mapping very thin deposits, whereas the Applied Acoustic Engineers Geopulse source will penetrate to greater depths in the sediment.

VIDEO GROUND-TRUTHING

Video ground-truthing will be performed to provide additional information on the physical characteristics and biological communities found on the bottom of the Cove. Data on substrate types and biota will be collected at discrete locations. A video camera will be lowered with a cable to obtain the images. The video data will be recorded on a VCR and will include voice annotation and navigation information. The locations of the video stations will be determined on the basis of preliminary field analysis of the side-scan sonar data. Video ground-truthing locations will be selected in conjunction with the van Veen sampling (see above). The following criteria will be used to select locations for video ground-truthing:

- Variations in the intensity of the sonar records (i.e., indicative of changes in lithology or grain size)
- The presence of coherent patterns (i.e., fiber mats, areas of bark debris, sandwaves, mudwaves, and drag marks)
- The presence of features with sharp outlines that produce acoustic shadows (i.e., evidence of cultural debris, logs, or rocks).

VESSEL NAVIGATION

To meet the goals of the geophysical survey, precise positioning of the survey vessel is required. Both absolute accuracy (i.e., ability to define position) and repeatable accuracy (i.e., ability to return to a survey transect) must be known with confidence. Vessel positioning will therefore be achieved with a DGPS integrated with Hypack navigation software that is capable of locating the survey vessel with an absolute accuracy of ± 2 m and a repeatable accuracy of ± 1 m. Differential corrections will be obtained from the U.S. Coast Guard beacon on Annette Island. Before the survey is conducted and upon completion of the survey, the positioning system will be checked by placing the DGPS antenna over a known monument on Dawson Point. The positions obtained from DGPS will be compared to published coordinates for this control monument.

DOCUMENTATION

Bathymetric data (i.e., X, Y, Z information in UTM coordinates) will be collected on computer disk in ASCII files. Side-scan sonar data will be developed into a plan view map. Subbottom profiling data (i.e., X, Y, Z information) will be collected on computer disk in ASCII files. Vessel positioning information will be documented on daily log sheets. A videotape with audio explanation that highlights selected areas of the bottom of Ward Cove will be prepared to provide video ground-truthing of the survey.

Two bound field notebooks will also be completed for this survey. These field notebooks will be maintained by PTI's chief scientist and the onboard geophysicist, respectively, and will provide daily records of significant events, observations of possible confirmatory van Veen samples, and kinds of measurements made during the geophysical survey. Any changes in the survey procedures described in this FSP will be documented in PTI's field notebook. All entries will be signed and dated.

SAFETY

Safety hazards are associated with the equipment and supplies that will be used, as well as with the general rigors of work on the water. The health and safety plan (HSP) is provided in Attachment A-1; its purpose is to identify potential hazards, institute procedures

for minimizing those hazards, identify the proper responses in case of accident and injury, and ensure that this information is known to all shipboard personnel. At the beginning of each field day, a health and safety briefing will be held onboard the survey vessel.

To ensure safe and efficient shipboard operations, the chief scientist will be designated the safety officer responsible for all shipboard operation, including evaluating hazardous conditions, ensuring compliance with safety precautions, and suspending shipboard operations if necessary. A halt to or suspension of operations can also be dictated by the vessel captain.

Physical Hazards

While gear deployment hazards are expected to be minimal, deployment of the sediment sampling gear (i.e., the van Veen grab sampler) does present hazards because of the weight of the sampling gear, its suspension above the deck, and the risk of entanglement or accidental or premature release. During deployment and retrieval of the sediment sampling gear, at least one crew member will watch for the gear to appear and alert the winch operator. Failure to observe the sampling gear and stop the winch can break the cable, loosen the sampling gear, and possibly injure personnel with falling gear or the end of the broken cable. The winch drum, the blocks, and the area between the sampling gear and the rail, deck, or other large equipment present significant pinching and crushing hazards. Personnel will be instructed to keep their hands, feet, and clothing clear of these points.

Lines, hoses, hatch covers, and mud on the deck present tripping, slipping, and falling hazards. Every crew member will be instructed to keep the working surface of the deck clear and clean by coiling hoses and lines and rinsing accumulations of mud from the deck. In addition, all crew members will remain aware of hatch cover positions and other gear at all times.

A drowning hazard exists for shipboard personnel working on the water primarily from tripping (discussed above) or excessively rough weather. Flotation vests will be worn by all personnel on deck. The vessel is also equipped with throwable life rings, and each crew member will be briefed on the use and storage location of these rings.

Fatigue presents a hazard when working on the water and can be compounded by the motion of the vessel, exposure, or hypothermia. Personnel will monitor their own condition and capabilities and are responsible for taking appropriate measures to relieve fatigue or exposure. The chief scientist may also direct any member of the crew to cease working.

Safe Work Practices

All crew members will wear hard hats when working on the rear deck during deployment of the sediment sampling gear (i.e., the van Veen grab sampler). Work gloves will be available, but not required. Flotation vests will be worn by all personnel on deck.

During sampling gear deployment and retrieval, personnel should pay close attention to the position of the gear, the motion of the boat, obstructions on the deck that could impede their mobility, and actual or potential fouling of the gear.

Weather conditions will be monitored by the chief scientist and vessel captain. The vessel is supplied with emergency flotation equipment and fire extinguishers. Food and shelter (the vessel's cabin) will be provided for the sampling crew. Each crew member will be required to bring clothing appropriate for the weather to minimize the hazards of exposure and hypothermia.

Emergency Planning

If an emergency or accident occurs during sampling, the chief scientist and vessel captain will determine the appropriate response, including assessing the severity of the incident and, if appropriate, contacting emergency assistance. The vessel captain is responsible for moving the boat into position to receive emergency aid, if necessary. A basic first-aid kit will be kept onboard to treat minor cuts or scrapes. At least one member of the field team (i.e., chief scientist) will have received first-aid and CPR training. All accidents must be reported to the chief scientist and will be recorded in the field notebook. Contact information for local emergency services, hospitals, and ambulance services will be onboard the boat in a location known to and accessible to all personnel. Emergency contact information is provided in the HSP (Attachment A-1).

DATA ANALYSIS AND REPORTING

Computerized data management systems will be used to the greatest extent possible to maximize the integrity of data handling and analysis procedures. An ARC/INFO-based geographic information system that allows survey data to be combined with spatial information for display and analysis will be used to present the results of the geophysical survey.

REFERENCES

ENSR. 1995. Ward Cove log distribution. Side-scan sonar survey. Document No. 4025-041-300. Prepared for Ketchikan Pulp Company, Ketchikan, AK. ENSR Consulting and Engineering, Redmond, WA.

ENSR. 1996. Study of solids deposition. Final Report. Document No. 4025-042-500. Prepared for Ketchikan Pulp Company, Ketchikan, AK. ENSR Consulting and Engineering, Redmond, WA.

NOAA. 1995. Revillagigedo Channel, Nichols Passage and Tongass Narrow. Map No. 17428. National Oceanic and Atmospheric Administration, National Ocean Service, Coast and Geodetic Survey, Washington, DC.

PTI. 1996. Ward Cove sediment remediation project technical studies work plan. Prepared for Ketchikan Pulp Company, Ketchikan, Alaska. PTI Environmental Services, Bellevue, WA.

Attachment A-1

**Health and Safety Plan for
Phase 2 Geophysical Survey**

PTI Environmental Services

SITE SAFETY PLAN

Site Name Ward Cove
Prepared by PTI Environmental Services Date 3/31/97

INTRODUCTION

This site-specific health and safety plan establishes procedures and practices to protect personnel from potential hazards posed by field activities at Ward Cove. In this health and safety plan, measures are provided to minimize potential exposure, accidents, and physical injuries that may occur during daily onsite activities and adverse conditions. Contingency arrangements are also provided for emergency situations.

DISCLAIMER

PTI does not guarantee the health or safety of any person entering this site. Because of the potentially hazardous nature of this site and the activity occurring thereon, it is not possible to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury and illness at this site. The health and safety guidelines in this plan were prepared specifically for this site and should not be used on any other site without prior evaluation by trained health and safety personnel.

SITE DESCRIPTION (use additional pages if necessary)

Site name: Ward Cove
Site location or address: 7559 North Tongass Highway
Ketchikan, Alaska
Owners/tenants: _____
Current site use: Marine bay adjacent to a sawmill
Past site use (if different): Pulp mill
Designated hazardous waste site: No (federal, state, other) _____
Industrial facility _____ Spill _____ Other Marine waters and sediment
Topography: Marine bay measuring approximately 1/2 mile by 1 mile
Name of and distance to nearest surface water body: Ward Cove is a branch of the Tongass Narrows.
Surrounding land use/nearest population: A cannery is located on one shore; the Ketchikan sawmill and former pulp mill are located on the other.

Site access: The Ketchikan Pulp Company (KPC) facility is on the Tongass Highway.

Nearest drinking water/sanitary facilities: On the sampling vessel and at the KPC facility.

Nearest telephone (list number if possible): KPC (907) 225-2151

List utilities located (or to be located): Project personnel will work with facility personnel and local authorities to determine the location of submerged utilities, if any, prior to sediment coring.

Site map attached: _____

PROJECT PERSONNEL

	<u>Name/Affiliation</u>	<u>Work Telephone</u>	<u>Home Telephone</u>
Project manager	<u>Lucinda Jacobs</u>	<u>(206) 643-9803</u>	<u>(206) 324-3380</u>
Field team leader	<u>Jane Sexton</u>	<u>(206) 643-9803</u>	<u>(206) 782-1754</u>
Site safety officer	<u>Jane Sexton</u>	<u>(206) 643-9803</u>	<u>(206) 782-1754</u>
PTI field personnel	<u>To be determined</u>	_____	_____
	_____	_____	_____
	_____	_____	_____
Facility contact	<u>Andy Maloy (KPC)</u>	<u>(907) 228-2312</u> <u>(907) 228-2191</u>	_____

WORK PROPOSED

Description of proposed work: The collection of geophysical data (i.e., bathymetry, side-scan sonar, subbottom profiling, and video ground-truthing) and possible collection of confirmatory sediment samples

Proposed work dates: May 1997

<u>Subcontractors</u>	<u>Name</u>	<u>Task</u>	<u>Contact</u>	<u>Telephone</u>
	<u>Golder Associates</u>	<u>Geophysical survey</u>	<u>Dick Sylwester</u>	<u>(206) 883-0777</u>
	<u>David Evans & Associates</u>	<u>Sampling vessel and bathymetry</u>	<u>Jon Dasler</u>	<u>(503) 499-0297</u>

HAZARD EVALUATION

Potentially hazardous chemicals known or suspected to be onsite (include preservatives and decontamination chemicals):

Substance	Concentration	Medium	OSHA PEL	OSHA STEL	Odor Threshold	IP(eV)	Carcinogen or Other Hazard
Dioxin	1-43 pg/g	sediment	--	--	NA	--	C
Methylmercury	0.42-5.89 ng/g	sediment	0.01 mg/m ³	0.03 mg/m ³	NA	--	P
Sulfides	62-8,500 mg/kg	sediment	--	--	NA	--	
Methylphenol	ND-9.100 mg/kg	sediment	5 ppm ^a	--	0.05 ^b	--	P ^b
Arsenic	5.2-39.1 mg/kg	sediment	0.01 mg/m ³	--	NA	NA	C
Cadmium	0.88-6.61 mg/kg	sediment	0.005 mg/m ³	--	NA	NA	C,P
Zinc	59.7-466 mg/kg	sediment	5 mg/m ^{3c}	--	NA	NA	irritant

Note: -- - none established
 C - carcinogen
 GW - groundwater
 IP(eV) - ionization potential
 N/A - not applicable
 NA - not available
 P - poison
 PCB - polychlorinated biphenyl
 PEL - permissible exposure level
 SC - suspected carcinogen
 STEL - short-term exposure level

^a PEL for phenol and o-cresol (skin).

^b Phenol.

^c Zinc oxide, respirable dust.

	Known	Possible	Unlikely
Potential chemical exposure routes at the site:			
Inhalation			X
Ingestion		X	
Skin absorption		X	
Skin contact		X	
Eye contact		X	
Chemical characteristics:			
Corrosive			X
Ignitable			X
Reactive			X
Volatile			X
Radioactive			X
Explosive			X
Biological agent			X
Particulates or fibers			X
If known or likely, describe:			

Possible physical hazards present during site investigation activities:

	Yes	No	Proposed Safety Procedure
Uneven terrain/tripping	X		Keep decks clear, exercise caution
Heat stress		X	
Cold/hypothermia	X		Keep dry, bring extra clothes, warm food/drink
Drowning	X		Wear PFDs when working over the water
Falling objects	X		Wear hard hats near overhead hazards (i.e., winch)
Noise		X	
Excavations		X	
Scaffolding		X	
Heavy equipment		X	
Material handling	X		Lift properly, do not overload coolers; seek help when moving heavy items.
Compressed air equipment		X	
Confined spaces		X	
Other <u>Vessel Operations</u>	X		Review marine safety SOP

Note: If confined space entry is required, personnel must first obtain a confined space entry permit.

Potential physical hazards posed by proposed site activities:

Activity	Potential Hazard
Sediment sampling	cold, drowning, falling objects, material handling

PERSONAL PROTECTIVE EQUIPMENT

Based on the hazards identified above, the following personal protective equipment will be required for the following site activities (specify both an initial level of protection and a more protective level of protection in the event conditions should change):

	Level of Protection	
	Initial	Contingency
Geophysical survey	D	No upgrade anticipated
Sediment sampling	MD	"

Each level of protection will incorporate the following equipment (specify type of coveralls, boots, gloves, respiratory cartridges or other protection, safety glasses, hard hat, and hearing protection):

Level D: Long pants/shirt, work shoes or boots, hard hat (near overhead hazard), safety glasses, work gloves (as needed)

Modified D: Same as D, with addition of coated tyvek coveralls or raingear, chemical resistant steel-toe boots, and chemical resistant boots. Silver shield gloves when handling decon solvents

Level C: _____

Level B: _____

Note: Project personnel are not permitted to deviate from the specified levels of protection without the prior approval of the site safety officer or PTI corporate health and safety officer.

SAFETY EQUIPMENT

The following safety equipment will be onsite during the proposed field activities:

First Aid Kit (mandatory, list any additional items required for the site)

Emergency blanket

Other (circle the items required for this project)

Eyewash

Drinking water

Fit test supplies

Fire extinguisher

Windsock

Warm clothes

Warm food and drink

SITE CONTROL

Describe how exclusion zones and contamination zones will be designed (attach sketch if possible):

The aft deck of the sampling vessel will be considered to be the exclusion zone. Sample collection and processing will occur in this area. Only properly equipped and trained (i.e., wearing modified D protective clothing) personnel will be allowed in this area. The area will be washed with sea water between sample stations.

The rest of the deck will be the contamination reduction zone. Sample storage, and other support functions will occur in these areas.

The pilot house will be the support zone. No chemical or sample handling activities will occur in this area. Personnel will be required to wash chemicals and sediment from raingear or tyvek coveralls before entering this area.

Describe controls to be used to prevent entry by unauthorized persons:

No unauthorized personnel will be allowed on the sample vessel.

AIR MONITORING

Air monitoring will be conducted when entering previously uncharacterized sites, when working in the vicinity of uncontaminated chemicals or spills, when opening containers and well casings, and prior to opening and entering confined spaces. Air monitoring must be conducted to identify potentially hazardous environments and determine reference or background concentrations. Air monitoring will be used to define exclusion zones. Air monitoring may also be conducted to evaluate the concentration of chemicals in samples.

The following equipment will be used to monitor air quality in the breathing zone during work activities:

Monitoring Instrument	Calibration Frequency	Parameters of Interest	Sampling Frequency
None.			

The following action levels have been established to determine the appropriate level of personal protection to be used during site investigation activities:

Instrument	Reading	Action ^a	Comments
None			

^a Examples: "upgrade to Level C" or "leave site."

DECONTAMINATION

To prevent the distribution of contaminants outside the exclusion zone or cross-contamination of samples, the following procedures will be used to decontaminate sampling equipment:

All sampling bowls and spoons, sediment sampling, and coring equipment will be scrubbed with Alconox® and water, and then rinsed with site water.

To prevent the distribution of contaminants outside the exclusion zone and personal exposure to chemicals, vehicles will not be allowed inside the exclusion zone. If vehicles are required in the exclusion zone (e.g., drill rigs), the following procedures will be used to prevent contamination or decontaminate the vehicles:

Samples will be packaged in secure containers before placement in a vehicle or vessel pilot house.
All sampling equipment and protective equipment will be decontaminated before placement in a vehicle or vessel pilot house.

To minimize or prevent personal exposure to hazardous materials, all personnel working in the exclusion zone and contamination reduction zones will comply with the following decontamination procedures:

All personnel will wash sediment from their raingear or tyvek coveralls before leaving the exclusion zone.

Decontamination equipment required on site will include the following:

Scrub brushes, Alconox® buckets, distilled water, paper towels, garbage bags

Decontamination wastewater and contaminated materials will be disposed of in the following manner:

Wash water and rinse water will be discharged overboard.

The following personal hygiene practices will be used:

- Long hair will be secured away from the face so it does not interfere with any activities.
- All personnel leaving potentially contaminated areas will wash their hands and faces prior to entering any clean areas or eating areas.
- Personnel leaving potentially contaminated areas will shower (including washing hair) and change to clean clothing as soon as possible after leaving the site.
- No person will eat, drink, or chew gum or tobacco in potentially contaminated areas. Drink containers and drinking of replacement fluids for heat stress control will be permitted only in areas that are free from contamination. Smoking is prohibited in all areas of the site because of the potential for contaminating samples and for health and safety reasons.

SPILL CONTAINMENT

Provisions must be made for spill containment at any site where bulk liquids will be handled.

Will the proposed fieldwork include the handling of bulk liquids, oil, or chemicals (other than water)?

Yes _____ No X

If yes, describe spill containment provisions for the site:

SHIPMENT OF RESTRICTED ARTICLES

Federal laws and international guidelines place restrictions on what materials may be shipped by passenger and cargo aircraft. In the course of this field investigation, the following items will be shipped to and from the site in the following manner:

Item	Hazardous Constituent	Quantity	Packaging	How Shipped
Samples	<u>None</u>	<u> </u>	<u> </u>	<u>No special procedures will be required</u>
Calibration gas (name)	<u>None</u>	<u> </u>	<u> </u>	<u> </u>
Preservatives (name)	<u>None</u>	<u> </u>	<u> </u>	<u> </u>
Other: <u> </u>	<u>None</u>	<u> </u>	<u> </u>	<u> </u>

MEDICAL MONITORING

OSHA requires medical monitoring for personnel potentially exposed to chemical hazards in concentrations in excess of the PEL for more than 30 days per year and for personnel who must use respiratory protection for more than 30 days per year.

Will personnel working at this site be enrolled in a medical monitoring program? Yes X No

HEALTH AND SAFETY TRAINING

State and federal laws establish training requirements for workers at uncontrolled hazardous waste sites (including areas where accumulations of hazardous waste create a threat to the health and safety of an individual, the environment, or both).

PTI and subcontractor personnel will be required to complete the following training requirements:

Duties	No Special Training ^a	24-hour	40-hour	80-hour	First Aid and CPR
PTI Personnel					
<u>Field team leader</u>	<u> </u>	<u> </u>	<u> X </u>	<u> X </u>	<u> X </u>
<u>Field personnel</u>	<u> </u>	<u> </u>	<u> X </u>	<u> </u>	<u> X </u>
Subcontractors					
<u>Geophysicist</u>	<u> </u>	<u> </u>	<u> X </u>	<u> </u>	<u> X </u>
<u>Vessel operator</u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> X </u>

^a Provide explanation or justification: Vessel operator will not be required to have 40-hour training. Vessel operator will stay out of the exclusion zone during sample collection and decon.

EMERGENCY INFORMATION

Local Resources	Name	Telephone	Notified Prior to Work (Yes/No)?
Fire	<u>Pond Reef Fire Department</u>	<u>911</u>	<u>No</u>
Police	<u>Alaska State Patrol</u>	<u>911</u>	<u>No</u>
Ambulance	<u>Pond Reef Fire Department</u>	<u>911</u>	<u>No</u>
Hospital	<u>Ketchikan General Hospital</u>	<u>(907) 225-5171</u>	<u>No</u>
Site phone	<u>KPC</u>	<u>(907) 225-2151</u>	<u>Yes</u>

Directions to hospital: The hospital is located at 3100 Tongass Avenue. Turn right when leaving the KPC facility. Drive south on Tongass Highway. Turn left at hospital.

Corporate Resources	Name	Work Telephone	Home Telephone
PTI health and safety officer	<u>Greg Bawden</u>	<u>(206) 643-9803</u>	<u>(206) 788-0436</u>
Medical consultant	<u>Dr. Jones</u>	<u>(206) 822-3651</u>	<u></u>

In case of serious injuries, death, or other emergency, the corporate health and safety officer must be notified immediately. To contact the corporate health and safety officer (or delegate), try calling Greg Bawden at the work and home numbers listed above. If no response, call the emergency pager (206) 996-1480. If no response, call Larry Marx at (206) 643-9803 or (206) 643-6019 or (206) 378-3252.

Other Resources	Agency Name/Location	Telephone
Local OSHA office	<u>U.S. OSHA, Anchorage, AK</u>	<u>(907) 271-5152</u>
State OSHA equivalent	<u>Division of Occupational Safety and Health, Juneau, AK</u>	<u>(907) 465-4855</u>

DOCUMENTATION

	Attached	In File	Not Applicable
PTI site safety acknowledgment forms	<u>X</u>	<u></u>	<u></u>
OSHA or equivalent state poster	<u>X</u>	<u></u>	<u></u>
Site safety meeting minutes	<u>X</u>	<u></u>	<u></u>
PTI accident/incident report form	<u></u>	<u>X</u>	<u></u>
Other: _____	<u></u>	<u></u>	<u></u>

EXHIBITS

	Attached	In File	Not Applicable
Site map	<u> X </u>	<u> </u>	<u> </u>
Work plan	<u> </u>	<u> X </u>	<u> </u>
Material safety data sheets	<u> </u>	<u> </u>	<u> X </u>
Health and safety training records	<u> </u>	<u> X </u>	<u> </u>
Other: <u> Marine safety SOP </u>	<u> X </u>	<u> </u>	<u> </u>

Exhibits



SITE SAFETY PLAN CONSENT AGREEMENT

I have reviewed the site safety plan prepared by PTI, dated 3/31/97, for the Ward Cove site fieldwork. I understand the purpose of the plan, and I consent to adhere to its policies, procedures, and guidelines while completing the tasks covered by this plan.

Employee signature	Firm	Date

JOB SAFETY & HEALTH PROTECTION

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers by promoting safe and healthful working conditions throughout the Nation. Provisions of the Act include the following:

Employers

All employers must furnish to employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm to employees. Employees must comply with occupational safety and health standards issued under the Act.

Employees

Employees must comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to their own actions and conduct on the job.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards, and its Compliance Safety and Health Officers conduct jobsite inspections to help ensure compliance with the Act.

Inspection

The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

Complaint

Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides that employees may not be discharged or discriminated against in any way for filing safety and health complaints or for otherwise exercising their rights under the Act.

Employees who believe they have been discriminated against may file a complaint with their nearest OSHA office within 30 days of the alleged discriminatory action.

Citation

If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

Proposed Penalty

The Act provides for mandatory penalties against employers of up to \$1,000 for each serious violation and for optional penalties of up to \$1,000 for each nonserious violation. Penalties of up to \$1,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to \$10,000 for each such violation.

There are also provisions for criminal penalties. Any willful violation resulting in death of an employee, upon conviction, is punishable by a fine of up to \$250,000 (or \$500,000 if the employer is a corporation), or by imprisonment for up to six months, or both. A second conviction of an employer doubles the possible term of imprisonment.

Voluntary Activity

While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries. OSHA's Voluntary Protection Programs recognize outstanding efforts of this nature.

OSHA has published Safety and Health Program Management Guidelines to assist employers in establishing or perfecting programs to prevent or control employee exposure to workplace hazards. There are many public and private organizations that can provide information and assistance in this effort, if requested. Also, your local OSHA office can provide considerable help and advice on solving safety and health problems or can refer you to other sources for help such as training.

Consultation

Free assistance in identifying and correcting hazards and in improving safety and health management is available to employers, without citation or penalty, through OSHA-supported programs in each State. These programs are usually administered by the State Labor or Health department or a State university.

Posting Instructions

Employers in States operating OSHA approved State Plans should obtain and post the State's equivalent poster.

Under provisions of Title 29, Code of Federal Regulations, Part 1903.2(a)(1) employers must post this notice (or facsimile) in a conspicuous place where notices to employees are customarily posted.

More Information

Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from your employer or from the nearest OSHA Regional Office in the following locations:

Atlanta	(404) 347-3573
Boston	(617) 565-7164
Chicago	(312) 353-2220
Dallas	(214) 767-4731
Denver	(303) 844-3061
Kansas City	(816) 428-5861
New York	(212) 337-2376
Philadelphia	(215) 565-1201
San Francisco	(415) 744-6670
Seattle	(206) 442-8930

Elizabeth Dole

Elizabeth Dole, Secretary of Labor

U.S. Department of Labor

Occupational Safety and Health Administration

Washington, D.C.
1989 (Revised)
OSHA 2203





SITE SAFETY MEETING MINUTES

Site Name _____ Contract No. _____

Meeting Location _____

Meeting Date _____ Time _____ Conducted By _____

Pre-fieldwork Orientation _____ Weekly Site Meeting _____ Other _____

Subjects Discussed _____

Safety Officer Comments _____

Name and Signature of Participating Personnel (list company name if subcontractor)

Note: Attach additional pages if necessary. Send this form to the PTI corporate health and safety officer. Copies will be placed in the appropriate project files.



Source: NOAA (1995)

Figure 1. Location of Ward Cove.

STANDARD OPERATING PROCEDURE

SAFETY DURING MARINE OPERATIONS

SOP 423

INTRODUCTION

PTI field projects often require the collection of biological, sediment, and water samples from vessels. In addition to the physical and chemical hazards associated with all field sampling, there are special hazards associated with vessels. This SOP provides guidance for ensuring the safety of PTI and subcontractor personnel when working on the water. These procedures address inland or protected waters only. Additional procedures are required for working on vessels offshore.

TRAINING

Appropriate training is essential for preventing accidents and ensuring the proper completion of all field duties. The following training requirements apply to all PTI field work conducted on the water:

All PTI and subcontractor personnel must participate in an initial safety briefing prior to beginning the field work, whenever new personnel come aboard, and when conditions or tasks change.

- If the field project is conducted at a designated hazardous materials site or there is any potential for chemical exposure, then all PTI and subcontractor personnel must have the appropriate 40-hour hazardous waste operations training and current 8-hour annual refresher training. Supervisors must have completed the 8-hour supervisors training course.
- The field team leader, or site safety officer must have current first aid and cardiopulmonary resuscitation (CPR) training.
- If the vessel is to be operated by PTI personnel, the operator must demonstrate proficiency in the operation of that type of vessel and knowledge of marine safety and navigation rules. Personnel without prior experience will be required to complete training in these subjects.

(Note: This requirement is intended to apply to small craft only; PTI does not anticipate training personnel to operate large vessels.)

REQUIRED SAFETY EQUIPMENT

To prevent accidents and ensure adequate preparation for any emergencies that may arise, it is the responsibility of the PTI project manager to secure appropriate safety equipment for the duration of the project. This equipment must include the following:

- **Personal Flotation Devices (PFDs)**—There must be one PFD for every person onboard the vessel, plus an additional throwable flotation device for vessels over 16 ft in length.
- **Fire Extinguisher**—Requirements for fire extinguishers vary based on the vessel length and whether the vessel has inboard engines or closed compartments. Fire extinguishers are recommended for all motorized vessels. Additional information regarding requirements for fire extinguishers can be obtained from the U.S. Coast Guard.
- **First-Aid Kit**—A first-aid kit must be provided during all PTI field projects. The contents of the first-aid kit will vary based on the number of persons present, but at a minimum should include a variety of bandages and compresses, disinfectant, gloves, a CPR shield, eyewash, and an emergency blanket. Additional information regarding requirements for first-aid kits can be obtained from the applicable federal or state department responsible for occupational safety and health.
- **Marine Radio with Weather Channel**—A VHF radio is required by law on commercial vessels and is required by PTI for all work on Puget Sound or other open waters. The frequency and call sign of local emergency services must be posted on the vessel and be included in the site health and safety plan.
- **Cellular Telephone**—If a two-way VHF marine radio is not available then a cellular telephone must be onboard.
- **Horn or Bell**—U.S. Coast Guard regulations require a signaling device be onboard all vessels longer than 36 ft and require that all vessels, regardless of length, be capable of making audible signals during certain events (i.e., approaching or overtaking other vessels).
- **Navigation Lights**—The requirements for navigation lights vary based on the length and type of vessel. All vessels operated at night must have the appropriate navigation lights.

- **Oars or Paddles**—Small power boats should be equipped with alternate means of propulsion.
- **Anchor and Suitable Line**—In most cases, vessels should be equipped with one (or two) anchors and sufficient anchor line for expected water depths and bottom conditions.
- **Flares**—A flare kit should be onboard all field vessels.
- **Reach Pole or Shepherd's Hook**—On larger vessels, a reach pole or shepherd's hook must be available to facilitate rescue of any persons who fall overboard.
- **Other Rescue Gear**—On larger vessels, a block and tackle or other means must be available to pull a person from the water.

HAZARDS AND PREVENTION

There are many physical hazards associated with working onboard a vessel. Potential hazards and appropriate precautions are listed below:

- **Slips/Trips/Falls**—The combination of a moving vessel and wet or slippery decks increases the potential for slips, trips, or falls. These can be prevented by increasing your awareness of the surroundings, keeping one hand free for handholds and support, keeping the deck and working areas clear of unnecessary obstacles or hazards, and wearing nonskid boots or shoes.
- **Drowning**—Even the best swimmer can drown if caught unprepared, tired, or weighted down with bulky clothing and boots. Drowning can be prevented by taking precautions against falling overboard (avoid reaching over the side, beware of slips/trips/falls, avoid ondeck work in heavy seas) and by wearing a PFD. PFDs should be worn underneath chemical protective clothing such as Tyvek[®] coveralls (thus allowing the wearer to remove the coveralls without first removing the PFD) and should be properly secured or buckled.
- **Crushing/Falling Objects**—The use of hoists to lift coring tools and other equipment could result in crushing or other injuries to field workers. These injuries can be avoided by using properly adjusted and maintained hoists, allowing only experienced personnel to operate the hoist, keeping all personnel out of the way during lifting and hoisting, and wearing hardhats to protect against head injuries or bumps.
- **Gear Deployment and Retrieval**—The deployment and retrieval of sampling gear presents a hazard because of the weight of the gear, its

suspension over the deck, and the risk of entanglement or accidental and premature release or closure. Setting the triggering mechanism must always be performed when the equipment is resting on a stable surface. During sample retrieval, at least one crew member is required to watch for the appearance of the sampling gear and alert the winch operator. Failure to observe the sampling gear and stop the winch could lead to breakage of the cable, loss of the sampling gear, and possible injury from either the falling gear or the end of the broken cable. All nonessential personnel should stay clear of the work area during the retrieval and deployment of sampling gear. All personnel should be knowledgeable in the proper hand signals for guiding the winch operator.

- **Cables**—After repeated use, stainless steel cables may fray or break. Sampling personnel must never take hold of the moving cable unless they are wearing work gloves. Periodically during the sampling event, the site safety officer should inspect the cable for wear, especially where the wire or cable is attached to the sampling equipment.
- **Climate**—Depending on the climate, field personnel may suffer from hypothermia, dehydration, or heat stress. Climate-related illnesses and injuries can be prevented by dressing appropriately for the expected climate and by having additional clothing onboard should personnel get wet or the weather change suddenly. When working in cold, wet weather, appropriate clothing may include raingear, wool, and modern synthetics. Cotton clothing should only be worn during warm, dry weather. In addition, fluid replenishment beverages (to protect against heat stress and dehydration) or warm beverages (to protect against hypothermia) should be available during field work.
- **Unsecured Gear**—Wherever possible, all ondeck sampling and safety gear should be secured to a deck, rail, or bulkhead to prevent loss from unexpected movement caused by wind or waves.
- **Hatches**—All personnel should be alerted to the presence of an open hatch and hatches should not be left open unnecessarily.
- **Chemical and Sample Storage**—To prevent fire, health hazards, or sample contamination, all field chemicals such as solvents and formalin should be stored on deck, not in the cabin, hold, or near samples.

EMERGENCY PROCEDURES

In case of a boating-related injury or fatality, PTI personnel must:

- Notify emergency medical or rescue personnel immediately (as appropriate). The U.S. Coast Guard emergency frequency is VHF Channel 16.
- Notify the site safety officer, the appropriate PTI project manager, and the corporate health and safety officer immediately. The project manager and corporate health and safety officer will coordinate notifications to the Occupational Safety and Health Administration and the U.S. Coast Guard.

In case of boating-related property damage exceeding \$200, PTI personnel must:

- Notify police or other legal jurisdiction (as appropriate).
- Notify the site safety officer, the appropriate PTI project manager, and the corporate health and safety officer within 48 hours of the incident. The project manager and corporate health and safety officer will coordinate notification of the U.S. Coast Guard.
- Notify the PTI business operations manager to initiate insurance claims.



Appendix B

**Addendum to the Quality
Assurance Project Plan**

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ACRONYMS AND ABBREVIATIONS

CoPC	chemical of potential concern
DQO	data quality objective
DRET	dredging elutriate test
EPA	U.S. Environmental Protection Agency
FSP	field sampling plan
KPC	Ketchikan Pulp Company
MET	modified elutriate test
PTI	PTI Environmental Services
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
SOP	standard operating procedure

1. INTRODUCTION

This addendum to the quality assurance project plan (QAPP) for the Ward Cove sediment remediation project (PTI 1996, Appendix B) describes quality assurance and quality control (QA/QC) procedures that will be used to support field and laboratory activities implemented during Phase 2 of the Ward Cove investigation. The QAPP, prepared as part of the Phase 1 investigation, addresses QA/QC procedures for all field and laboratory activities for the Phase 1 investigation and for Phase 2 activities that were judged likely to be implemented. QA/QC procedures that apply to Phase 2 activities but were not described in the QAPP are included in this addendum.

A complete description of Phase 1 results, rationale for the current sampling specifications, and the intended end use of the data acquired from the Phase 2 investigation can be found in the Phase 1 data report (PTI 1997). A detailed description of Phase 2 field activities is provided in the field sampling plan (FSP; main text of this document). As discussed in the FSP, the Phase 2 investigation includes the following study components:

- Geophysical survey (bathymetry, side-scan sonar, video survey, and subbottom profiling)
- Surface sediment characterization (toxicity testing [static and static-renewal], analysis of selected chemicals of potential concern [CoPCs] in sediment and selected pore water samples, and toxicity identification evaluation)
- Surface sediment characterization (toxicity testing and analysis of additional chemicals for National Pollutant Discharge Elimination System monitoring)
- Sediment column characterization (chemical analysis of CoPCs in sediment and sediment elutriate testing)
- Sediment accumulation testing (fine resolution sediment core analyses for lead-210, cesium-137, and grain size).

A summary of target analytes for the Phase 2 investigation is provided in Table B-1.

QA/QC considerations that pertain to the geophysical survey are discussed in the FSP for the geophysical survey (Appendix A of this document). A summary of information included in the QAPP is provided in the following section. Supplementary QA/QC information for Phase 2 is provided in Sections 3 through 6 of this QAPP addendum. References cited in this addendum are listed in Section 7.

TABLE B-1. TARGET ANALYTES FOR THE PHASE 2 SEDIMENT INVESTIGATION

Surface Sediment Characterization	Sediment Column Characterization
<p>Sediment Toxicity Tests</p> <p>10-Day amphipod test (static)</p> <p>10-Day amphipod test (static-renewal)</p> <p>96-Hour echinoderm embryo test</p> <p>TIE tests (described in Appendix F of the FSP)</p> <p>Sediment Chemistry</p> <p>Total ammonia</p> <p>Total organic carbon</p> <p>Total sulfide</p> <p>Acid-volatile sulfide^a</p> <p>Biological oxygen demand</p> <p>Chemical oxygen demand</p> <p>Grain size</p> <p>Total solids</p> <p>Arsenic^a</p> <p>Cadmium^a</p> <p>Methylmercury^a</p> <p>Total mercury^a</p> <p>Zinc^a</p> <p>Phenol^a</p> <p>4-Methylphenol</p> <p>Dioxin and furan congeners^a</p> <p>Polycyclic aromatic hydrocarbons^a</p> <p>Benzoic acid^a</p> <p>Extractable organic halides^a</p> <p>Pore Water Analyses (to support TIE tests)</p> <p>Total ammonia</p> <p>Total sulfide</p> <p>Salinity</p> <p>pH</p> <p>Sediment Accumulation Testing</p> <p>Cesium-137</p> <p>Lead-210</p> <p>Grain size</p> <p>Total solids</p>	<p>Sediment Chemistry</p> <p>Total ammonia</p> <p>Total organic carbon</p> <p>Total sulfide</p> <p>Biological oxygen demand</p> <p>Chemical oxygen demand</p> <p>Grain size</p> <p>Total solids</p> <p>Cadmium</p> <p>Total mercury</p> <p>Zinc</p> <p>Phenol</p> <p>4-Methylphenol</p> <p>Dioxin and furan congeners</p> <p>Engineering Properties</p> <p>Modified elutriate test</p> <p>Dredging elutriate test</p> <p>Water samples (to support elutriate tests; analyzed for TSS)</p> <p>Column settling test</p> <p>One-dimensional consolidation test</p> <p>Desiccation characteristics</p> <p>Physical properties</p> <p>Grain size</p> <p>Water content and void ratio</p> <p>Specific gravity</p> <p>Atterberg limits (liquid and plasticity limits)</p> <p>Sediment Elutriate Chemistry</p> <p>Total ammonia</p> <p>Total suspended solids</p> <p>Cadmium (total and dissolved)</p> <p>Total mercury (total and dissolved)</p> <p>Zinc (total and dissolved)</p> <p>Phenol (total and dissolved)</p> <p>4-Methylphenol (total and dissolved)</p> <p>Dioxin and furan congeners (total and dissolved)</p>

Note: See Table 3-1 in the main text of the FSP for a summary of analytes by station.

- FSP - field sampling plan
- NPDES - National Pollutant Discharge Elimination System
- TIE - toxicity identification evaluation

^a NPDES stations only.

2. SUMMARY OF QAPP CONTENTS AND PHASE 2 MODIFICATIONS

The QAPP includes descriptions of QA/QC procedures that are relevant to both the Phase 1 and Phase 2 investigations. The following QA/QC procedures are described in the QAPP (modifications for Phase 2 are provided in the indicated sections of this appendix):

- Project organization and responsibilities (modifications for Phase 2 are described in Section 3)
- Quality assurance objectives and sampling strategy (modifications for Phase 2 are described in Section 4)
- Sampling procedures (complete text and modifications for Phase 2 are included in Section 5)
- Sample custody (no modifications for Phase 2)
- Calibration procedures and frequency (no modifications for Phase 2)
- Analytical procedures (modifications for Phase 2 are described in Section 6)
- Data validation, reduction, and reporting (no modifications for Phase 2)
- Internal quality control (no modifications for Phase 2)
- Quality assurance performance and system audits (no modifications for Phase 2)
- Preventive maintenance procedures and schedules (no modifications for Phase 2)
- Specific routine procedures used in data validation (no modifications for Phase 2)
- Corrective actions (no modifications for Phase 2)
- Quality assurance reports to management (no modifications for Phase 2).

The first page of Section 4 of the QAPP, *Sampling Procedures*, was inadvertently omitted from the QAPP. The text from Section 4 of the QAPP is provided in full in Section 5 of this addendum, with modifications made as necessary to include Phase 2 activities.

3. PROJECT ORGANIZATION

The quality assurance organization for this project and the individuals responsible for ensuring the quality of field and laboratory operations and the data collected are provided below. These personnel have the following responsibilities:

Personnel	Responsibilities
Project Manager and Site Coordinator (Andy Maloy, Ketchikan Pulp Company [KPC]; Karen Keeley, U.S. Environmental Protection Agency [EPA] Region 10)	Overall responsibility for KPC activities. Oversee all program activities to ensure compliance; perform technical oversight and consultation on major quality assurance problems; provide final approval of all necessary actions and adjustments for activities to accomplish project objectives.
PTI Project Manager (Lucinda Jacobs)	Oversee all program activities under KPC direction to ensure appropriate quality control review; provide technical oversight; implement necessary actions and adjustments for activities to accomplish project objectives.
PTI Quality Assurance Coordinator (Maja Tritt)	Provide technical quality assurance assistance; develop, prepare, and review QAPP; coordinate with project laboratories; oversee quality assurance activities to ensure compliance with QAPP; track submittal and analysis of samples to the laboratory and ensure delivery of data; monitor field investigations; prepare and submit quality assurance reports.
Laboratory Quality Assurance Officers	Ensure that sample receipt and custody records are properly handled, data are reported within specified turnaround times, instruments are calibrated and maintained as specified, internal quality control measures and analytical methods are performed as required, corrective action is taken and the PTI Quality Assurance Coordinator is notified when problems occur, and data and quality assurance information are reported.

A laboratory quality assurance officer, as described above, will be identified at each contract laboratory to ensure that appropriate procedures are followed during sample analysis and preparation of the data packages. The laboratory quality assurance officer will be identified prior to submittal of samples. Laboratory contracts will be negotiated as described in the QAPP.

4. QUALITY ASSURANCE OBJECTIVES AND SAMPLING STRATEGY

Section 3 of the QAPP includes a discussion of data quality objectives (DQOs) for the Ward Cove investigation and the strategy used to meet these DQOs and quantify the bias and precision of the data. Table B-2 of this QAPP addendum provides a summary of quantitative DQOs, target method reporting limits, and method numbers or references for the Phase 2 investigation.

Field quality control samples will be collected during Phase 2 for all matrices at the same frequencies used for Phase 1. Field replicates and equipment blanks will be collected for 5 percent of samples for each sample type. Reference materials will be supplied to the laboratory as available and applicable. Field quality control samples are discussed in detail in Section 9.1 of the QAPP.

TABLE B-2. SUMMARY OF DATA QUALITY OBJECTIVES

Analysis	Method Reference	Units	Method Reporting Limit ^a	Bias (percent)	Precision (RPD)	Completeness (percent)
Sediment^b						
Toxicity Tests						
Amphipod mortality (<i>R. abronius</i>)	PSEP (1995)	percent survival, percent non-reburial	--	--	--	100
Echinoderm abnormality (<i>D. excentricus</i>)	PSEP (1995)	percent survival, percent normality	--	--	--	100
Conventional Analyses						
Total ammonia	EPA 350.1M	mg/kg	1	75-125	±35	95
Total organic carbon	Standard Method 5310B	percent	0.05	75-125	±35	95
Total sulfide	EPA 9030	mg/kg	20	50-150	±50	95
Acid-volatile sulfide	EPA Draft 12/91	mg/kg	4	50-150	±50	95
Biological oxygen demand	EPA 405.1M	mg/kg	200	75-125	±25	95
Chemical oxygen demand	EPA 410.1M	mg/kg	500	75-125	±25	95
Grain size	PSEP (1986)	percent	0.1	--	±35	95
Total solids	PSEP (1986)	weight percent	0.1	--	±35	95
Metals						
Arsenic	EPA 200.8	mg/kg	0.5	75-125	±35	95
Cadmium	EPA 200.8	mg/kg	0.02	75-125	±35	95
Methylmercury	Bloom (1989)	µg/kg	0.05	50-150	±50	95
Total mercury	EPA 7471	mg/kg	0.2	75-125	±35	95
Zinc	EPA 200.8	mg/kg	0.5	75-125	±35	95
Organic Compounds						
Phenol, 4-methylphenol	GC/MS with SIM	µg/kg	10	50-150	±50	95
Dioxin and furan congeners	EPA 8290	ng/kg	1-10	50-150	±50	95

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TABLE B-2. (cont.)

Analysis	Method Reference	Units	Method Reporting Limit ^a	Bias (percent)	Precision (RPD)	Completeness (percent)
PAHs, benzoic acid	GC/MS with SIM	µg/kg	10	50-150	±50	95
Extractable organic halides	EPA 9020M	mg/kg	150	50-150	±50	95
Radionuclides						
Cesium-137	Laboratory SOPc	dpm/g	0.1	75-125	±35	95
Lead-210	Laboratory SOPc	dpm/g	0.1	75-125	±35	95
Engineering Properties						
Column settling testing	U.S. COE (1987)				±15	95
Consolidation testing	U.S. COE (1980, 1987)	coefficient of consolidation and stress vs. strain		--	±15	95
Desiccation characteristics	Stark (1989)		--	--	±15	95
Physical Properties						
Grain size	PSEP (1986)	percent	0.5	--	±35	95
Water content	U.S. COE (1980)	percent	0.1	--	±15	95
Void ratio	U.S. COE (1980)	--	--	--	±15	95
Specific gravity	U.S. COE (1980)	--	--	--	±15	95
Atterberg limits						
Liquid limit	U.S. COE (1980)	percent	1.0	--	±15	95
Plasticity limit	U.S. COE (1980)	percent	1.0	--	±15	95
Extracted Pore Water						
Ammonia	EPA 350.1	mg N/L	0.05	75-125	±25	95
Total sulfide	EPA 376.2	mg/L	0.05	65-135	±35	95
Salinity	EPA Standard Method 2520B	ppt	--	90-110	±0.1	95
pH	EPA 150.1	pH units	--	0.1 unit	±0.1 unit	95
Sediment Elutriate						
Total ammonia	EPA 350.1	mg N/L	0.05	75-125	±25	95

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TABLE B-2. (cont.)

Analysis	Method Reference	Units	Method Reporting Limit ^a	Bias (percent)	Precision (RPD)	Completeness (percent)
Total suspended solids	EPA 160.2	mg/L	5	85-115	±20	95
Cadmium (total and dissolved)	EPA 200.7	µg/L	4	75-125	±25	95
Total mercury (total and dissolved)	EPA 245.1	µg/L	0.5	75-125	±25	95
Zinc (total and dissolved)	EPA 200.7	µg/L	10	75-125	±25	95
Phenol (total and dissolved)	GC/MS with SIM	µg/L	0.5	70-130	±30	95
4-Methylphenol (total and dissolved)	GC/MS with SIM	µg/L	0.5	70-130	±30	95
Dioxin and furan congeners (total and dissolved)	EPA 8290	pg/L	10-100	50-150	±20	95

Note: ASTM - American Society for Testing and Materials RPD - relative percent difference
 EPA - U.S. Environmental Protection Agency SIM - selective ion monitoring
 GC/MS - gas chromatography/mass spectrometry SOP - standard operating procedure
 PAH - polycyclic aromatic hydrocarbon -- - not applicable

^a For organic analytes, the practical quantification limit is given. For inorganic analytes, the method reporting limit is the instrument detection limit adjusted for sample size and dilution during sample preparation.

^b Data quality objectives for toxicity identification evaluation tests will be determined when details of these procedures are established.

^c For example, Battelle Marine Sciences Laboratory (Sequim, Washington) SOPs: Pb²¹⁰ Dating Digestion and Analysis *and* Laboratory Method for Cs¹³⁷.

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5. SAMPLING PROCEDURES

The overall quality of the data collected during an environmental study depends largely on the quality of the field sampling activities. The following procedures for sample collection and handling are specified and documented in the FSPs for Phase 1 (PTI 1996) and Phase 2 (main text of this document):

- Guidance for establishing and documenting the locations of sampling stations
- Standard operating procedures (SOPs) for decontaminating equipment and work surfaces prior to sample collection, between samples, and between sampling events
- SOPs for labeling, processing, and shipping samples to ensure sample integrity from collection to analysis
- Instructions and SOPs for completing field data sheets, sample log forms, chain-of-custody forms, and field notebooks.

Sample container, preservation, and handling requirements, as well as the sample mass required by the laboratory for each analysis, are summarized in Table B-3. New ICH^{EM}[®] 300 Series Superanalyzed[®] or equivalent sample containers, with certificates of analysis, will be provided by the analytical laboratories. Sample containers will be kept closed until used. As they are collected, samples will be fully labeled, recorded in the field logbook along with other pertinent data, and placed in coolers as soon as possible. Field replicates and other field quality control samples will be clearly identified on the sample log forms but will be submitted to laboratories as blind samples. However, field quality control samples will be identified in a manner that will avoid the use of field blanks or reference materials as laboratory quality control samples.

The following additional criteria will be implemented for the samples to ensure that data are representative of environmental conditions and comparable to existing data from the site and that detection limits are commensurate with the intended uses of the data:

- Whenever feasible, samples will be of sufficient size to allow attainment of target detection limits and analysis of laboratory quality control samples
- All subsamples will be taken from well-homogenized samples

TABLE B-3. SAMPLE PRESERVATION AND HANDLING PROCEDURES

Analyte	Approximate Laboratory Subsample	Container	Preservation and Handling	Maximum Holding Time (from date of collection)
Sediment				
Toxicity Tests				
Amphipod mortality (<i>R. abronius</i>)	1.25 L	2 x 1-L glass jar, Teflon®-lined lid	Store in dark; 4°C	14 days
Echinoderm abnormality (<i>D. excentricus</i>)	200 g	1-L glass jar; Teflon®-lined lid	Store in dark; 4°C	14 days
Conventional Analyses				
Total ammonia	20 g	Wide-mouth, high-density polyethylene jar	4°C (do not freeze)	7 days
Total organic carbon	1 g	Wide-mouth, high-density polyethylene jar	4°C or freeze	28 days 6 months
Total sulfide	10 g	125-mL wide-mouth, high-density polyethylene jar	No headspace; 4°C (do not freeze)	14 days
Acid-volatile sulfide	10 g	125-mL wide-mouth, high-density polyethylene jar	No headspace; 4°C (do not freeze)	14 days
Biological oxygen demand	1–5 g	Wide-mouth, high-density polyethylene jar	No headspace; 4°C	7 days
Chemical oxygen demand	0.5–2 g	Wide-mouth, high-density polyethylene jar	4°C	7 days
Grain size	250 g	Wide-mouth, high-density polyethylene jar	4°C (do not freeze)	180 days
Total solids	10 g	Wide-mouth, high-density polyethylene jar	4°C	180 days

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TABLE B-3. (cont.)

Analyte	Approximate Laboratory Subsample	Container	Preservation and Handling	Maximum Holding Time (from date of collection)
Metals				
Methylmercury	1 g	Wide-mouth, high-density polyethylene jar	4°C	28 days ^a
Total mercury	0.2 g	Wide-mouth, high-density polyethylene jar	4°C	28 days ^a
Arsenic, cadmium, zinc	1 g	Wide-mouth, high-density polyethylene jar	4°C	180 days
Organic Compounds				
Phenol, 4-methylphenol, PAHs, benzoic acid	10-30 g	Wide-mouth glass jar; Teflon [®] -lined lid	4°C	14 days to extraction ^{b,c}
Dioxin and furan congeners	10-30 g	Wide-mouth glass jar; Teflon [®] -lined lid	4°C; store in dark	30 days to extraction ^{b,d}
Extractable organic halides	1-5 g	Wide-mouth glass jar; Teflon [®] -lined lid	4°C; store in dark	28 days
Radionuclides/Sediment Accumulation Testing				
Cesium-137	2 g	Wide-mouth, high-density polyethylene jar	4°C or freeze	1 year
Lead-210	5 g	Wide-mouth, high-density polyethylene jar	4°C or freeze	1 year
Sediment and Water for Engineering Properties Tests				
MET				
Sediment	3,000 g wet weight ^e	4 × 1-L glass bottle, Teflon [®] -lined lid or 2 × 1-gal plastic container with Teflon [®] bag	4°C (do not freeze)	14 days
Water	20 L	20 × 1-L glass bottle, Teflon [®] -lined lid or 6 × 1-gal plastic container with Teflon [®] bag	4°C (do not freeze)	14 days

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TABLE B-3. (cont.)

Analyte	Approximate Laboratory Subsample	Container	Preservation and Handling	Maximum Holding Time (from date of collection)
DRET				
Sediment	200 g wet weight ^f	1 × 1-L glass bottle, Teflon [®] -lined lid or 1 × 1-gal plastic container with Teflon [®] bag	4°C (do not freeze)	14 days
Water	20 L	20 × 1-L glass bottle, Teflon [®] -lined lid or 6 × 1-gal plastic container with Teflon [®] bag	4°C (do not freeze)	14 days
Column Settling Tests				
Sediment	20 L	6 × 1-gal plastic container	4°C (do not freeze)	180 days
Water	80 L	24 × 1-gal plastic container	4°C (do not freeze)	180 days
Sediment for Consolidation Tests	1 L	1 × 1-gal plastic container	4°C (do not freeze)	180 days
Sediment for Desiccation Characteristics	1 L	1 × 1-gal plastic container	4°C (do not freeze)	180 days
Sediment for Physical Properties (grain size, water content, void ratio, specific gravity, and Atterberg limits)	225 g wet weight	8 oz glass jar, Teflon [®] -lined lid or 8 oz high-density polyethylene jar	4°C (do not freeze)	180 days
Sediment for Pore Water Extraction	1 L ^g	1-L glass jar, Teflon [®] -lined lid	4°C	5 days
Extracted Pore Water				
Ammonia	25 mL	High-density polyethylene bottle	Add H ₂ SO ₄ to pH <2; 4°C	28 days
Total sulfide	100 mL	125-mL glass VOA vial	Add 0.5 mL zinc acetate, NaOH to pH >9; 4°C	5 days
Salinity and pH	25 mL	High-density polyethylene bottle	4°C	48 hours
Sediment Elutriate				
Conventional Analyses				
Total ammonia	25 mL	High-density polyethylene bottle	Add H ₂ SO ₄ to pH <2; 4°C	28 days
Total suspended solids	250 mL	High-density polyethylene bottle	Add H ₂ SO ₄ to pH <2; 4°C	7 days

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TABLE B-3. (cont.)

Analyte	Approximate Laboratory Subsample	Container	Preservation and Handling	Maximum Holding Time (from date of collection)
Metals				
Cadmium, zinc (total and dissolved)	400 mL	High-density polyethylene bottle	Add HNO ₃ to pH < 2	6 months
Total mercury (total and dissolved)	200 mL	High-density polyethylene bottle	Add HNO ₃ to pH < 2	28 days
Organic Compounds				
Phenol, 4-methylphenol (total and dissolved)	1 L	1-L amber glass jar, Teflon [®] -lined lid	4°C; store in dark	7 days ^c
Dioxin and furan congeners (total and dissolved)	1 L	1-L amber glass jar, Teflon [®] -lined lid	4°C; store in dark	30 days ^d

Note: Sample requirements for toxicity identification evaluation tests using *Rhepoxynius abronius*, *Dendraster excentricus*, and *Ampelisca abdita* will be determined when details of these procedures are established.

- DRET - dredging elutriate test
- MET - modified elutriate test
- PAH - polycyclic aromatic hydrocarbon

a Samples for total mercury will maintain their integrity for several years if stored frozen (Bloom 1995, pers. comm.) and may be archived at -20°C for up to 1 year for this project.

b Samples may be archived in the freezer (-20°C) for up to 1 year (PSEP 1989).

c Extracts must be analyzed within 40 days of extraction.

d Analysis must be completed within 45 days of extraction.

e A total of 2.5 L of sediment should be provided to the laboratory. Approximately 600 g dry weight will be required to complete the MET.

f A total of 250 L of sediment should be provided to the laboratory. Approximately 10 g wet weight will be required to complete the DRET.

g A sediment volume of 1 L is expected to yield at least 200 mL of pore water. Final sample size requirements will be determined during the preliminary sampling in May.

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- Verification that each sample is isolated from point-source and cross-contamination during sampling will be accomplished by using field blanks
- Subsamples will be placed in appropriate containers and held under appropriate conditions (Table B-3) to avoid sample contamination or analyte loss.

A complete record of stations, samples, and events will be maintained, as described in the FSP (main text of this document), throughout the field effort for this site investigation. Any modifications to the field sampling procedures described in the QAPP, addendum to the QAPP, or FSP will be documented and justified in the field notebooks and will be identified as a change from the intended method in subsequent project reports. Major modifications to the sampling strategy or collection procedures must be approved in advance by the PTI project manager and the PTI quality assurance coordinator, in consultation with KPC and EPA Region 10.

6. ANALYTICAL PROCEDURES

Chemical analysis methods to be used during this investigation are referenced in Table B-2. The QAPP includes discussions of sediment toxicity tests and analytical procedures for analyses of semivolatile organic compounds and metals, conventional analyses, and radiological analyses in sediment that will be completed during Phase 2. Analytical procedures for additional Phase 2 testing are summarized in the following sections.

6.1 SEDIMENT ANALYSES

Analyses for grain size require only the determination of the sand fraction (particles larger than 62.5 μm) and the silt/clay fraction (particles smaller than 62.5 μm). The sediment will be sieved wet to separate the sand and silt/clay fractions, but the pipet method will not be used to further subdivide the silt and clay fractions of the sediment.

6.2 PORE WATER ANALYSES

Pore water analyses will be completed for conventional analytes as indicated in Table B-1. All pore water samples will be analyzed using EPA-approved (e.g., U.S. EPA 1983) or recommended methods when available and will include all associated QA/QC procedures recommended in each method. Method references for pore water analyses are provided in Table B-2.

6.3 ELUTRIATE TESTING

All applicable QA/QC procedures described in the QAPP, in this addendum, and in the applicable method descriptions (references provided in Table B-2) will be observed during any elutriate preparation and testing procedures that are completed for this investigation. Applicable procedures include, but are not limited to, equipment decontamination, sample documentation and custody, sample storage and handling, and analytical QA/QC procedures. Detailed information regarding methodology and QA/QC procedures for toxicity identification evaluation will be provided in an addendum to the Phase 2 work plan.

Elutriate tests will include the modified elutriate test (MET; Palermo 1986) and the dredging elutriate test (DRET; DiGiano et al. 1995). For the MET procedure, sediment and dredging site water will be combined in a ratio of 150 g sediment (dry weight) to 1 L water. The resulting slurry will be mixed to a uniform consistency and aerated for 1 hour. Finally, the slurry will be allowed to settle for 24 hours, and supernatant water (elutriate) will be removed for chemical analysis. The procedure for the DRET will be similar to the

MET, but the sediment-to-water ratio will be smaller (10 g sediment to 1 L water) and the settling time will be shorter (1 hour).

Both total and dissolved fractions of the elutriate will be tested for cadmium, total mercury, zinc, phenol, 4-methylphenol, and dioxin and furan congeners. Analyses will also be conducted for total ammonia and total suspended solids on the total elutriate fractions. Samples to be analyzed for dissolved metals and total suspended solids will be filtered using a 0.45- μm membrane filter. EPA Method 160.2 for analysis of total suspended solids will be modified to include the use of a 0.45- μm membrane filter rather than the glass fiber filter specified in the method description. Analyses will be conducted for dissolved phenol, 4-methylphenol, and dioxin and furan congeners on elutriate samples centrifuged at 10,000 g in Teflon[®], glass, or aluminum centrifuge tubes.

6.3.1 Metals

Analyses for cadmium and zinc will be completed by inductively coupled plasma/atomic emission spectrometry in accordance with EPA Method 200.7 (U.S. EPA 1994a). Samples will be digested with nitric and hydrochloric acids prior to analysis, as described in Method 200.7. Analyses for mercury will be completed by cold vapor atomic absorption spectrometry in accordance with EPA Method 245.1 (U.S. EPA 1994a). Samples will be digested with potassium permanganate and potassium persulfate as described in Method 245.1.

6.3.2 Organic Compounds

Analyses for phenol and 4-methylphenol in sediment elutriate (Table B-1) will be completed using gas chromatography/mass spectrometry with selective ion monitoring (SIM). The SIM method is more sensitive than the commonly used EPA Method 8270A (U.S. EPA 1994b) and is expected to yield detection limits of 0.5 $\mu\text{g/L}$ (Table B-2). Samples will be extracted with methylene chloride in accordance with EPA Method 3510B (U.S. EPA 1994b).

Elutriate samples will be analyzed for dioxin and furan congeners by EPA Method 8290 (U.S. EPA 1994b). This high resolution gas chromatography/high resolution mass spectrometry method is summarized in the QAPP. Samples will be extracted with methylene chloride in accordance with EPA Method 3510B (U.S. EPA 1994b).

6.3.3 Conventional Analyses

Conventional wet chemistry analyses will be completed in accordance with the methods referenced in Table 3-1 in the main test of the FSP. Analyses for total ammonia will be completed by a potentiometric procedure in accordance with EPA Method 350.3

(U.S. EPA 1983). Analyses for total suspended solids will be completed in accordance with EPA Method 160.2 (U.S. EPA 1983).

6.4 ENGINEERING PROPERTIES

All applicable QA/QC procedures described in the QAPP, in this addendum, and in the applicable method descriptions (references provided in Table B-2) will be observed during any engineering testing procedures that are completed for this investigation. Applicable procedures include, but are not limited to, equipment decontamination, sample documentation and custody, sample storage and handling, and analytical QA/QC procedures. Detailed information regarding methodology and QA/QC procedures for toxicity identification evaluation will be provided in an addendum to the Phase 2 work plan.

The engineering properties (i.e., geotechnical parameters) of sediment samples will be determined to provide information for selecting the type of dredge required, determining disposal site conditions, and identifying potential capping alternatives. The engineering properties that will be determined are described below.

6.4.1 Column Settling Testing

Column settling testing of sediment samples will be completed in accordance with procedures specified in the U.S. Army Corps of Engineers (U.S. COE) Engineer Manual No. 1110-2-5027 (U.S. COE 1987). The column that will be used for the column settling tests is approximately 8 in. in diameter and 8 ft tall with a series of sampling ports spaced every 6 in. along its length. Wet sediment will be weighed out and added to the required volume of site water to provide approximately 85 L of a 150-g/L slurry (dry-weight basis). If the sediment samples contain a large amount of wood debris, the wood debris will be manually removed before the slurry is prepared. The column will be filled with the slurry, aerated, and sampled at specified time intervals. Results will be reported for total suspended solids (mg/L), turbidity (nephelometric turbidity units), compression settling (solids concentration per time), zone settling (zone settling velocity vs. ft/hr per concentration), and flocculent settling (solids loading per solid concentration).

6.4.2 Consolidation Testing

One-dimensional consolidation testing and undrained pre-consolidation testing of sediment samples will be completed in accordance with procedures specified in U.S. COE Engineer Manual No. 1110-2-5027 (U.S. COE 1987) and Engineer Manual No. 1110-2-1906 (U.S. COE 1980). The consolidation testing will provide data for evaluating filling and settling rates for confined disposal sites. The one-dimensional consolidation test will be conducted by applying incremental vertical loads to allow the sediment to consolidate under each load. Each incremental load will be left in place until 100 percent consolidation is attained. Measurements will be taken of the compression of the sample over time

under each load increment and the rebound of the sediment during the unloading. The consolidated undrained pre-consolidation test is designed to directly measure the change in height of the sediment over time as a specific weight is applied.

6.4.3 Desiccation Characteristics

Desiccation characteristics of sediment samples will be determined in accordance with procedures specified in U.S. COE Instruction Report D-91-1 (Stark 1989). Determination of the desiccation characteristics will include the shrinkage limit, which is the amount of water required to just fill all voids of a given cohesive sediment at its minimum void ratio obtained by oven-drying. The results obtained from determining the shrinkage limit will also be used to calculate other parameters such as the shrinkage ratio, volumetric shrinkage, linear shrinkage, and crack development potential.

6.4.4 Grain Size

Grain-size distributions will be determined in accordance with protocols specified by the Puget Sound Estuary Program (PSEP 1986). Sediment samples will be oxidized by wet-sieving the samples with hydrogen peroxide and then dry-sieving the gravel and sand fractions. The silt/clay fraction will be subdivided into silt and clay fractions using a pipet technique.

6.4.5 Water Content, Void Ratio, Specific Gravity, and Atterberg Limits

Water content, void ratio, specific gravity, and Atterberg limits (i.e., liquid and plasticity limits) will be completed in accordance with procedures specified in U.S. COE Engineer Manual No. 1110-2-1906 (U.S. COE 1980).

7. REFERENCES

Bloom, N. 1995. Personal communication (telephone conversation with M. Tritt, PTI Environmental Services, Bellevue, WA, regarding sediment sample integrity over time). Frontier Geosciences, Inc., Bellevue, WA.

DiGiano, F.A., C.T. Miller, and J. Yoon. 1995. Dredging elutriate test (DRET) development. Contract Report D-95-1. Prepared for U.S. Army Corps of Engineers, Washington, DC. University of North Carolina, Chapel Hill, NC.

Palermo, M.R. 1986. Development of a modified elutriate test for estimating the quality of effluent from confined dredged material disposal areas. Technical Report D-86-4. Prepared for the U.S. Department of the Army, U.S. Army Corps of Engineers. U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, MS.

PSEP. 1986. Recommended protocols for measuring conventional sediment variables in Puget Sound water, sediment, and tissue samples. Prepared for U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Seattle, WA.

PSEP. 1989. Recommended guidelines for measuring organic compounds in Puget Sound sediment and tissue samples. U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA.

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Stark, T.D. 1989. Program documentation and users guide: PCDDF89, primary consolidation and desiccation of dredged fill. Instruction Report D-91-1, 1989. Prepared for the Department of the Army, U.S. Army Corps of Engineers, Washington, DC. San Diego State University, Department of Civil Engineering, San Diego, CA.

U.S. COE. 1980. Engineering design, laboratory soils testing. Engineer Manual No. 1110-2-1906, May 1980. Department of the Army, U.S. Army Corps of Engineers, Washington, DC.

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U.S. EPA. 1983. Methods for chemical analysis of water and wastes. EPA/600/4-79/020. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, OH.

U.S. EPA. 1994a. Supplement to methods for the determination of metals in environmental samples. Document No. EPA-600/X-94-XXX. Environmental Monitoring Systems Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH.

U.S. EPA. 1994b. Test methods for evaluating solid waste—physical/chemical methods, SW-846. Revised Methods. Third Edition. U.S. Environmental Protection Agency, Washington, DC.



Appendix C

Health and Safety Plan



SITE SAFETY PLAN

Site Name Ward Cove
Prepared by PTI Environmental Services Date 11/28/95; modified 4/23/97

INTRODUCTION

This site-specific health and safety plan establishes procedures and practices to protect personnel from potential hazards posed by field activities at Ward Cove. In this health and safety plan, measures are provided to minimize potential exposure, accidents, and physical injuries that may occur during daily onsite activities and adverse conditions. Contingency arrangements are also provided for emergency situations.

DISCLAIMER

PTI does not guarantee the health or safety of any person entering this site. Because of the potentially hazardous nature of this site and the activity occurring thereon, it is not possible to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury and illness at this site. The health and safety guidelines in this plan were prepared specifically for this site and should not be used on any other site without prior evaluation by trained health and safety personnel.

SITE DESCRIPTION (use additional pages if necessary)

Site name: Ward Cove
Site location or address: 7559 North Tongass Highway
Ketchikan, Alaska
Owners/tenants: _____
Current site use: Marine bay adjacent to a sawmill
Past site use (if different): Pulp mill
Designated hazardous waste site: No (federal, state, other) _____
Industrial facility _____ Spill _____ Other Marine waters and sediment
Topography: Marine bay measuring approximately 1/2 mile by 1 mile
Name of and distance to nearest surface water body: Ward Cove is a branch of the Tongass Narrows.
Surrounding land use/nearest population: A cannery is located on one shore; the Ketchikan sawmill and former pulp mill are located on the other.

Site access: The Ketchikan Pulp Company (KPC) facility is on the Tongass Highway.

Nearest drinking water/sanitary facilities: On the sampling vessel and at the KPC facility.

Nearest telephone (list number if possible): KPC (907) 225-2151

List utilities located (or to be located): Project personnel will work with facility personnel and local authorities to determine the location of submerged utilities, if any, prior to sediment coring.

Site map attached: _____

PROJECT PERSONNEL

	<u>Name/Affiliation</u>	<u>Work Telephone</u>	<u>Home Telephone</u>
Project manager	<u>Lucinda Jacobs</u>	<u>(206) 643-9803</u>	<u>(206) 324-3380</u>
Field team leader	<u>Jane Sexton</u>	<u>(206) 643-9803</u>	<u>(206) 782-1754</u>
Site safety officer	<u>Jane Sexton</u>	<u>(206) 643-9803</u>	<u>(206) 782-1754</u>
PTI field personnel	<u>Sherrill Doran</u>	<u>(206) 643-9803</u>	<u>(206) 828-0824</u>
	<u>Shawn Arbuckle</u>	<u>(303) 444-7270</u>	<u>(303) 384-3572</u>
Facility contact	<u>Andy Maloy (KPC)</u>	<u>(907) 228-2312</u> <u>(907) 228-2191</u>	

WORK PROPOSED

Description of proposed work: The collection of sediment samples (both shallow and cores) for chemical analysis.

Proposed work dates: July/August 1997

<u>Subcontractors</u>	<u>Name</u>	<u>Task</u>	<u>Contact</u>	<u>Telephone</u>
	<u>Golder Associates</u>	<u>Sediment coring</u>	<u>Dick Sylwester</u>	<u>(206) 883-0777</u>
	<u>David Evans & Associates</u>	<u>Station positioning</u>	<u>Jon Dasler</u>	<u>(503) 499-0297</u>

HAZARD EVALUATION

Potentially hazardous chemicals known or suspected to be onsite (include preservatives and decontamination chemicals):

Substance	Concentration	Medium	OSHA PEL	OSHA STEL	Odor Threshold	IP(eV)	Carcinogen or Other Hazard
Dioxin	1-43 pg/g	sediment	--	--	NA	--	C
Sulfides	62-8,500 mg/kg	sediment	--	--	NA	--	
Methylphenol	ND-9.100 mg/kg	sediment	5 ppm ^a	--	0.05 ^b	--	P ^b
			1,000 ppm	--	13-100 ppm	9.69	flammable
Acetone	product	decon	50 ppm	50 ppm	130 ppm	10.18	flammable
Hexane	product	decon	0.005 mg/m ³	--	NA	NA	C,P
Cadmium	0.88-6.61 mg/kg	sediment	5 mg/m ^{3c}	--	NA	NA	irritant
Zinc	59.7-466 mg/kg	sediment					

- Note:**
- - none established
 - C - carcinogen
 - GW - groundwater
 - IP(eV) - ionization potential
 - N/A - not applicable
 - NA - not available
 - P - poison
 - PCB - polychlorinated biphenyl
 - PEL - permissible exposure level
 - SC - suspected carcinogen
 - STEL - short-term exposure level

^a PEL for phenol and o-cresol (skin).

^b Phenol.

^c Zinc oxide, respirable dust.

	Known	Possible	Unlikely
Potential chemical exposure routes at the site:			
Inhalation	X (decon chemicals)		X
Ingestion		X	
Skin absorption		X	
Skin contact		X	
Eye contact		X	
Chemical characteristics:			
Corrosive			X
Ignitable			X
Reactive			X
Volatile	X (decon chemicals)		X
Radioactive			X
Explosive			X
Biological agent			X
Particulates or fibers			X
If known or likely, describe:			

Possible physical hazards present during site investigation activities:

	Yes	No	Proposed Safety Procedure
Uneven terrain/tripping	X		Keep decks clear, exercise caution
Heat stress		X	
Cold/hypothermia	X		Keep dry, bring extra clothes, warm food/drink
Drowning	X		Wear PFDs when working over the water
Falling objects	X		Wear hard hats near overhead hazards (i.e., winch)
Noise		X	
Excavations		X	
Scaffolding		X	
Heavy equipment		X	
Material handling	X		Lift properly, do not overload coolers; seek help when moving heavy items.
Compressed air equipment		X	
Confined spaces		X	
Other <u>Vessel Operations</u>	X		Review marine safety SOP

Note: If confined space entry is required, personnel must first obtain a confined space entry permit.

Potential physical hazards posed by proposed site activities:

Activity	Potential Hazard
Sediment sampling	cold, drowning, falling objects, material handling
Sample handling/mobilization	material handling

PERSONAL PROTECTIVE EQUIPMENT

Based on the hazards identified above, the following personal protective equipment will be required for the following site activities (specify both an initial level of protection and a more protective level of protection in the event conditions should change):

	Level of Protection	
	Initial	Contingency
Sediment sampling	MD	No upgrade anticipated
Sediment coring	MD	"
Sample handling	D	MD
Decon	MD	C

Each level of protection will incorporate the following equipment (specify type of coveralls, boots, gloves, respiratory cartridges or other protection, safety glasses, hard hat, and hearing protection):

Level D: Long pants/shirt, work shoes or boots, hard hat (near overhead hazard), safety glasses, work gloves (as needed)

Modified D: Same as D, with addition of coated tyvek coveralls or raingear, chemical resistant steel-toe boots, and chemical resistant boots. Silver shield gloves when handling decon solvents

Level C: Same as Modified D, with addition of 1/2 face respirator with organic vapor cartridges during chemical decon (only when cross wind or otherwise suitable ventilation is not possible)

Level B: _____

Note: Project personnel are not permitted to deviate from the specified levels of protection without the prior approval of the site safety officer or PTI corporate health and safety officer.

SAFETY EQUIPMENT

The following safety equipment will be onsite during the proposed field activities:

First Aid Kit (mandatory, list any additional items required for the site)

Emergency blanket

Air Monitoring (circle the items required for this project)

PID

CG/O₂ meter

H₂S meter

Detector pump and tubes

Air sampling pumps

Miniram

Radiation meter

Other: _____

Other (circle the items required for this project)

Eyewash

Drinking water

Fit test supplies

Fire extinguisher

Windsock

Warm clothes

Warm food and drink

SITE CONTROL

Describe how exclusion zones and contamination zones will be designed (attach sketch if possible):

The aft deck of the sampling vessel will be considered to be the exclusion zone. Sample collection and processing will occur in this area. Only properly equipped and trained (i.e., wearing modified D protective clothing) personnel will be allowed in this area. The area will be washed with sea water between sample stations.

To prevent the distribution of contaminants outside the exclusion zone and personal exposure to chemicals, vehicles will not be allowed inside the exclusion zone. If vehicles are required in the exclusion zone (e.g., drill rigs), the following procedures will be used to prevent contamination or decontaminate the vehicles:

Chemicals and samples will be packaged in secure containers before placement in a vehicle or vessel pilot house. All sampling equipment and protective equipment will be decontaminated before placement in a vehicle or vessel pilot house.

To minimize or prevent personal exposure to hazardous materials, all personnel working in the exclusion zone and contamination reduction zones will comply with the following decontamination procedures:

All personnel will wash sediment and chemicals from their raingear or tyvek coveralls before leaving the exclusion zone.

Decontamination equipment required on site will include the following:

Scrub brushes, Alconox® buckets, distilled water, foil, hexane, acetone, plastic bags, paper towels, garbage bags

Decontamination wastewater and contaminated materials will be disposed of in the following manner:

Wash water and rinse water will be discharged overboard. Chemical wastes will be containerized for disposal in accordance with applicable regulations.

The following personal hygiene practices will be used:

- Long hair will be secured away from the face so it does not interfere with any activities.
- All personnel leaving potentially contaminated areas will wash their hands and faces prior to entering any clean areas or eating areas.
- Personnel leaving potentially contaminated areas will shower (including washing hair) and change to clean clothing as soon as possible after leaving the site.
- No person will eat, drink, or chew gum or tobacco in potentially contaminated areas. Drink containers and drinking of replacement fluids for heat stress control will be permitted only in areas that are free from contamination. Smoking is prohibited in all areas of the site because of the potential for contaminating samples and for health and safety reasons.

SPILL CONTAINMENT

Provisions must be made for spill containment at any site where bulk liquids will be handled.

Will the proposed fieldwork include the handling of bulk liquids, oil, or chemicals (other than water)? Yes _____ No X

If yes, describe spill containment provisions for the site: _____

SHIPMENT OF RESTRICTED ARTICLES

Federal laws and international guidelines place restrictions on what materials may be shipped by passenger and cargo aircraft. In the course of this field investigation, the following items will be shipped to and from the site in the following manner:

Item	Hazardous Constituent	Quantity	Packaging	How Shipped
Samples	<u>None</u>	_____	_____	<u>No special procedures will be required</u>
Solvents (name)	<u>Acetone and hexane</u>	<u>8 L each</u>	<u>Glass bottles protected against breakage in manufacturers' shipping containers or plastic bottle jackets</u>	<u>Barge to Ketchikan, then private vehicle.</u>
Calibration gas (name)	<u>None</u>	_____	_____	_____
Preservatives (name)	<u>None</u>	_____	_____	_____
Other: _____	<u>None</u>	_____	_____	_____

MEDICAL MONITORING

OSHA requires medical monitoring for personnel potentially exposed to chemical hazards in concentrations in excess of the PEL for more than 30 days per year and for personnel who must use respiratory protection for more than 30 days per year. PTI requires medical monitoring for all employees potentially exposed to chemical hazards.

Will personnel working at this site be enrolled in a medical monitoring program? Yes X No _____

HEALTH AND SAFETY TRAINING

State and federal laws establish training requirements for workers at uncontrolled hazardous waste sites (including areas where accumulations of hazardous waste create a threat to the health and safety of an individual, the environment, or both).

PTI and subcontractor personnel will be required to complete the following training requirements:

Duties	No Special Training ^a	24-hour	40-hour	80-hour	Other
PTI Personnel					
Field team leader			X	X	X
Field personnel			X		X
Subcontractors					
Sediment coring			X		X
Station positioning			X		X
Vessel operator					X

^a Provide explanation or justification: Vessel operator will not be required to have 40-hour training. Vessel operator will stay out of the exclusion zone during sample collection and decon.

EMERGENCY INFORMATION

Local Resources	Name	Telephone	Notified Prior to Work (Yes/No)?
Fire	Pond Reef Fire Department	911	No
Police	Alaska State Patrol	911	No
Ambulance	Pond Reef Fire Department	911	No
Hospital	Ketchikan General Hospital	(907) 225-5171	No
Site phone	KPC	(907) 225-2151	Yes

Directions to hospital: The hospital is located at 3100 Tongass Avenue. Turn right when leaving the KPC facility. Drive south on Tongass Highway. Turn left at hospital.

Corporate Resources	Name	Work Telephone	Home Telephone
PTI health and safety officer	<u>Greg Bawden</u>	<u>(206) 643-9803</u>	<u>(206) 788-0436</u>
Medical consultant	<u>Dr. Jones</u>	<u>(206) 822-3651</u>	

In case of serious injuries, death, or other emergency, the corporate health and safety officer must be notified immediately. To contact the corporate health and safety officer (or delegate), try calling Greg Bawden at the work and home numbers listed above. If no response, call the emergency pager (206) 996-1480. If no response, call Larry Marx at (206) 643-9803 or (206) 643-6019 or (206) 378-3252.

Other Resources	Agency Name/Location	Telephone
Local OSHA office	<u>U.S. OSHA, Anchorage, AK</u>	<u>(907) 271-5152</u>
State OSHA equivalent	<u>Division of Occupational Safety and Health, Juneau, AK</u>	<u>(907) 465-4855</u>

DOCUMENTATION

	Attached	In File	Not Applicable
PTI site safety acknowledgment forms	<u>X</u>		
OSHA or equivalent state poster	<u>X</u>		
Site safety meeting minutes	<u>X</u>		
PTI accident/incident report form		<u>X</u>	
Other: _____			

ATTACHMENTS

	Attached	In File	Not Applicable
Site map	<u>X</u>		
Work plan		<u>X</u>	
Material safety data sheets for acetone and hexane	<u>X</u>		
Health and safety training records		<u>X</u>	
Other: <u>Marine safety SOP</u>	<u>X</u>		

Attachments



SITE SAFETY PLAN CONSENT AGREEMENT

I have reviewed the site safety plan prepared by PTI, dated 11/28/95 and modified on 4/23/97, for the Ward Cove site fieldwork. I understand the purpose of the plan, and I consent to adhere to its policies, procedures, and guidelines while completing the tasks covered by this plan.

Employee signature	Firm	Date

JOB SAFETY & HEALTH PROTECTION

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers by promoting safe and healthful working conditions throughout the Nation. Provisions of the Act include the following:

Employers

All employers must furnish to employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm to employees. Employers must comply with occupational safety and health standards issued under the Act.

Employees

Employees must comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to their own actions and conduct on the job.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards, and its Compliance Safety and Health Officers conduct jobsite inspections to help ensure compliance with the Act.

Inspection

The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

Complaint

Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides that employees may not be discharged or discriminated against in any way for filing safety and health complaints or for otherwise exercising their rights under the Act.

Employees who believe they have been discriminated against may file a complaint with their nearest OSHA office within 30 days of the alleged discriminatory action.

Citation

If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

Proposed Penalty

The Act provides for mandatory penalties against employers of up to \$1,000 for each serious violation and for optional penalties of up to \$1,000 for each nonserious violation. Penalties of up to \$1,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to \$10,000 for each such violation.

There are also provisions for criminal penalties. Any willful violation resulting in death of an employee, upon conviction, is punishable by a fine of up to \$250,000 (or \$500,000 if the employer is a corporation), or by imprisonment for up to six months, or both. A second conviction of an employer doubles the possible term of imprisonment.

Voluntary Activity

While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries. OSHA's Voluntary Protection Programs recognize outstanding efforts of this nature.

OSHA has published Safety and Health Program Management Guidelines to assist employers in establishing or perfecting programs to prevent or control employee exposure to workplace hazards. There are many public and private organizations that can provide information and assistance in this effort, if requested. Also, your local OSHA office can provide considerable help and advice on solving safety and health problems or can refer you to other sources for help such as training.

Consultation

Free assistance in identifying and correcting hazards and in improving safety and health management is available to employers, without citation or penalty, through OSHA-supported programs in each State. These programs are usually administered by the State Labor or Health department or a State university.

Posting Instructions

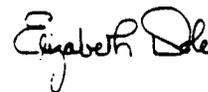
Employers in States operating OSHA approved State Plans should obtain and post the State's equivalent poster.

Under provisions of Title 29, Code of Federal Regulations, Part 1903.2(a)(1) employers must post this notice (or facsimile) in a conspicuous place where notices to employees are customarily posted.

More Information

Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from your employer or from the nearest OSHA Regional Office in the following locations:

Atlanta	(404) 347-3573
Boston	(617) 565-7184
Chicago	(312) 353-2220
Dallas	(214) 767-4731
Denver	(303) 844-3061
Kansas City	(816) 426-5861
New York	(212) 337-2378
Philadelphia	(215) 598-1201
San Francisco	(415) 744-6670
Seattle	(206) 442-5830



Elizabeth Dole, Secretary of Labor

U.S. Department of Labor

Occupational Safety and Health Administration

Washington, D.C.
1989 (Revised)
OSHA 2203





SITE SAFETY MEETING MINUTES

Site Name _____ Contract No. _____

Meeting Location _____

Meeting Date _____ Time _____ Conducted By _____

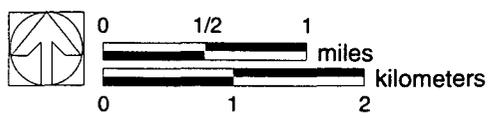
Pre-fieldwork Orientation _____ Weekly Site Meeting _____ Other _____

Subjects Discussed _____

Safety Officer Comments _____

Name and Signature of Participating Personnel (list company name if subcontractor)

Note: Attach additional pages if necessary. Send this form to the PTI corporate health and safety officer. Copies will be placed in the appropriate project files.



Source: NOAA (1995)

Figure 1. Location of Ward Cove.

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MALLINCKRODT BAKER, INC., 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865

=====
SECTION I - PRODUCT IDENTIFICATION
=====

PRODUCT NAME: ACETONE
COMMON SYNONYMS: DIMETHYL KETONE; 2-PROPANONE; DIMETHYL KETAL
CHEMICAL FAMILY: KETONES
FORMULA: (CH₃)₂CO
FORMULA WT.: 58.08
CAS NO.: 67-64-1
NIOSH/RTECS NO.: AL3150000
PRODUCT USE: LABORATORY REAGENT
PRODUCT CODES: 9007,9254,9004,5356,9015,9002,A134,9009,9001,9008,9006,9010
9005,5580,9125,5805

=====
PRECAUTIONARY LABELING
=====

BAKER SAF-T-DATA* SYSTEM

HEALTH	-	1	SLIGHT
FLAMMABILITY	-	4	EXTREME (FLAMMABLE)
REACTIVITY	-	2	MODERATE
CONTACT	-	1	SLIGHT

LABORATORY PROTECTIVE EQUIPMENT

GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER

U.S. PRECAUTIONARY LABELING

DANGER

EXTREMELY FLAMMABLE. HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM. KEEP AWAY FROM HEAT, SPARKS AND FLAME. KEEP CONTAINER CLOSED. USE WITH ADEQUATE VENTILATION. WASH THOROUGHLY AFTER HANDLING. AVOID BREATHING VAPOR. AVOID CONTACT WITH EYES, SKIN AND CLOTHING.

INTERNATIONAL LABELING

HIGHLY FLAMMABLE.

KEEP CONTAINER IN A WELL-VENTILATED PLACE. KEEP AWAY FROM SOURCES OF IGNITION - NO SMOKING. DO NOT BREATHE VAPOR. TAKE PRECAUTIONARY MEASURES AGAINST STATIC DISCHARGES.

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=====

PRECAUTIONARY LABELING (CONTINUED)

=====

SAF-T-DATA* STORAGE COLOR CODE: RED (FLAMMABLE)

=====

SECTION II - COMPONENTS

=====

COMPONENT	CAS NO.	WEIGHT %	OSHA/PEL	ACGIH/TLV
ACETONE	67-64-1	99-100	750 PPM	750 PPM

=====

SECTION III - PHYSICAL DATA

=====

BOILING POINT: 56 C (132 F)
(AT 760 MM HG)

VAPOR PRESSURE (MMHG): 184
(20 C)

MELTING POINT: -95 C (-139 F)
(AT 760 MM HG)

VAPOR DENSITY (AIR=1): 2.0

SPECIFIC GRAVITY: 0.79
(H2O=1)

EVAPORATION RATE: 7.7
(BUTYL ACETATE = 1)

SOLUBILITY(H2O): COMPLETE (100%)

% VOLATILES BY VOLUME: 100
(21 C)

PH: N/A

ODOR THRESHOLD (P.P.M.): 100

PHYSICAL STATE: LIQUID

COEFFICIENT WATER/OIL DISTRIBUTION: N/A

APPEARANCE & ODOR: CLEAR, COLORLESS LIQUID. SWEET ODOR.

=====

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

=====

FLASH POINT (CLOSED CUP): -17 C (0 F)

NFPA 704M RATING: 1-3-0

AUTOIGNITION TEMPERATURE: 464 C (869 F)

FLAMMABLE LIMITS: UPPER - 13.0 % LOWER - 2.2 %

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=====
SECTION IV - FIRE AND EXPLOSION HAZARD DATA (CONTINUED)
=====

FIRE EXTINGUISHING MEDIA

USE ALCOHOL FOAM, DRY CHEMICAL OR CARBON DIOXIDE. (WATER MAY BE INEFFECTIVE.)

SPECIAL FIRE-FIGHTING PROCEDURES

FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE. MOVE CONTAINERS FROM FIRE AREA IF IT CAN BE DONE WITHOUT RISK. USE WATER TO KEEP FIRE-EXPOSED CONTAINERS COOL.

UNUSUAL FIRE & EXPLOSION HAZARDS

VAPORS MAY FLOW ALONG SURFACES TO DISTANT IGNITION SOURCES AND FLASH BACK. CLOSED CONTAINERS EXPOSED TO HEAT MAY EXPLODE. CONTACT WITH STRONG OXIDIZERS MAY CAUSE FIRE. THIS MATERIAL MAY PRODUCE A FLOATING FIRE HAZARD.

TOXIC GASES PRODUCED

CARBON MONOXIDE, CARBON DIOXIDE

EXPLOSION DATA-SENSITIVITY TO MECHANICAL IMPACT

NONE IDENTIFIED.

EXPLOSION DATA-SENSITIVITY TO STATIC DISCHARGE

YES.

=====
SECTION V - HEALTH HAZARD DATA
=====

THRESHOLD LIMIT VALUE (TLV/TWA): 1780 MG/M3 (750 PPM)

SHORT-TERM EXPOSURE LIMIT (STEL): 2400 MG/M3 (1000 PPM)

PERMISSIBLE EXPOSURE LIMIT (PEL): 1780 MG/M3 (750 PPM)

TOXICITY OF COMPONENTS

ORAL RAT LD50 FOR ACETONE	5800 MG/KG
ORAL MOUSE LD50 FOR ACETONE	3000 MG/KG
INTRAPERITONEAL MOUSE LD50 FOR ACETONE	1297 MG/KG
SKIN RABBIT LD50 FOR ACETONE	20 G/KG

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=====
SECTION V - HEALTH HAZARD DATA (CONTINUED)
=====

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

CARCINOGENICITY
NONE IDENTIFIED.

REPRODUCTIVE EFFECTS
NONE IDENTIFIED.

EFFECTS OF OVEREXPOSURE

INHALATION: INHALATION OF VAPORS IRRITATES THE RESPIRATORY TRACT.
MAY CAUSE COUGHING, DIZZINESS, DULLNESS, AND HEADACHE.
HIGHER CONCENTRATIONS CAN PRODUCE CENTRAL NERVOUS SYSTEM
DEPRESSION, NARCOSIS, AND UNCONSCIOUSNESS.

SKIN CONTACT: IRRITATING DUE TO DEFATTING ACTION ON SKIN. MAY CAUSE
REDNESS, PAIN, DRYING AND CRACKING OF THE SKIN.

EYE CONTACT: VAPORS ARE IRRITATING TO THE EYES. SPLASHES MAY CAUSE
SEVERE IRRITATION, WITH STINGING, TEARING, REDNESS AND
PAIN.

SKIN ABSORPTION: MAY OCCUR

INGESTION: SWALLOWING SMALL AMOUNTS IS NOT LIKELY TO PRODUCE
HARMFUL EFFECTS. LARGER AMOUNTS MAY PRODUCE LIVER AND
KIDNEY DAMAGE AND NARCOTIC EFFECTS WITH OTHER SYMPTOMS
PARALLELING THOSE FROM INHALATION EXPOSURE.

CHRONIC EFFECTS: PROLONGED OR REPEATED SKIN CONTACT MAY PRODUCE SEVERE
IRRITATION OR DERMATITIS.

TARGET ORGANS

RESPIRATORY TRACT, EYES, SKIN, CENTRAL NERVOUS SYSTEM

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

USE OF ALCOHOLIC BEVERAGES ENHANCES TOXIC EFFECTS. EXPOSURE MAY INCREASE
THE TOXIC POTENTIAL OF CHLORINATED HYDROCARBONS, SUCH AS CHLOROFORM,
TRICHLOROETHANE.

PRIMARY ROUTES OF ENTRY

INHALATION, INGESTION, EYE CONTACT, SKIN CONTACT

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=====
SECTION V - HEALTH HAZARD DATA (CONTINUED)
=====

EMERGENCY AND FIRST AID PROCEDURES

INGESTION: ASPIRATION HAZARD. IF SWALLOWED, DO NOT INDUCE VOMITING
GIVE LARGE QUANTITIES OF WATER OR MILK IF AVAILABLE. NEVER
GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

INHALATION: IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE
ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE
OXYGEN.

SKIN CONTACT: IN CASE OF CONTACT, IMMEDIATELY FLUSH SKIN WITH PLENTY OF
WATER FOR AT LEAST 15 MINUTES. IN ALL CASES CALL A
PHYSICIAN.

EYE CONTACT: IN CASE OF EYE CONTACT, IMMEDIATELY FLUSH WITH PLENTY OF
WATER FOR AT LEAST 15 MINUTES. GET MEDICAL ATTENTION IF
SYMPTOMS OCCUR.

SARA/TITLE III HAZARD CATEGORIES AND LISTS

ACUTE: YES CHRONIC: NO FLAMMABILITY: YES PRESSURE: NO REACTIVITY: NO

EXTREMELY HAZARDOUS SUBSTANCE: NO
CERCLA HAZARDOUS SUBSTANCE: YES CONTAINS ACETONE (RQ = 5000 LBS)
SARA 313 TOXIC CHEMICALS: NO
GENERIC CLASS: GENERIC CLASS REMOVED FROM CFR: 7/1/91
TSCA INVENTORY: YES

=====
SECTION VI - REACTIVITY DATA
=====

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: HEAT, FLAME, OTHER SOURCES OF IGNITION

INCOMPATIBLES: STRONG OXIDIZING AGENTS, STRONG BASES, HALOGEN ACIDS
AND HALOGEN COMPOUNDS, CAUSTICS, AMINES AND AMMONIA,
CHLORINE AND CHLORINE COMPOUNDS, STRONG ACIDS, ESP.
SULFURIC, NITRIC, HYDROCHLORIC

DECOMPOSITION PRODUCTS: CARBON MONOXIDE, CARBON DIOXIDE

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=====
SECTION VII - SPILL & DISPOSAL PROCEDURES
=====

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE

VENTILATE AREA OF LEAK OR SPILL. REMOVE ALL SOURCES OF IGNITION. WEAR APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT AS SPECIFIED IN SECTION VIII. ISOLATE HAZARD AREA. KEEP UNNECESSARY AND UNPROTECTED PERSONNEL FROM ENTERING. CONTAIN AND RECOVER LIQUID WHEN POSSIBLE. USE NON-SPARKING TOOLS AND EQUIPMENT. COLLECT LIQUID IN AN APPROPRIATE CONTAINER OR ABSORB WITH AN INERT MATERIAL (E.G., VERMICULITE, DRY SAND, EARTH), AND PLACE IN A CHEMICAL WASTE CONTAINER. DO NOT USE COMBUSTIBLE MATERIALS, SUCH AS SAW DUST. DO NOT FLUSH TO SEWER

J. T. BAKER SOLUSORB(R) SOLVENT ADSORBENT IS RECOMMENDED FOR SPILLS OF THIS PRODUCT.

DISPOSAL PROCEDURE

WHATEVER CANNOT BE SAVED FOR RECOVERY OR RECYCLING SHOULD BE HANDLED AS HAZARDOUS WASTE AND SENT TO A RCRA APPROVED WASTE FACILITY. PROCESSING, USE OR CONTAMINATION OF THIS PRODUCT MAY CHANGE THE WASTE MANAGEMENT OPTIONS. STATE AND LOCAL DISPOSAL REGULATIONS MAY DIFFER FROM FEDERAL DISPOSAL REGULATIONS. U.S. REGULATIONS REQUIRE REPORTING SPILLS AND RELEASES TO SOIL, WATER AND AIR IN EXCESS OF REPORTABLE QUANTITIES. THE TOLL-FREE NUMBER FOR THE U.S. COAST GUARD NATIONAL RESPONSE CENTER IS (800) 424-8802.

EPA HAZARDOUS WASTE NUMBER: U002 (TOXIC WASTE)

=====
SECTION VIII - INDUSTRIAL PROTECTIVE EQUIPMENT
=====

VENTILATION:

A SYSTEM OF LOCAL AND/OR GENERAL EXHAUST IS RECOMMENDED TO KEEP EMPLOYEE EXPOSURES BELOW THE AIRBORNE EXPOSURE LIMITS. LOCAL EXHAUST VENTILATION IS GENERALLY PREFERRED BECAUSE IT CAN CONTROL THE EMISSIONS OF THE CONTAMINANT AT ITS SOURCE, PREVENTING DISPERSION OF IT INTO THE GENERAL WORK AREA. PLEASE REFER TO THE ACGIH DOCUMENT, "INDUSTRIAL VENTILATION, A MANUAL OF RECOMMENDED PRACTICES," MOST RECENT EDITION, FOR DETAILS.

RESPIRATORY PROTECTION:

IF THE EXPOSURE LIMIT IS EXCEEDED, AN ORGANIC VAPOR RESPIRATOR MAY BE WORN FOR UP TO TEN TIMES THE EXPOSURE LIMIT. FOR EMERGENCIES OR INSTANCES WHERE THE EXPOSURE LEVELS ARE NOT KNOWN, USE A POSITIVE-PRESSURE, AIR-SUPPLIED RESPIRATOR. WARNING: AIR-PURIFYING RESPIRATORS DO NOT PROTECT WORKERS IN

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=====
SECTION VIII - INDUSTRIAL PROTECTIVE EQUIPMENT (CONTINUED)
=====

OXYGEN-DEFICIENT ATMOSPHERES.

EYE/SKIN PROTECTION: USE CHEMICAL SAFETY GOGGLES AND/OR FULL FACE SHIELD
WHERE SPLASHING IS POSSIBLE. MAINTAIN EYE WASH
FOUNTAIN AND QUICK-DRENCH FACILITIES IN WORK AREA.

WEAR IMPERVIOUS PROTECTIVE CLOTHING, INCLUDING BOOTS, GLOVES, LAB COAT, APRON
OR COVERALLS, AS APPROPRIATE, TO PREVENT SKIN
CONTACT.

=====
SECTION IX - STORAGE AND HANDLING PRECAUTIONS
=====

SAF-T-DATA* STORAGE COLOR CODE: RED (FLAMMABLE)

STORAGE REQUIREMENTS

PROTECT AGAINST PHYSICAL DAMAGE. STORE IN A COOL, DRY WELL-VENTILATED
LOCATION, AWAY FROM ANY AREA WHERE THE FIRE HAZARD MAY BE ACUTE. OUTSIDE
OR DETACHED STORAGE IS PREFERRED. SEPARATE FROM OXIDIZING MATERIALS.
CONTAINERS SHOULD BE BONDED AND GROUNDED FOR TRANSFERS TO AVOID STATIC
SPARKS. STORAGE AND USE AREAS SHOULD BE NO SMOKING AREAS. USE
NON-SPARKING TYPE TOOLS AND EQUIPMENT.

SPECIAL PRECAUTIONS

CONTAINERS OF THIS MATERIAL MAY BE HAZARDOUS WHEN EMPTY SINCE THEY RETAIN
PRODUCT RESIDUES (VAPORS, LIQUID); OBSERVE ALL WARNINGS AND PRECAUTIONS
LISTED FOR THE PRODUCT.

=====
SECTION X - TRANSPORTATION DATA AND ADDITIONAL INFORMATION
=====

DOMESTIC (D.O.T.)

PROPER SHIPPING NAME: ACETONE
HAZARD CLASS: 3
UN/NA: UN1090 REPORTABLE QUANTITY: 5000 LBS. PACKAGING GROUP: II
LABELS: 3 FLAMMABLE LIQUID
REGULATORY REFERENCES: 49CFR 172.101

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=====
SECTION X - TRANSPORTATION DATA AND ADDITIONAL INFORMATION (CONTINUED)
=====

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME: ACETONE
HAZARD CLASS: 3.1
UN: UN1090 MARINE POLLUTANTS: NO
LABELS: 3 FLAMMABLE LIQUID
REGULATORY REFERENCES: 49CFR PART 176; IMDG CODE

I.M.O. PAGE: 3102
PACKAGING GROUP: II

AIR (I.C.A.O.)

PROPER SHIPPING NAME: ACETONE
HAZARD CLASS: 3
UN: UN1090
LABELS: 3 FLAMMABLE LIQUID
REGULATORY REFERENCES: 49CFR PART 175; ICAO==

PACKAGING GROUP: II

WE BELIEVE THE TRANSPORTATION DATA AND REFERENCES CONTAINED HEREIN TO BE FACTUAL AND THE OPINION OF QUALIFIED EXPERTS. THE DATA IS MEANT AS A GUIDE TO THE OVERALL CLASSIFICATION OF THE PRODUCT AND IS NOT PACKAGE SIZE SPECIFIC, NOR SHOULD IT BE TAKEN AS A WARRANTY OR REPRESENTATION FOR WHICH THE COMPANY ASSUMES LEGAL RESPONSIBILITY.=== THE INFORMATION IS OFFERED SOLELY FOR YOUR CONSIDERATION, INVESTIGATION, AND VERIFICATION. ANY USE OF THE INFORMATION MUST BE DETERMINED BY THE USER TO BE IN ACCORDANCE WITH APPLICABLE FEDERAL, STATE, AND LOCAL LAWS AND REGULATIONS. SEE SHIPPER REQUIREMENTS 49CFR 171.2, CERTIFICATION 172.204, AND EMPLOYEE TRAINING 49 CFR 173.1(B).

U.S. CUSTOMS HARMONIZATION NUMBER: 29141100008

=====
NOTE: WHEN HANDLING LIQUID PRODUCTS, SECONDARY PROTECTIVE CONTAINERS MUST BE USED FOR CARRYING.

-N/A = NOT APPLICABLE, OR NOT AVAILABLE; -N/E = NOT ESTABLISHED

=====
MALLINCKRODT BAKER PROVIDES THE INFORMATION CONTAINED HEREIN IN GOOD FAITH BUT MAKES NO REPRESENTATION AS TO ITS COMPREHENSIVENESS OR ACCURACY. THIS DOCUMENT IS INTENDED ONLY AS A GUIDE TO THE APPROPRIATE PRECAUTIONARY HANDLING OF THE MATERIAL BY A PROPERLY TRAINED PERSON USING THIS PRODUCT. INDIVIDUALS RECEIVING THE INFORMATION MUST EXERCISE THEIR INDEPENDENT JUDGMENT IN DETERMINING ITS APPROPRIATENESS FOR A PARTICULAR PURPOSE.

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J.T.BAKER INC. 222 RED SCHOOL LANE, PHILLIPSBURG, NJ 08865
M A T E R I A L S A F E T Y D A T A S H E E T
24-HOUR EMERGENCY TELEPHONE -- (908) 859-2151
CHEMTREC # (800) 424-9300 -- NATIONAL RESPONSE CENTER # (800) 424-8802

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=====

NOTE: CHEMTREC, CANUTEC AND NATIONAL RESPONSE CENTER EMERGENCY TELEPHONE NUMBERS ARE TO BE USED ONLY IN THE EVENT OF CHEMICAL EMERGENCIES INVOLVING A SPILL, LEAK, FIRE, EXPOSURE, OR ACCIDENT INVOLVING CHEMICALS. ALL NON-EMERGENCY QUESTIONS SHOULD BE DIRECTED TO CUSTOMER SERVICE (1-800-JTBAKER) FOR ASSISTANCE.

=====

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*TRADEMARKS OF MALLINCKRODT BAKER, INC.
APPROVED BY QUALITY ASSURANCE DEPARTMENT.

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"ISSUED BY VWR 05/02/96"

MATERIAL SAFETY DATA SHEET

EM SCIENCE

11. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MANUFACTURER.....:

EM SCIENCE
A DIVISION OF EM INDUSTRIES
P.O. BOX 70
480 DEMOCRAT RD.
GIBBSTOWN, N.J. 08027

PREPARATION DATE.: 11/20/95
DATE MSDS PRINTED.: DEC 18, 1995

INFORMATION PHONE NUMBER.: 609-423-6300
HOURS: MON. TO FRI. 8:30-5
CHEMTREC EMERGENCY NUMBER: 800-424-9300
HOURS: 24 HRS A DAY

CATALOG NUMBER(S):
HX0295 HX0302

PRODUCT NAME.....:

HEXANE

SYNONYMS.....:

HEXANES

CHEMICAL FAMILY..:

ALIPHATIC HYDROCARBON

FORMULA.....:

C6H14

MOLECULAR WEIGHT.:

86.18

12. COMPOSITION / INFORMATION ON INGREDIENTS

COMPONENT	CAS #	APPR %
HEXANE	110-54-3	95-99%

ALSO CONTAINS METHYL PENTANES 0-5% CAS# UNKNOWN. MAY CONTAIN
TRACE LEVELS BENZENE (0.0002%) CAS# 71-43-2.
BENZENE HAS BEEN FOUND TO CAUSE CANCER.
NOTIFICATION OF CARCINOGENIC INGREDIENTS IN QUANTITY LESS THAN
0.1% IS NOT REQUIRED UNDER FEDERAL HAZARD COMMUNICATION LAW.

13. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

EXTREMELY FLAMMABLE LIQUID AND VAPOR.
HARMFUL IF INHALED OR SWALLOWED.

MSDS (CONTINUED) - HX0295

PAGE # 1

MAY CAUSE DAMAGE TO KIDNEYS, NERVES, AND RESPIRATORY SYSTEM.
IRRITATING TO SKIN, EYES AND MUCOUS MEMBRANES.

APPEARANCE.....:
CLEAR, COLORLESS LIQUID

POTENTIAL HEALTH EFFECTS (ACUTE AND CHRONIC)

SYMPTOMS OF EXPOSURE:

TOXIC BY INGESTION AND INHALATION.
VAPOR INHALATION CAUSES IRRITATION OF NASAL AND RESPIRATORY PASSAGES,
HEADACHE, DIZZINESS, NAUSEA, CENTRAL NERVOUS SYSTEM DEPRESSION.
N-HEXANE IS NEUROTOXIC. CHRONIC OVEREXPOSURE CAN CAUSE SEVERE NERVE
DAMAGE. MAINLY RESPONSIBLE FOR THE (CHRONIC) TOXICITY IS
THE METABOLITE 2,5-HEXANDION. IN HUMANS, THIS DIKETONE IS FORMED
AS A MAIN METABOLITE, WHICH THE RAT MOSTLY METABOLIZES TO
2-HEXANOL. CONSEQUENTLY THE LD50 VALUE OF THE RAT WITH 28710
MG/KG IS NOT SUITABLE FOR THE TOXICITY IN HUMANS. IN THE RAT,
A NEUROTOXIC EFFECT SHOWS UP ONLY ABOVE A CONCENTRATION OF 200
ML/CU.M., WHILE THE HUMAN ORGANISM CAN REACT WITH PLYNEUROPATHIC
SYMPTOMS AT 100 ML/CU.M.
CAUSES IRRITATION ON CONTACT WITH SKIN OR EYES.
MAY CAUSE DAMAGE TO KIDNEYS AND/OR LIVER.

MEDICAL COND. AGGRAVATED BY EXPOSURE:
KIDNEY, LIVER, RESPIRATORY AND CNS
CONDITIONS

ROUTES OF ENTRY.....:
INHALATION, INGESTION OR SKIN CONTACT.

CARCINOGENICITY.....:
THE MATERIAL IS NOT LISTED (IARC, NTP, OSHA) AS CANCER CAUSING
AGENT.
MAY CONTAIN TRACE BENZENE (SEE SECTION TWO).

4. FIRST AID MEASURES

EMERGENCY FIRST AID:

GET MEDICAL ASSISTANCE FOR ALL CASES OF OVEREXPOSURE.
SKIN: IMMEDIATELY FLUSH THOROUGHLY WITH LARGE AMOUNTS OF WATER.
EYES: IMMEDIATELY FLUSH THOROUGHLY WITH WATER FOR AT LEAST 15
MINUTES.
INHALATION: REMOVE TO FRESH AIR; GIVE ARTIFICIAL RESPIRATION IF
BREATHING HAS STOPPED.
INGESTION: DO NOT INDUCE VOMITING; GET IMMEDIATE MEDICAL
ATTENTION.

5. FIRE FIGHTING MEASURES

FLASH POINT (F).....: -7F (CC)
FLAMMABLE LIMITS LEL (%): 1.20
FLAMMABLE LIMITS UEL (%): 7.50
EXTINGUISHING MEDIA.....:
WATER, DRY CHEMICAL, OR CO2

FIRE FIGHTING PROCEDURES.:
WEAR SELF-CONTAINED BREATHING APPARATUS AND PROTECTIVE CLOTHING.

FIRE & EXPLOSION HAZARDS.:
DANGEROUS FIRE AND EXPLOSIVE HAZARD.
VAPOR CAN TRAVEL DISTANCES TO IGNITION SOURCE AND FLASH BACK.

6. ACCIDENTAL RELEASE MEASURES

SPILL RESPONSE:

EVACUATE THE AREA OF ALL UNNECESSARY PERSONNEL.
WEAR SUITABLE PROTECTIVE EQUIPMENT LISTED UNDER EXPOSURE /
PERSONAL PROTECTION.
ELIMINATE ANY IGNITION SOURCES UNTIL THE AREA IS DETERMINED TO BE
FREE FROM EXPLOSION OR FIRE HAZARDS.
CONTAIN THE RELEASE AND ELIMINATE ITS SOURCE, IF THIS CAN BE DONE
WITHOUT RISK.
TAKE UP AND CONTAINERIZE FOR PROPER DISPOSAL AS DESCRIBED UNDER
DISPOSAL.
COMPLY WITH FEDERAL, STATE, AND LOCAL REGULATIONS ON REPORTING
RELEASES. REFER TO REGULATORY INFORMATION FOR REPORTABLE
QUANTITY AND OTHER REGULATORY DATA.
EM SCIENCE RECOMMENDS SPILL-X ABSORBENT AGENTS FOR VARIOUS TYPES
OF SPILLS. ADDITIONAL INFORMATION ON THE SPILL-X PRODUCTS CAN BE
PROVIDED THROUGH THE EM SCIENCE TECHNICAL SERVICE DEPARTMENT
(609) 354-9200.
THE FOLLOWING EM SCIENCE SPILL-X ABSORBENT IS RECOMMENDED FOR
THIS PRODUCT:

SX0863 SOLVENT SPILL TREATMENT KIT

7. HANDLING AND STORAGE

HANDLING & STORAGE:

KEEP CONTAINER CLOSED.
STORE IN A COOL, DRY AREA AWAY FROM IGNITION SOURCES AND
OXIDIZERS.
DO NOT BREATHE VAPOR OR MIST.
ELECTRICALLY GROUND ALL EQUIPMENT WHEN HANDLING THIS PRODUCT.
RETAINED RESIDUE MAY MAKE EMPTY CONTAINERS HAZARDOUS; USE
CAUTION!
DO NOT GET IN EYES, ON SKIN, OR ON CLOTHING.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

ENGINEERING CONTROLS AND PERSONAL PROTECTIVE EQUIPMENT:

VENTILATION, RESPIRATORY PROTECTION, PROTECTIVE CLOTHING, EYE PROTECTION
RESPIRATORY PROTECTION: IF WORKPLACE EXPOSURE LIMIT(S) OF PRODUCT
 OR ANY COMPONENT IS EXCEEDED (SEE TLV/PEL), A NIOSH/MSHA APPROVED
 AIR SUPPLIED RESPIRATOR IS ADVISED IN ABSENCE OF PROPER
 ENVIRONMENTAL CONTROL. OSHA REGULATIONS ALSO PERMIT OTHER
 NIOSH/MSHA RESPIRATORS (NEGATIVE PRESSURE TYPE) UNDER SPECIFIED
 CONDITIONS (SEE YOUR SAFETY EQUIPMENT SUPPLIER). ENGINEERING
 AND/OR ADMINISTRATIVE CONTROLS SHOULD BE IMPLEMENTED TO REDUCE
 EXPOSURE.
 MATERIAL SHOULD BE HANDLED OR TRANSFERRED IN AN APPROVED FUME
 HOOD OR WITH ADEQUATE VENTILATION.
 PROTECTIVE GLOVES SHOULD BE WORN TO PREVENT SKIN CONTACT
 (NITRILE OR EQUIVALENT)
 SAFETY GLASSES WITH SIDE SHIELDS SHOULD BE WORN AT ALL TIMES.

WORK / HYGENIC PRACTICES:
 WASH THOROUGHLY AFTER HANDLING.
 DO NOT TAKE INTERNALLY.
 EYE WASH AND SAFETY EQUIPMENT SHOULD BE READILY AVAILABLE.

EXPOSURE GUIDELINES

OSHA - PEL:

COMPONENT	TWA		STEL		CL		SKIN
	PPM	MG/M3	PPM	MG/M3	PPM	MG/M3	
HEXANE	50	180					

ACGIH - TLV:

COMPONENT	TWA		STEL		CL		SKIN
	PPM	MG/M3	PPM	MG/M3	PPM	MG/M3	
HEXANE	50	176					

9. PHYSICAL AND CHEMICAL PROPERTIES

BOILING POINT (C 760 MMHG): 65C
 MELTING POINT (C): -95C
 SPECIFIC GRAVITY (H2O = 1): 0.6603
 VAPOR PRESSURE (MM HG): 125 20C
 PERCENT VOLATILE BY VOL (%): 100%
 VAPOR DENSITY (AIR = 1): 3.0
 EVAPORATION RATE (BUAC = 1): 9.0
 SOLUBILITY IN WATER (%): SLIGHT
 APPEARANCE:

CLEAR, COLORLESS LIQUID

STABILITY AND REACTIVITY

STABILITY.....: YES

HAZARDOUS POLYMERIZATION:
DOES NOT OCCUR

HAZARDOUS DECOMPOSITION.:
COX

CONDITIONS TO AVOID.....:
HEAT; CONTACT WITH IGNITION SOURCES.

MATERIALS TO AVOID.....:

- () WATER
- () ACIDS
- () BASES
- () CORROSIVES
- (X) OXIDIZERS
- () OTHER :

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA:

HL-HMN TCLD: 5000 PPM/10M
ORL-RAT LD50: 28710 MG/KG
(SEE SECTION 3 - SYMPTOMS OF EXPOSURE)

TOXICOLOGICAL FINDINGS:

TESTS ON LABORATORY ANIMALS INDICATE MATERIAL MAY PRODUCE ADVERSE
MUTAGENIC AND REPRODUCTIVE EFFECTS.
CITED IN REGISTRY OF TOXIC EFFECTS OF CHEMICAL SUBSTANCES (RTECS)

12. DISPOSAL CONSIDERATIONS

EPA WASTE NUMBERS: D001

TREATMENT:

INCINERATION, FUELS BLENDING OR RECYCLE. CONTACT YOUR LOCAL
PERMITTED WASTE DISPOSAL SITE (TSD) FOR PERMISSIBLE TREATMENT
SITES.

ALWAYS CONTACT A PERMITTED WASTE DISPOSER (TSD) TO ASSURE
COMPLIANCE WITH ALL CURRENT LOCAL, STATE AND FEDERAL REGULATIONS.

13. TRANSPORT INFORMATION

DOT PROPER SHIPPING NAME....:
HEXANE

DOT ID NUMBER.....:
N1208

14. REGULATORY INFORMATION

TSCA STATEMENT:
THE CAS NUMBER OF THIS PRODUCT IS LISTED ON THE TSCA INVENTORY.

COMPONENT	SARA EHS (302)	SARA EHS TPQ (LBS)	CERCLA RQ (LBS)
HEXANE			5000

COMPONENT	OSHA FLOOR LIST	SARA 313	DEMINIMIS FOR SARA 313 (%)
HEXANE	Y	Y	1.0

OTHER INFORMATION

COMMENTS:
NONE

NFPA HAZARD RATINGS:
HEALTH : 1
FLAMMABILITY : 3
REACTIVITY : 0
SPECIAL HAZARDS :

REVISION HISTORY:
01/04/89 06/28/89 03/01/91 06/23/93 01/25/94 03/06/95 09/08/95

I = REVISED SECTION
N/A = NOT AVAILABLE
N/E = NONE ESTABLISHED

THE STATEMENTS CONTAINED HEREIN ARE OFFERED FOR INFORMATIONAL PURPOSES ONLY AND ARE BASED UPON TECHNICAL DATA THAT EM SCIENCE BELIEVES TO BE ACCURATE. IT IS INTENDED FOR USE ONLY BY PERSONS HAVING THE NECESSARY TECHNICAL SKILL AND AT THEIR OWN DESCRETION AND RISK. SINCE CONDITIONS AND MANNER OF USE ARE OUTSIDE OUR CONTROL, WE MAKE NO WARRANTY, EXPRESS
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OR IMPLIED, OF MERCHANTABILITY, FITNESS OR OTHERWISE.

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STANDARD OPERATING PROCEDURE

SAFETY DURING MARINE OPERATIONS

SOP 423

INTRODUCTION

PTI field projects often require the collection of biological, sediment, and water samples from vessels. In addition to the physical and chemical hazards associated with all field sampling, there are special hazards associated with vessels. This SOP provides guidance for ensuring the safety of PTI and subcontractor personnel when working on the water. These procedures address inland or protected waters only. Additional procedures are required for working on vessels offshore.

TRAINING

Appropriate training is essential for preventing accidents and ensuring the proper completion of all field duties. The following training requirements apply to all PTI field work conducted on the water:

All PTI and subcontractor personnel must participate in an initial safety briefing prior to beginning the field work, whenever new personnel come aboard, and when conditions or tasks change.

- If the field project is conducted at a designated hazardous materials site or there is any potential for chemical exposure, then all PTI and subcontractor personnel must have the appropriate 40-hour hazardous waste operations training and current 8-hour annual refresher training. Supervisors must have completed the 8-hour supervisors training course.
- The field team leader, or site safety officer must have current first aid and cardiopulmonary resuscitation (CPR) training.
- If the vessel is to be operated by PTI personnel, the operator must demonstrate proficiency in the operation of that type of vessel and knowledge of marine safety and navigation rules. Personnel without prior experience will be required to complete training in these subjects.

(Note: This requirement is intended to apply to small craft only; PTI does not anticipate training personnel to operate large vessels.)

REQUIRED SAFETY EQUIPMENT

To prevent accidents and ensure adequate preparation for any emergencies that may arise, it is the responsibility of the PTI project manager to secure appropriate safety equipment for the duration of the project. This equipment must include the following:

- **Personal Flotation Devices (PFDs)**—There must be one PFD for every person onboard the vessel, plus an additional throwable flotation device for vessels over 16 ft in length.
- **Fire Extinguisher**—Requirements for fire extinguishers vary based on the vessel length and whether the vessel has inboard engines or closed compartments. Fire extinguishers are recommended for all motorized vessels. Additional information regarding requirements for fire extinguishers can be obtained from the U.S. Coast Guard.
- **First-Aid Kit**—A first-aid kit must be provided during all PTI field projects. The contents of the first-aid kit will vary based on the number of persons present, but at a minimum should include a variety of bandages and compresses, disinfectant, gloves, a CPR shield, eyewash, and an emergency blanket. Additional information regarding requirements for first-aid kits can be obtained from the applicable federal or state department responsible for occupational safety and health.
- **Marine Radio with Weather Channel**—A VHF radio is required by law on commercial vessels and is required by PTI for all work on Puget Sound or other open waters. The frequency and call sign of local emergency services must be posted on the vessel and be included in the site health and safety plan.
- **Cellular Telephone**—If a two-way VHF marine radio is not available then a cellular telephone must be onboard.
- **Horn or Bell**—U.S. Coast Guard regulations require a signaling device be onboard all vessels longer than 36 ft and require that all vessels, regardless of length, be capable of making audible signals during certain events (i.e., approaching or overtaking other vessels).
- **Navigation Lights**—The requirements for navigation lights vary based on the length and type of vessel. All vessels operated at night must have the appropriate navigation lights.

- **Oars or Paddles**—Small power boats should be equipped with alternate means of propulsion.
- **Anchor and Suitable Line**—In most cases, vessels should be equipped with one (or two) anchors and sufficient anchor line for expected water depths and bottom conditions.
- **Flares**—A flare kit should be onboard all field vessels.
- **Reach Pole or Shepherd's Hook**—On larger vessels, a reach pole or shepherd's hook must be available to facilitate rescue of any persons who fall overboard.
- **Other Rescue Gear**—On larger vessels, a block and tackle or other means must be available to pull a person from the water.

HAZARDS AND PREVENTION

There are many physical hazards associated with working onboard a vessel. Potential hazards and appropriate precautions are listed below:

- **Slips/Trips/Falls**—The combination of a moving vessel and wet or slippery decks increases the potential for slips, trips, or falls. These can be prevented by increasing your awareness of the surroundings, keeping one hand free for handholds and support, keeping the deck and working areas clear of unnecessary obstacles or hazards, and wearing nonskid boots or shoes.
- **Drowning**—Even the best swimmer can drown if caught unprepared, tired, or weighted down with bulky clothing and boots. Drowning can be prevented by taking precautions against falling overboard (avoid reaching over the side, beware of slips/trips/falls, avoid ondeck work in heavy seas) and by wearing a PFD. PFDs should be worn underneath chemical protective clothing such as Tyvek® coveralls (thus allowing the wearer to remove the coveralls without first removing the PFD) and should be properly secured or buckled.
- **Crushing/Falling Objects**—The use of hoists to lift coring tools and other equipment could result in crushing or other injuries to field workers. These injuries can be avoided by using properly adjusted and maintained hoists, allowing only experienced personnel to operate the hoist, keeping all personnel out of the way during lifting and hoisting, and wearing hardhats to protect against head injuries or bumps.
- **Gear Deployment and Retrieval**—The deployment and retrieval of sampling gear presents a hazard because of the weight of the gear, its

suspension over the deck, and the risk of entanglement or accidental and premature release or closure. Setting the triggering mechanism must always be performed when the equipment is resting on a stable surface. During sample retrieval, at least one crew member is required to watch for the appearance of the sampling gear and alert the winch operator. Failure to observe the sampling gear and stop the winch could lead to breakage of the cable, loss of the sampling gear, and possible injury from either the falling gear or the end of the broken cable. All nonessential personnel should stay clear of the work area during the retrieval and deployment of sampling gear. All personnel should be knowledgeable in the proper hand signals for guiding the winch operator.

- **Cables**—After repeated use, stainless steel cables may fray or break. Sampling personnel must never take ahold of the moving cable unless they are wearing work gloves. Periodically during the sampling event, the site safety officer should inspect the cable for wear, especially where the wire or cable is attached to the sampling equipment.
- **Climate**—Depending on the climate, field personnel may suffer from hypothermia, dehydration, or heat stress. Climate-related illnesses and injuries can be prevented by dressing appropriately for the expected climate and by having additional clothing onboard should personnel get wet or the weather change suddenly. When working in cold, wet weather, appropriate clothing may include raingear, wool, and modern synthetics. Cotton clothing should only be worn during warm, dry weather. In addition, fluid replenishment beverages (to protect against heat stress and dehydration) or warm beverages (to protect against hypothermia) should be available during field work.
- **Unsecured Gear**—Wherever possible, all ondeck sampling and safety gear should be secured to a deck, rail, or bulkhead to prevent loss from unexpected movement caused by wind or waves.
- **Hatches**—All personnel should be alerted to the presence of an open hatch and hatches should not be left open unnecessarily.
- **Chemical and Sample Storage**—To prevent fire, health hazards, or sample contamination, all field chemicals such as solvents and formalin should be stored on deck, not in the cabin, hold, or near samples.

EMERGENCY PROCEDURES

In case of a boating-related injury or fatality, PTI personnel must:

- Notify emergency medical or rescue personnel immediately (as appropriate). The U.S. Coast Guard emergency frequency is VHF Channel 16.
- Notify the site safety officer, the appropriate PTI project manager, and the corporate health and safety officer immediately. The project manager and corporate health and safety officer will coordinate notifications to the Occupational Safety and Health Administration and the U.S. Coast Guard.

In case of boating-related property damage exceeding \$200, PTI personnel must:

- Notify police or other legal jurisdiction (as appropriate).
- Notify the site safety officer, the appropriate PTI project manager, and the corporate health and safety officer within 48 hours of the incident. The project manager and corporate health and safety officer will coordinate notification of the U.S. Coast Guard.
- Notify the PTI business operations manager to initiate insurance claims.



Appendix D

**Standard Operating
Procedures**

LIST OF STANDARD OPERATING PROCEDURES

SOP 2	Sample Packaging and Shipping
SOP 4	Field Documentation
SOP 5	Sample Custody
SOP 6B	Preparation of Field Quality Control Samples—Sediment
SOP 51	Station Positioning
SOP 71B	Preparation of Reference Materials—Sediment
SOP 100	Surface Sediment Sampling Using a Modified van Veen Grab Sampler
SOP 101	Decontamination of Equipment—Sediments
SOP 102	Preservation and Handling of Samples
SOP 104	Sediment Coring Procedures Using Slide-Hammer and Gravity Corers
SOP 130	Geochronological Dating of Sediment Using Pb-210 and Cs-137

SOP 2

**Sample Packaging and
Shipping**

Note: SOPs 4 and 5 cited within.

STANDARD OPERATING PROCEDURE

SAMPLE PACKAGING AND SHIPPING

SOP 2

Specific requirements for sample packaging and shipping must be followed to ensure the proper transfer and documentation of environmental samples collected during field operations. Procedures for the careful and consistent transfer of samples from the field to the laboratory are outlined herein.

EQUIPMENT REQUIRED

Specific equipment or supplies necessary to properly pack and ship environmental samples include the following:

- Ice in sealed bags or blue ice
- Sealable airtight bags
- Plastic garbage bags
- Coolers
- Bubble wrap
- Fiber reinforced packing tape
- Scissors
- Chain-of-custody seals
- Airbills for overnight shipment
- Chain-of-custody record/sample analysis request forms.

PROCEDURE

The following steps should be followed to ensure the proper transfer of samples from the field to the laboratories:

1. Appropriately document all samples using the proper logbooks and tracking forms specified in SOP 4 and SOP 5.
2. Make sure all applicable laboratory quality control sample designations have been made on the sample analysis request forms. Samples that will be archived for future possible analysis should be clearly identified on the sample analysis request form. Such samples should also be labeled on the sample analysis request form as "Do Not Analyze: Hold and archive for possible future analysis" because some laboratories interpret "archive" as meaning to continue holding the residual sample after analysis.
3. Notify the laboratory contact and the project QA/QC coordinator that samples will be shipped and the estimated arrival time. Send copies of all chain-of-custody record/sample analysis request forms (example provided in Attachment 2-1) to the QA/QC coordinator.
4. Clean the outside of all dirty sample containers to remove any residual contamination.
5. Check sample containers against the chain-of-custody record to ensure all samples intended for shipment are accounted for.
6. Store each sample container in a sealable bag that allows the sample label (example provided in Attachment 2-1) to be read. Volatile organic analyte (VOA) vials for a single sample must be encased in bubble wrap before being sealed in bags.
7. Choose the appropriate size cooler (or coolers) and line with bubble wrap and a plastic garbage bag.
8. Fill the cooler with the samples, separating glass containers with bubble wrap and allowing room for ice to keep the samples cold. Add enough ice or blue ice to keep the samples refrigerated overnight. Ice should be enclosed in sealable plastic bags to prevent leakage. Avoid separating the samples from the ice with excess bubble wrap because it will insulate the containers from the ice. After all samples and ice have been added to the cooler, use bubble wrap to fill any empty space to keep the samples from shifting during transport.
9. Remember to consolidate any VOA samples in a single cooler, and ship them with a trip blank if the quality assurance project plan calls for one.
10. Once all the samples are packed, close the plastic garbage bag and fasten it with a chain-of-custody seal (example provided in Attachment 2-1).

11. Store the signed chain-of-custody records/sample analysis request forms in a sealable bag and tape them to the inside of the cooler lid. Fill out the sample analysis request as described in SOP 5, and retain the back cop of the form for the project records prior to sealing the cooler.
12. Once the cooler is sufficiently packed to prevent shifting of the containers, close the lid and seal it shut using fiber reinforced packing tape. Also, if the cooler has a drain at the bottom, it should be taped shut.
13. As security against unauthorized handling of the samples, apply one or two chain-of-custody seals across the opening of the cooler lid. Be sure the seals are properly affixed to the cooler so they are not removed during shipment.
14. Label the cooler with destination and return addresses, and add other appropriate stickers, such as "This End Up," "Fragile," and "Handle With Care."
15. If an overnight courier is used, fill out the airbill as required and fasten it to the top of the cooler. The identification number sticker should be taped to the lid, because tracking problems can occur if a sticker is removed during shipment.

Attachment 2-1

**Example Chain-of-Custody
Record/Sample Analysis
Request Form, and Label
and Custody Seal**

PTI ENVIRONMENTAL SERVICES OFFICIAL SAMPLE SEAL		SAMPLE NO. SIGNATURE PRINT NAME AND TITLE	DATE	DATE
			SEAL BROKEN BY	

PTI ENVIRONMENTAL SERVICES	_____	Sample No.
	_____	Preservative
	_____	Sampler
	_____	Date/Time
	_____	SITE NAME 1301
	_____	Tag No.

Example label and custody seal.

SOP 4

Field Documentation

Note: SOP 5 cited within.

STANDARD OPERATING PROCEDURE

FIELD DOCUMENTATION SOP 4

All information relevant to field operations must be properly documented to ensure that activities are accounted for and can be reconstructed from written records. Several types of logbooks will be used for this purpose and should be consistently used by field crews (e.g., field logbooks, sample logbooks, field data logbooks). Logbooks will be labeled on the cover with the project name, dates of field work, survey name, and the PTI contract number. Each logbook will have a unique document control number assigned by the data management coordinator.

The information recorded in each logbook should be written in indelible ink. All corrections should consist of a single line-out deletion, followed by the author's initials and the date. When all pages in a logbook are used, copies will be made and kept in the field office, and the original will be sent to the project data management coordinator to be placed in the PTI library. No bound logbooks should be discarded, even if they are illegible or contain inaccuracies that require a replacement document. When not in use, all logbooks will be stored in the field office.

FIELD LOGBOOKS

The purpose of the field logbook is to document events that occur in the field to the extent that someone not present at the site can reconstruct the activity without relying on the memory of the field crew. A bound logbook with consecutively numbered pages will be used for each survey element. The author will initial and date entries at the end of each day, and a line will be drawn through the remainder of the page. The logbooks, at a minimum, must contain the following information:

1. A purpose and description of the field task
2. The time and date the field work began
3. The location and description of the work area, including sketches, map references, and photographs, if appropriate
4. The names and titles of field personnel and anyone present during the field work, including the times they are present

5. The name, agency, and telephone number of any field contacts
6. The meteorological conditions at the beginning of the field work and any changes that occur throughout the day, including the approximate time of the change
7. Details of the field work performed, with a description of any deviations from the sampling and analysis plan or field methods
8. All field measurements made (unless a specific logbook is available for this purpose), including the time of measurement
9. Any field results not appearing in the field data logbook
10. Personnel and equipment decontamination procedures
11. References to other logbooks used to record information (e.g., station log, sample log, health and safety log)
12. Deviations from the sampling and analysis plan.

SAMPLE LOGBOOKS

Each sampling element requires a unique sample logbook, which will be used to record the relevant sample information. For instructions regarding proper use of sample identifiers, sampling personnel should consult the project data management coordinator or field sampling plan. The project sample logbooks require the following information:

1. Sampling station number and description
2. Date and time of sample collection
3. Method of locating sampling site and the coordinates
4. Location characteristics, such as water depth and sample depth
5. Sampling method
6. Sample identifier information, such as sample ID, sample number and tag number, field replicate ID, and subsample ID
7. Sample volume
8. Sample analysis and identification of any quality control samples
9. Any observations or comments relevant to the sampling procedure, including suspected chemical concentration (low-level, moderate, or high-level), deviations from the sampling and analysis plan, and information regarding split samples

10. Information regarding photographs taken
11. Names of all sampling personnel.

SAMPLE LABELS

Sample labels are designed to uniquely identify each container that is used for a sample. Field crews will be provided with preprinted sample labels (also known as tags), which must be affixed to each sample container used. The labels should be filled out at the time the samples are collected and should consist of the following information:

1. Sample number
2. General category of analytes (primarily for identification purposes); the laboratory will follow instructions on the sample analysis request form (see SOP 5 for example) provided with the samples
3. Date and time sample is collected
4. Initials of the samplers
5. Preservatives used, if any
6. A unique tag number (preprinted on the tag) consisting of six digits, used to identify individual containers.

FIELD DATA LOGBOOKS

The purpose of the field data logbooks is to record data that are measured during field activities. They are organized to allow methodical and consistent entry of information by field crews. Field data logbooks to be used on a project include a field observation logbook for pH, conductivity, dissolved oxygen, and temperature measurements; a stream flow measurement logbook; and a site safety monitoring logbook for organic vapor and H₂S measurements. These logbooks typically contain space for the following information:

1. Station identification and location
2. Date and time of measurements
3. Field personnel
4. Measurements and calculations.

PHOTOGRAPHS

Photographs will be taken of field activities using a camera-lens system with a perspective similar to the naked eye. Photographs should include a measured scale in the picture, when practical. Telephoto or wide-angle shots will not be used because they cannot be used in enforcement proceedings. The following items should be recorded in the field logbook for each photograph taken:

1. The photographer's name, the date, the time of the photograph, and the general direction faced
2. A brief description of the subject and the field work portrayed in the picture
3. The sequential number of the photograph and the roll number on which it is contained.

The slides or prints and associated negatives will be placed in task files in the field office after the film is developed. Any supporting documentation from the field logbooks will be photocopied and placed in the task files to accompany the slides or prints.

SOP 5

Sample Custody

Note: SOPs 2 and 4 cited within.

STANDARD OPERATING PROCEDURE

SAMPLE CUSTODY SOP 5

A stringent, established program of sample chain-of-custody will be followed during sample storage and shipping activities to account for each sample. The procedure outlined herein will be used in conjunction with SOP 4, which covers the use of sample logbooks, and SOP 2, which covers sample packaging and shipping. Chain-of-custody record/sample analysis request forms (Attachment 5-1) ensure that samples are traceable from the time of collection through processing and analysis until final disposition. A sample is considered to be in a person's custody if any of the following criteria are met:

1. The sample is in the person's possession
2. The sample is in the person's view after being in possession
3. The sample is in the person's possession and is being transferred to a designated secure area
4. The sample has been locked up to prevent tampering after it was in the person's possession.

PROCEDURE

The chain-of-custody record portion of the form is the most critical because it documents sample possession from the time of collection through the final disposition of the sample. The sample analysis request portion of the form provides information to the laboratory regarding what analyses are to be performed on the samples that are shipped.

The chain-of-custody record/sample analysis request form will be completed after each field collection activity and before the samples are shipped to the laboratory. Sampling personnel are responsible for the care and custody of the samples until they are shipped. When transferring possession of the samples, the individuals relinquishing and receiving the samples must sign the chain-of-custody record/sample analysis request form(s), indicating the time and date that the transfer occurs. Copies of the forms will be made and kept by PTI, and the originals will be included with the samples in the transfer container. The following guidelines will be followed to ensure consistent shipping procedures and to maintain the integrity of the samples:

1. Each chain-of-custody record/sample analysis request form contains a line where all sampling personnel will sign. The person who relinquishes custody of the samples must sign this form. Samplers' signatures not on the chain-of-custody record/sample analysis request form should be entered in the field logbook.
2. The chain-of custody record/sample analysis request form should not be signed until the information has been checked for inaccuracies by the lead sampler. All changes should be made by drawing a single line through the incorrect entry and initialing and dating it. Revised entries should be made in the space below the entries. On the handwritten chain-of custody record/sample analysis request forms, spaces remaining at the bottom of the page after corrections are made should be marked out with single lines. This procedure will preclude any unauthorized additions.
3. At the bottom of each chain-of custody record/sample analysis request form is a space for the signatures of the persons relinquishing and receiving the samples and the time and date that the transfer occurred. The time that the samples were relinquished should match exactly the time they were received by another party. Under no circumstances should there be any time when custody of the samples is undocumented.
4. If samples are sent by a courier not affiliated with the laboratory, such as Federal Express or UPS, the name of the courier should be entered in the "received by" block. The time of transfer should be as close to the actual drop-off time as possible. Once the chain-of custody record/sample analysis request forms are signed and copied, they should be sealed inside the transfer container.
5. If errors are found after the shipment has left the custody of PTI personnel, a corrected version of the forms must be made and sent to all relevant parties. Minor errors can be rectified by making the change on a copy of the original with a brief explanation and signature. The person who makes the changes should appear on the chain-of custody record/sample analysis request form as a sampler. Errors in the signature block may require a letter of explanation.
6. Samples that are archived internally at PTI should be accompanied by a chain-of custody record/sample analysis request form. While samples remain in PTI's custody before being shipped, all containers will be kept securely locked to preclude tampering with the samples.

Attachment 5-1

**Example Chain-of-Custody
Record/Sample Analysis
Request Form**

SOP 6B

**Preparation of Field
Quality Control Samples—
Sediment**

Note: SOPs 2, 5, 71B, and 104 cited within.

STANDARD OPERATING PROCEDURE

PREPARATION OF FIELD QUALITY CONTROL SAMPLES—SEDIMENT

SOP 6B

This SOP describes the purpose, preparation, and collection frequency of equipment rinsate blanks, replicate samples, trip blanks, and reference materials for solid matrices.

As part of the QA/QC program, all field quality control samples will be sent blind to the laboratories. To accomplish this, the samples will be sent in the same form as regular samples, including all containers, sample numbers, and analytes. The sample ID for field quality control samples should allow data management and data validation staff to identify them as such. Under no circumstances should the laboratory be allowed to use reference materials, rinsate blanks, or trip blanks for matrix spike and matrix spike duplicate analysis. The laboratory should be instructed to contact the project QA/QC coordinator when a laboratory quality control sample is not specified on the sample analysis request form for a sample digestion group so that one can be assigned.

All field quality control samples will be packaged and shipped with other samples in accordance with procedures outlined in SOP 2, *Sample Packaging and Shipping*. Sample custody will be maintained in accordance with procedures outlined in SOP 5, *Sample Custody*.

Field quality control samples will be prepared at least once per sampling event, and certain types will be prepared more often at predetermined frequencies. If the number of samples taken does not equal an integer multiple of the intervals specified in this SOP, the number of field quality control samples is specified by the next higher multiple. For example, if a frequency of 1 quality control sample per 20 is indicated and 28 samples are collected, 2 quality control samples will be prepared. The text below describes the preparation and frequency of field quality control samples required for sediment sampling activities.

EQUIPMENT RINSATE BLANKS

Equipment rinsate blanks will be used to help identify possible contamination from the sampling environment or from improperly decontaminated sampling equipment. Equipment rinsate blanks will be prepared by processing a representative amount of laboratory deionized water through the decontaminated sample collection equipment, then transfer-

ring the water to the appropriate sample containers and adding any necessary preservatives. Because the matrix for rinsate blanks is water, rather than solids, bottle types and volumes should be coordinated with the laboratory. Equipment rinsate blanks will be prepared for sediment core sampling and analyzed for all inorganic, organic, and conventional analytes at least once per sampling event. The actual number of equipment rinsate blanks prepared during an event will be determined on a case-by-case basis by the project QA/QC coordinator.

Sediment collected with the gravity corer comes in contact with the polycarbonate tube that holds the sample and the stainless-steel bowl used for homogenizing the sediment sections. To prepare the equipment rinsate blank, the core tube and stainless-steel bowl will be decontaminated and allowed to air-dry as specified in SOP 104, *Sediment Coring Procedures Using Slide Hammer and Gravity Corers*. The procedure will likely require two people to be done effectively. One person should hold the polycarbonate tube at an angle above the stainless-steel bowl. While this person slowly turns the tube, the second person pours deionized water through the tube into the bowl. When the bowl is one-half full, the sample bottles will be filled with the water and preserved as necessary. The process will be repeated until all sample bottles are filled. When finished, the ends of the tube will be capped and the bowl covered with aluminum foil (dull side down) for use at the next station.

FIELD TRIPLICATE SAMPLES

Field triplicate samples are co-located samples collected in an identical manner over a minimum period of time to provide a measure of the analytical precision (field and laboratory) variance, including variance resulting from sample heterogeneity. Field triplicates will consist of three samples (one sample and two replicates) collected consecutively at the same location and placed in different bottles for separate analysis. Each replicate will have a unique sample number to distinguish it from the others. The three samples will be sent to the laboratory and analyzed for identical chemical parameters but will not be distinguishable by the laboratory as being replicates. Field triplicates will be collected for sediment core and surface sediment sampling at a minimum frequency of 1 per 50 samples or once per sampling event, whichever is more frequent.

TRIP BLANKS

Trip blanks will be used to help identify cross-contamination in the shipment of aqueous samples for analyzing volatile organic compounds (VOCs) only. Trip blanks will be prepared in the field office by pouring deionized water into two 40-mL VOC vials and tightly closing the lids. Each vial will be inverted and tapped lightly to ensure that no air bubbles exist.

The blanks will be transported unopened to and from the field in the cooler with the VOC samples. One trip blank will be sent with each shipment of samples for analyzing VOCs for sediment core and surface sediment sampling.

REFERENCE MATERIALS

Reference materials are materials of known composition that have been prepared by and obtained from EPA-approved sources and that have undergone multilaboratory analyses using a standard method. Reference material samples provide a measure of analytical performance and/or analytical method bias of the laboratory. Several reference materials may be required to cover all analytical parameters. Reference materials will be prepared for sediment core and surface sediment sampling at a minimum frequency of 1 per 50 samples or once per sampling event, whichever is more frequent. Details on preparation of the reference materials can be found in SOP 71B, *Preparation of Reference Materials—Sediment*.

SOP 51

Station Positioning

STANDARD OPERATING PROCEDURE

STATION POSITIONING SOP 51

This SOP describes the equipment and procedures used to position sampling vessels and locate sampling stations.

EQUIPMENT REQUIRED

The locations of sampling stations will be surveyed in the field using one of the following four positioning systems:

- LORAN receiver (King 7000)
- Electronic distance measuring (EDM) system (Nikon NTD2-EDM)
- Global positioning system (GPS) (Magellan 5000)
- Range-range microwave positioning system (Del Norte 540).

Selection of the appropriate positioning system for a particular survey is based on the degree of accuracy required, as discussed below for each system.

LORAN RECEIVER

The LORAN receiver can be used to locate an approximate position, with a repeatable accuracy that varies from 20 to 30 m, depending on the weather and the geometry of the receiver within the LORAN station network. To use the LORAN receiver, the boat operator positions the boat at the target station and the chief scientist observes and records the LORAN reading at that station. A position fix is obtained by reading the time difference (TD) displayed from two LORAN stations or by switching the receiver to the "lat-long" display and comparing the displayed latitude-longitude to the preplotted coordinates for a particular station.

ELECTRONIC DISTANCE MEASURING SYSTEM

The EDM system can achieve an absolute and repeatable positioning accuracy ranging from less than 1 m to 5 km. Required equipment includes a range reflector and two marine band VHF radio-telephones. The following procedures are used for locating and documenting the position of a sampling station:

1. From the sampling vessel, collect a sample at the sampling station and deploy a buoy at the station.
2. Notify the surveyors by radio that positioning of the buoys is required.
3. Locate the sampling vessel (or motorized dingy) at the station and hold the survey prism directly above the sampling station buoy.
4. Radio the surveyor with the sampling station number.
5. Confirm the station number with the surveyor, who will read and record the range and azimuth displayed on the EDM.

GLOBAL POSITIONING SYSTEM

Accuracy requirements for reconnaissance surveys allow the use of a portable GPS receiver. The geographic and repeatable accuracy of a hand-held GPS receiver is approximately 15 m. The United States government, however, has decided not to provide this full level of accuracy to non-military GPS users. GPS signals are intentionally degraded to provide varying levels of accuracy over time. This results in an accuracy of 50 m, 50 percent of the time, and 100 m, 95 percent of the time. Accuracy can be increased by averaging fixes taken at a single location at several points in time. The only equipment required for the GPS positioning system is the GPS receiver and a spare set of AA batteries. The following procedures are used for locating and documenting the position of a sampling station:

1. Enter the latitude and longitude of the sampling station into the GPS receiver.
2. Program the GPS receiver to display the range and distance to the sampling station, and steer the boat to the station.
3. When the boat arrives at the sampling station, deploy the sampler and a buoy labeled with the number of the sampling station.
4. Hold the GPS receiver over the station buoy and record the latitude and longitude of the station in the field logbook.

RANGE-RANGE MICROWAVE POSITIONING SYSTEM

The range-range microwave positioning system uses radio beacons, located onshore, that respond to interrogations from the survey vessel's navigation system. The distance from the survey vessel to each of the beacons can be determined based on the travel time interval between the interrogation from the shipboard system and the response from the shore stations. The microwave system transmits on the line of sight. Therefore, the practicable range of the system is limited by the height of the beacons. The position information is updated every second with a position repeatability of ± 1 m. A minimum of three beacons (usually four) are used during the survey. All positioning data are recorded on disk and printed by the vessel's navigation acquisition system. The angles of intersection between adjacent shoreline stations must be greater than 30° and less than 150° to maintain an absolute position accuracy of about 1.5 m for each range used to compute a fix.

The required equipment includes four shore beacons with two 12-V batteries wired in series, a ship-board receive-transmit beacon, and an HP 2000 personal computer with the navigation software. The following procedures are used to position the vessel:

1. Calibrate the navigation beacons on survey control points.
2. Compare the ranges on the receiver to the calculated range between the two control points and adjust the calibration if necessary.
3. Install the receive-transmit beacon and the navigation acquisition system onboard the survey vessel.
4. Deploy the shore beacons on the shoreline stations.
5. Enter the coordinates of the sampling stations and/or track lines into the shipboard computer.
6. Navigate the vessel in accordance with the graphics display on the computer CRT screen.

SOP 71B

**Preparation of Reference
Materials—Sediment**

Note: SOPs 2, 6B, and 102 cited within.

STANDARD OPERATING PROCEDURE

PREPARATION OF REFERENCE MATERIALS— SEDIMENT SOP 71B

Reference materials will be used in the field quality control program to provide a measure of laboratory accuracy. Reference materials used on the project must be from EPA-approved sources and be submitted for all available project analytes. A minimum frequency of reference material analysis will be 1 per 50 samples or once per sampling event, whichever is more frequent. If the number of samples lies between multiples of 50, the higher multiple should be used to determine the number of reference material samples to submit.

Reference materials for sediments are typically prepared by a certified laboratory and are ready to be transferred to the appropriate sample container. In preparing the sample for shipment, field personnel should read and fully understand the instructions provided with the reference material and should follow SOP 6B, *Preparation of Field Quality Control Samples—Sediment*. The field method presented below describes typical preparation requirements and standard laboratory practices that may not be covered in the instructions provided by the manufacturer.

EQUIPMENT REQUIRED

Equipment required for the preparation of reference materials for solids includes the following:

- Reference material with instructions
- Reference material logbook
- Stainless-steel spoon
- Deionized water
- Industrial detergent
- Decontamination solvents (methanol, hexane)
- Decontamination acid (10 percent nitric acid)

- Squirt bottles for decontamination
- Top load scale.

MINIMUM DOCUMENTATION REQUIREMENTS

All reference material preparations must be documented in a project logbook developed for that purpose. Pages must be numbered and nonremovable. All entries must be in ink, and any mistakes must be corrected by drawing a single line through the error and initialing it. Logbook information required for each reference material includes the name of the person preparing the sample, the date, sample identification (e.g., sample number, sample ID, tag number), the reference material lot and batch numbers, analytes, and the steps followed in preparing the sample. The reference material samples also must be documented in the sample logbook along with the other environmental samples. It should be clearly stated that the samples are reference materials.

The purpose of reference material samples is to provide a check on the quality of work by the primary and referee laboratories; therefore, it is extremely important that the samples are not identified as quality control samples by those running the analyses. To accomplish this, the samples must be sent to the laboratory in the same form as regular samples, including all containers, sample numbers, and analytes (e.g., if the reference material includes only benzene, but monochlorobenzene analysis is normally made from the same container, the sample analysis request should include both).

The sample ID for reference materials should allow data management and quality control staff to trace the sample back to a particular reference material concentration (e.g., use the reference material lot and batch numbers in the sample ID, or use a single ID for all reference materials in a sampling event that can be matched with the lot and batch numbers in the reference material logbook).

Under no circumstances should the laboratory be allowed to use a reference material sample for matrix spike and matrix spike duplicate analysis. The laboratory should be instructed to contact the project QA/QC coordinator whenever a laboratory quality control sample is not specified for a sample delivery group in the sample analysis request so that one can be assigned.

REFERENCE MATERIAL SAMPLE PREPARATION

The following steps will be taken to prepare the reference material samples:

1. Read the instructions provided with the reference material carefully, including the Material Safety Data Sheet and other safety information.

Also, note any information that may relate to the holding time for the reference material.

2. Remove the reference material container from its packaging, and check for any inconsistencies between the identification information given on the container and the instructions. Record any discrepancies in the reference material logbook.
3. Reference materials that are in dry powder form may be poured directly into the sample bottle, provided no contact is made between the two containers. Samples that cannot be poured should be transferred using a stainless-steel spoon.
4. The spoon, and any other items that will come in contact with the reference material, must be cleaned appropriately. Clean the items with Alconox[®] or a similar industrial detergent and rinse thoroughly with tap water. For metal reference materials, rinse with dilute acid before the final deionized water rinse. For organic reference materials, rinse with appropriate solvents after rinsing with deionized water. Consult the project QA/QC coordinator and health and safety officer for the appropriate cleaning chemicals to use and any related safety information. Spoons used for powdered reference materials should be air-dried to avoid clumping of the sample. Solvent-cleaned glassware should be set aside until all of the solvent has volatilized.
5. Weigh out approximately the amount required for analysis using a scale. To do this, weigh the sample container to be filled to establish a tare weight, then add the proper amount of sample.
6. Pour or spoon out the contents of the container (or containers, if more volume is required than is provided with a single reference material) directly into a sample bottle of the appropriate material for the analytes. Avoid contacting the lip of the reference material bottle with the sample container because it is a possible source of external contamination.
7. Create sample identifiers consistent with those used for environmental samples being sent to the laboratory, and label the bottle accordingly.
8. Store and ship the samples according to SOP 102, *Preservation and Handling of Samples*, and SOP 2, *Sample Packaging and Shipping*.
9. Date and store all records of the reference material, including the container used (this information may be needed in the future if tracking problems occur).
10. Copy and send all relevant information regarding the preparation and documentation of all reference materials to the appropriate staff, who

include, at a minimum, the project QA/QC coordinator and data management coordinator.

11. Keep an inventory of reference materials used on the project that can be checked after each sampling event. Order any reference materials as necessary to ensure that they will be available at the appropriate time. Solid reference materials can usually be saved if only a portion of the volume is used.
12. Inorganic reference materials can be stored in a cool dry place. Organic reference materials should be stored frozen at -20°C .

SOP 100

**Surface Sediment
Sampling Using a Modified
van Veen Grab Sampler**

STANDARD OPERATING PROCEDURE

SURFACE SEDIMENT SAMPLING USING A MODIFIED VAN VEEN GRAB SAMPLER SOP 100

This SOP describes the procedures used to collect surface sediment with a van Veen grab sampler. Surface sediment is typically analyzed for various physical and chemical variables. For the purposes of this SOP, surface sediment is defined as the upper 2 cm of the sediment column.

A modified stainless-steel van Veen grab sampler is capable of collecting acceptable samples from a variety of substrates, such as mud, sand, gravel, and pebbles (APHA 1989). The modified van Veen grab sampler incorporates several design improvements over the traditional van Veen grab sampler that improve the quality of the sediment samples. The modified grab sampler has two doors on top to allow easy access to the sediment for visual characterization and subsampling of surface sediments. The interiors of the doors are made of screens to minimize the bow wake and the resulting disturbance of the sediment surface when the grab sampler is lowered to the bottom. Rubber flaps cover each screen as the grab sampler is retrieved to prevent disturbing the sediment sample as it is raised through the water column. The arms of the modified grab sampler are lengthened and arced to provide a stronger seal when the grab sampler is closed, thereby minimizing sample leakage when the grab sample is retrieved. Finally, the modified grab sampler has four detachable, epoxy-coated lead weights that allow the weight and penetration of the grab sampler to be optimized with respect to the kind of sediment being sampled.

The procedures for collecting surface sediment samples using the modified van Veen grab sampler are described below.

EQUIPMENT REQUIRED

Equipment required for sediment sampling using the van Veen grab sampler includes the following:

- Stainless-steel van Veen grab sampler (typically 0.06 m² or 0.1 m²)
- Winch and hydrowire (with load capacities ≥ 3 times the weight of a full sampler)

- Sample collection table
- Teflon[®] or polyethylene siphon (inner diameter = 1.27 cm, length = 60–90 cm)
- Stainless-steel or plastic ruler
- Stainless-steel spatulas
- Stainless-steel spoons
- Stainless-steel mixing bowl
- Scrub brush
- Squirt bottles (for solvents)
- Alconox[®] (laboratory detergent)
- Methanol or acetone
- Hexane
- Socket and crescent wrenches (for adding or removing the detachable weights of the grab sampler)
- Water pump and hose (for rinsing the grab sampler, sampling utensils, and sample collection table).

DECONTAMINATION

Before each station is sampled, decontaminate the inner surfaces of the grab sampler and all stainless-steel sampling utensils by scrubbing them with Alconox[®] and site water, rinsing them with site water, rinsing them with methanol or acetone, rinsing them with hexane, and allowing them to air-dry.

GRAB SAMPLER DEPLOYMENT

1. Attach the grab sampler to the hydrowire with a swivel. The swivel minimizes the twisting forces on the sampler during deployment and ensures that proper contact is made with the bottom. For safety, the hydrowire, swivel, and all shackles should have a load capacity at least 3 times the weight of a full sampler.
2. Place the grab sampler on the sample collection table and open it.
3. Ensure that the two release chains and the two retrieval chains are hanging free and are not wrapped around the arms of the sampler.

4. Attach the ring of the release chains to the release mechanism, and insert the safety pin to prevent the mechanism from being activated prematurely.
5. Start the winch, raise the release mechanism and the sampler, and swing it outboard.
6. Remove the safety pin from the trigger and lower the sampler through the water column at a slow and steady speed (e.g., 30 cm/second).
7. Allow the grab sampler to contact the bottom gently, with only its weight being used to force it into the sediments. The sampler should never be allowed to "free fall" to the bottom because this may result in premature triggering, an excessive bow wake, or improper orientation upon contact with the bottom.
8. Allow approximately 60 cm of slack in the hydrowire after contact with the bottom is made to ensure that the release mechanism is activated.

GRAB RETRIEVAL

1. After the grab sampler has rested on the bottom for approximately 5 seconds, begin retrieving it at a slow and steady rate (e.g., 30 cm/second).
2. Ensure that the sampling vessel is not headed into any waves before the sampler breaks the water surface to minimize vessel rolling and potential sample disturbance.
3. After the grab sampler breaks the water surface and is raised above the height of the sample collection table, swing the grab sampler inboard and gently lower it onto the table, maintaining tension on the hydrowire to prevent the grab sampler from rolling when it contacts the table.
4. When the grab sampler contacts the table, insert wedges under both jaws so that the grab sampler will be held in an upright position when tension on the hydrowire is relaxed.
5. Relax the tension on the hydrowire, and remove the release and retrieval chains from the surface of the grab sampler.
6. Open the doors on the top of the grab sampler, and inspect the sample for acceptability. The following acceptability criteria should be satisfied:

- The sampler is not overfilled with sample to the point that the sediment surface presses against the top of the sampler or is extruded through the top of the sampler
- Overlying water is present (indicates minimal leakage)
- The overlying water is not excessively turbid (indicates minimal disturbance or winnowing)
- The desired penetration depth is achieved (i.e., 4-5 cm for a 2-cm-deep surficial sample).

Penetration depth should be determined by placing a ruler against the center of the inside edge of the opening on the top of one side of the grab sampler and extending it into the grab sampler until it contacts the top of the sample. The penetration depth is determined by the difference between that measurement and the total depth of the grab sampler.

SAMPLE REMOVAL AND PROCESSING

1. For acceptable samples, remove the overlying water by slowly siphoning it off near one or more sides of the grab sampler. Ensure that the siphon does not contact the sediments or that fine-grained suspended sediment is not siphoned off. If sediment is suspended in the overlying water, do not proceed with siphoning until the sediment is allowed sufficient time to settle.
2. After the overlying water is removed, characterize the sample as specified in the study design. Characteristics that are often recorded include:
 - Texture
 - Color
 - Biological structures (e.g., shells, tubes, macrophytes)
 - Presence of debris (e.g., twigs, leaves)
 - Presence of an oily sheen
 - Odor (e.g., hydrogen sulfide, oil, creosote).
3. After the sample is characterized, remove the top 2 cm using a stainless-steel spatula. Unrepresentative material (e.g., large shells, stones) should be removed under the supervision of the chief scientist and noted on the field log sheet.

4. Remove subsamples for analysis of unstable constituents (e.g., volatile organic compounds, acid-volatile sulfides), and place them directly into sample containers without homogenization.
5. Transfer the remaining surface sediment to a stainless-steel mixing bowl for homogenization. Additional grab samples may be required to collect the volume of sediment specified in the study design. The mixing bowl should be covered with aluminum foil while additional samples are being collected to prevent sample contamination (e.g., from precipitation, splashing water).
6. After the surface sediment from a sample is collected, move the sampling vessel away from the station, open the jaws of the grab sampler, attach the ring of the deployment chains to the release mechanism, insert the safety pin, start the winch, raise the grab sampler, and allow the remainder of the sediment sample to fall onto the sample collection table. Discard this material away from the station, and rinse away any sediment adhering to the inside of the grab sampler. The grab sampler is now ready for additional sampling at the same station or decontamination prior to sampling at a new station.
7. After a sufficient volume of sediment is transferred to the mixing bowl, homogenize the contents of the bowl using stainless-steel spoons until the texture and color of the sediment appears to be uniform.
8. After the sample is homogenized, distribute subsamples to the various containers specified in the study design and preserve the samples as specified in the study design.

REFERENCES AND OTHER SOURCES

APHA. 1989. Standard methods for the examination of water and waste water. Seventeenth Edition. Prepared and published by American Public Health Association, the American Water Works Association, and the Water Pollutant Control Federation.

SOP 101

**Decontamination of
Equipment—Sediments**

Note: SOP 6B cited within.

STANDARD OPERATING PROCEDURE

DECONTAMINATION OF EQUIPMENT—SEDIMENTS SOP 101

To prevent potential cross contamination of samples, all reusable sediment sampling equipment will be decontaminated before each use. A decontamination station will be set up onsite in a clean location, upwind of actual sampling locations. Decontaminated equipment will be stored away from areas that may cause recontamination, and rinsate blanks will be collected according to SOP 6B, *Preparation of Field Quality Control Samples—Sediment*. When handling decontamination chemicals, field personnel will follow all relevant procedures outlined in the site health and safety plan.

EQUIPMENT REQUIRED

Equipment required for decontamination includes the following:

- Plastic brushes
- Extension arm for cleaning core liners
- Squirt bottles
- 5-gal plastic bucket(s)
- Tap water or site water
- Alconox[®] or similar industrial detergent
- Acetone (for organic contaminants)
- Hexane (for organic contaminants)
- 0.1 normal nitric acid (HNO₃) for inorganic contaminants
- Sealable waste containers equipped with a funnel
- Aluminum foil
- Core liner caps or plastic wrap and rubber bands.

DECONTAMINATION PROCEDURES

Potential sources of contamination of samples include the stainless-steel equipment used to prepare the samples (e.g., bowls, spoons, spatulas), the polycarbonate core liners and extruding tube, and the sampler. The following steps should be followed to properly clean all equipment that comes into contact with the samples:

1. Rinse the equipment thoroughly with tap or site water to remove most of the remaining sediment. This step should be performed onsite for all equipment, including core liners that will not be used again until the next day of sampling. Pieces that do not need to be used again that day may be set aside and thoroughly cleaned in the field laboratory at the end of the day.
2. Pour a small amount of concentrated industrial detergent into a 5-gal bucket and fill it with tap or site water.
3. Scrub the equipment in the detergent solution using a plastic brush with rigid bristles. For the polycarbonate core liners, use a brush attached to an extension to reach the entire inside of the liners, scrubbing with a back-and-forth motion. Be sure to clean the outside of core liners, bowls, and other pieces that may be covered with sediment.
4. Rinse the equipment with tap or site water and set aside to drain.
5. Wash the equipment with acetone from a squirt bottle, and let the excess solvent drain into a waste container equipped with a funnel. Acetone acts primarily as a drying agent, but it also works as a solvent for some organic contamination. Core liners must be held over the waste container and turned slowly to be effectively cleaned. The sample apparatus may be turned on its side and opened to be washed more effectively. Set the equipment in a clean location and allow it to air dry.
6. Rinse the air-dried equipment with hexane from a squirt bottle, and let the excess solvent drain into the waste container. The opening of the squirt bottle may need to be widened to allow enough solvent to run through the core liners without evaporating. Hexane acts as the primary organic solvent, but it is insoluble with water. If water beading occurs, it may mean that the equipment was not thoroughly rinsed with acetone. When the equipment has been thoroughly washed with hexane, set it in a clean location and allow the hexane to evaporate before using it for sampling.
7. If inorganic compounds are being sampled, rinse the equipment a final time with clean water, 0.1 normal nitric acid, and water.

8. Wrap small stainless-steel items in aluminum foil (dull side facing the cleaned area) after decontamination is completed. Seal the polycarbonate core liners at both ends with either core caps or cellophane plastic and rubber bands.
9. When not in use, keep the waste solvent container closed and store in a secure area. The waste should be transferred to empty solvent bottles and disposed of at a licensed facility.

SOP 102

**Preservation and Handling
of Samples**

STANDARD OPERATING PROCEDURE

PRESERVATION AND HANDLING OF SAMPLES

SOP 102

This SOP defines bottle types and preservation and handling techniques for environmental samples. All bottles will be precleaned and provided by either a supply house or a subcontracted laboratory.

If preservatives are added before the bottles are brought into the field, each bottle must be marked to identify the preservative. Preserved bottles must be closed tightly and kept upright during storage. Test bottles will be prepared for each sampling site to determine the volume of preservative to use.

Immediately after collection, samples will be placed in coolers on ice. To ensure that bottles are kept at the proper temperature when stored onsite, each refrigerator must be monitored with its own thermometer. Daily readings will be recorded in a logbook to be kept near the refrigerators.

Preservation and handling guidelines for site analytes are provided in Table 102-1. Analytes with similar bottle and preservative requirements will be analyzed from the same container when possible.

TABLE 102-1. RECOMMENDED PRESERVATION AND HANDLING PROCEDURES FOR SAMPLES^a

Analyte	Matrix	Container	Preservation and Handling	Holding Time (from date of collection)
Acid-volatile sulfides	Solids	HDPE	Fill bottle, leaving no headspace Store samples in the dark at -20 °C	14 days
Alkalinity	Water	HDPE	Store samples at 4°C	14 days
<i>Ambrosia</i> pollen	Solids	HDPE	Store samples at 4°C	No specific holding time
Ammonia-nitrogen	Water	HDPE	Preserve with 1:1 sulfuric acid (H ₂ SO ₄) to a pH of 2 or less Store samples at 4°C	28 days
Carbon dioxide	Water	HDPE	Fill bottle, leaving no headspace Store samples at 4°C	1 day, but analysis should be performed onsite when possible
Carbonate	Solids	HDPE	Store samples at 4°C	28 days
Chloride	Solids	HDPE	Store samples at 4°C	28 days
	Water	HDPE	Store samples at 4°C	28 days
Grain size	Solids	HDPE	Store samples at 4°C	28 days
Lead-210 and cesium-137	Solids	HDPE	Store samples at 4°C	365 days
Mercury species ^b	Solids	HDPE	Store samples at 4°C	28 days
	Water	TFE [®] bottle and lid	Fill bottle, leaving no headspace Store samples at 4°C	28 days, but analyze samples as soon as possible after collection
	Tissue	Sealed polyethylene bag	Eviscerate; store samples below -10 °C	28 days, but analyze samples as soon as possible after collection
Percent lipids	Tissue	Aluminum foil; sealed polyethylene bag	Store samples at -20 °C ^c	360 days ^d
Percent moisture	Solids	HDPE	Store samples at 4°C	No specific holding time
Polychlorinated biphenyls	Solids	Glass, with TFE [®] -lined lid	Store samples in the dark at 4°C	7 days ^e
	Tissue	Sealed polyethylene bag	Eviscerate, store samples at -20 °C	360 days
Polycyclic aromatic hydrocarbons	Solids	Glass, with TFE [®] -lined lid	Store samples in the dark at 4°C	7 days ^e

TABLE 102-1. (cont.)

Analyte	Matrix	Container	Preservation and Handling	Holding Time (from date of collection)
TAL and site metals and cyanide (except mercury)	Solids	HDPE	Store samples at 4°C	180 days
	Water	HDPE	Preserve with 1:1 nitric acid (HNO ₃) to a pH of 2 or less Store samples at 4°C	180 days
	Tissue	Aluminum foil; sealed polyethylene bag	Eviscerate; store samples at 4°C	180 days; CN: 14 days
TCL pesticides and polychlorinated biphenyls	Solids	Glass, with TFE®-lined lid	Store samples in the dark at 4°C	7 days°
	Water	Glass, with TFE®-lined lid	Store samples in the dark at 4°C	7 days°
	Tissue	Aluminum foil; sealed polyethylene bag	Eviscerate; store samples at 4°C	7 days°
TCL and site semivolatile organic compounds	Solids	Glass, with TFE®-lined lid	Store samples in the dark at 4°C	7 days°
	Water	Glass, with TFE®-lined lid	Store samples in the dark at 4°C	7 days°
	Tissue	Aluminum foil; sealed polyethylene bag	Eviscerate; store samples at 4°C	7 days°
TCL and site volatile organic compounds	Solids	Glass, with TFE®-lined lid	Fill bottle, leaving no headspace Store samples in the dark at 4°C	7 days
	Water	40-mL glass vial with TFE®-lined septum	Fill bottle, leaving no headspace Invert and tap vial to ensure no air bubbles are present Store samples in the dark at 4°C	7 days
	Tissue	Aluminum foil; sealed polyethylene bag	Eviscerate; store samples at 4°C	7 days
Total inorganic carbon	Solids	HDPE	Store samples in the dark at 4°C	28 days

TABLE 102-1. (cont.)

Analyte	Matrix	Container	Preservation and Handling	Holding Time (from date of collection)
Total and dissolved organic carbon	Water	Glass, with TFE [®] -lined lid	Store samples in the dark at 4°C	28 days
	Solids	HDPE	Store samples in the dark at 4°C	28 days
Total sulfate	Water	Glass, with TFE [®] -lined lid	Preserve with 1:1 sulfuric acid (H ₂ SO ₄) to a pH of 2 or less Store samples in the dark at 4°C	28 days
	Solids	HDPE	Fill bottle, leaving no headspace Store samples in the dark at -20 °C	28 days
Total sulfide	Water	HDPE	Store samples at 4°C	28 days
	Solids	HDPE	Fill bottle, leaving no headspace Store samples in the dark at -20 °C	7 days
Total suspended solids	Water	HDPE	Preserve with 4 mL 2N zinc acetate per liter of sample, and NaOH to a pH of 9 or greater Store samples at 4°C	7 days
	Water	HDPE	Store samples at 4°C	7 days

Note: HDPE - high-density polyethylene
TAL - target analyte list
TCL - target compound list

^a For more information, see the project quality assurance project plan or laboratory statements of work.

^b Sampling for mercury and handling containers requires extreme care to avoid contaminating the samples.

^c Samples that will also be analyzed for Contract Laboratory Program target list analytes will be stored at 4°C.

^d Samples that will also be analyzed for Contract Laboratory Program target list analytes must be analyzed within 7 days.

^e Samples must be analyzed within 40 days of extraction.

SOP 104

**Sediment Coring Procedures
Using Slide-Hammer and
Gravity Corers**

STANDARD OPERATING PROCEDURES

SEDIMENT CORING PROCEDURES USING SLIDE-HAMMER AND GRAVITY CORERS

SOP 104

This SOP describes the procedure for collecting and processing sediment core samples using slide-hammer and gravity corers. These corers can be used for sampling both coarse, consolidated sediment and fine-grained, cohesive sediment. The same corer barrel is adapted for use as either a slide-hammer or gravity corer by changing a few parts. In both coring methods, heavy weights are supported overhead by ropes or cables and pulleys. Therefore, hardhats are required in the vicinity of the equipment. Sample processing using a hydraulic extruder is also described.

Both corers rely on a one-way valve at the top of the corer that allows water to pass through the corer while being lowered and provides suction to prevent the sample from slipping out while being raised. The corers use 3-in. outside diameter tubing with a 1/16-in. wall thickness. The main corer barrel accepts liners that are 150 cm long and can be used for cores of up to about 140 cm long. Cores up to 3 m in length can be collected by adding 1-m and 1.5-m barrel extensions. Prior to use, the corer should be inspected for worn and damaged parts and should be cleaned.

SLIDE-HAMMER CORING

This coring method uses a slide hammer that pounds the corer into the sediment with repeated impacts. This method is most useful in nearshore zones where the sediment is difficult to penetrate and would require more than 500 lb of static weight if a gravity corer were used. The slide-hammer corer is illustrated in Figure 104-1. The slide-hammer corer uses one cable for lowering and retrieving the corer and one rope for actuating the hammer. The slide hammer works best when the hammer is heavier than the rest of the corer, so before use, all of the weights should be removed from the corer. The following procedures are based on using the corer aboard a pontoon boat equipped with a 12-ft tripod, a power winch, and a hole in the floor centered below the tripod. Because the coring is typically done in shallow water, it is necessary to anchor the boat with at least three anchors so the boat will not drift.

1. With the corer laying flat on the boat, screw the hammer guide onto the impact plate, slide the hammer onto the hammer guide, and screw the eyebolt onto the top of the hammer guide (see Note 1). Run the main

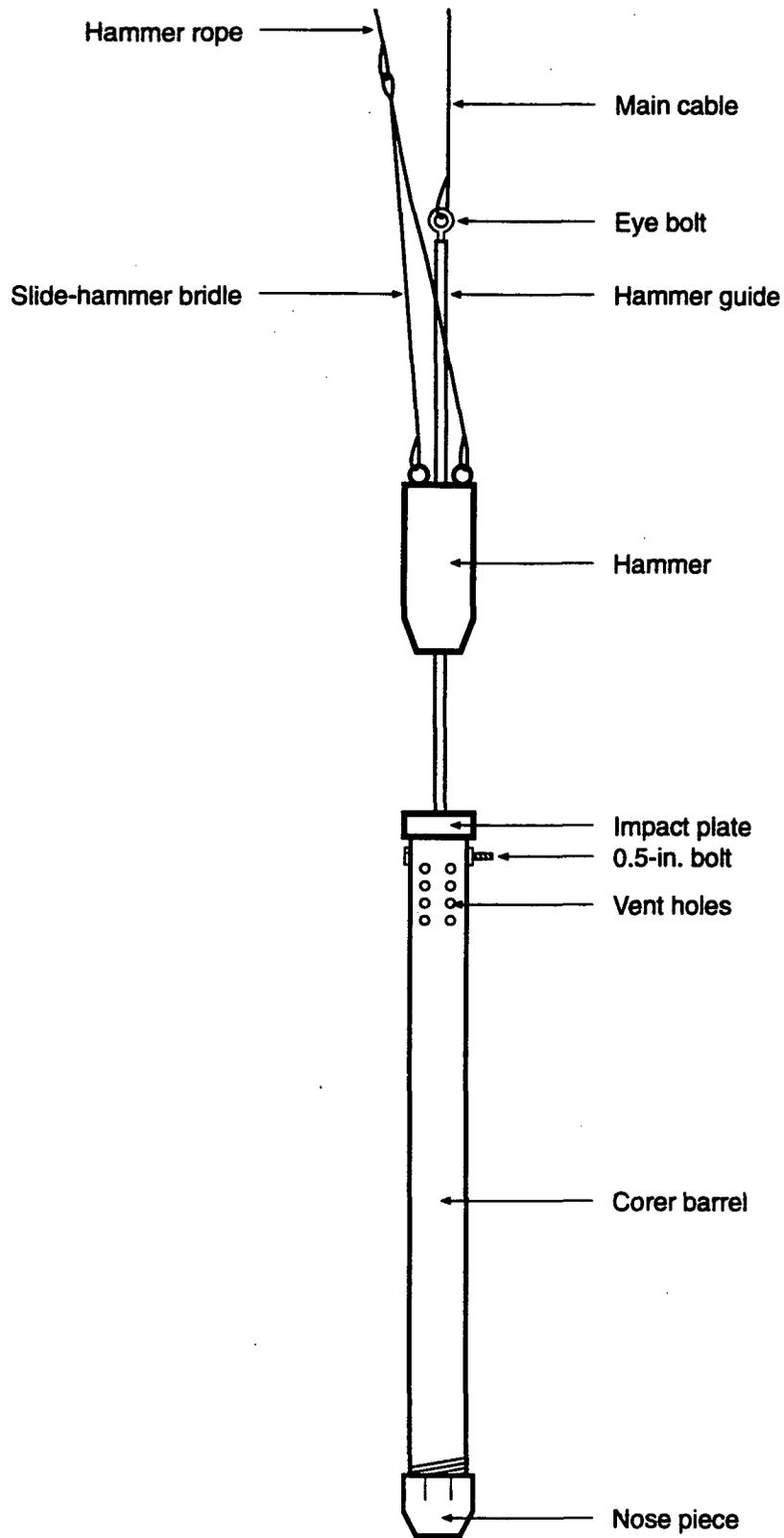


Figure 104-1. Diagram of slide-hammer corer.

cable and the hammer rope through the appropriate pulleys. Attach the main retrieval line to the eyebolt. *Caution:* When handling the slide-hammer assembly, be careful to keep hands away from the area where the hammer slides to avoid injury.

2. After the ball and valve are cleaned, align the holes in the top of the corer and impact plate and attach the impact plate to the top of the corer with the 0.5-in. diameter bolt. Inspect the bolt periodically for wear near the cap and 3.5 in. from the cap.
3. Attach the two thimbles at the ends of the slide-hammer bridle to the two eyebolts at the top of the hammer with small carabiniers, and secure the middle thimble to the hammer rope. The hammer rope should be at least 0.5 in. in diameter so it is easy to hold by hand.
4. Insert the 3-in. outside diameter polycarbonate liner into the corer barrel, making sure that about 0.75 in. protrudes out the end (see Note 2). Wrap the threads on the corer with Teflon[®] plumber's tape and screw the nose piece onto the barrel by hand until it is as tight as possible.
5. Slide the hammer down to the impact plate, being careful to keep hands free from the path of the hammer, and raise the corer to the vertical position using the main retrieval cable.
6. Lower the corer and let out the hammer rope at the same rate. As the corer is being lowered, valve popping can be heard as water displaces air inside the corer. Continue lowering the corer slowly until the nose piece contacts the sediment. Keep tension on the main retrieval cable, measure the length of the core needed from the water surface upward, and mark this point on the main cable with a piece of tape.
7. With just enough tension on the main retrieval cable to keep the corer vertical but still allow the cable to be let out at a rate of a few inches per impact, lift the hammer about 4 ft and release the rope. *Caution:* Before releasing the hammer rope, be sure that no one is standing on the rope or that the rope is not caught on anything.
8. Repeat Step 7 until the piece of tape is slightly below the water. When lifting the hammer, be careful not to lift so fast and high that it hits the eyebolt at the top of the hammer guide and hammers the corer back out of the sediment. Depending on how much the sediment core is compacted, it may be necessary to pound the corer until the tape is well below the water surface. Penetration should be stopped before the headspace between the sediment-water interface and the valve is less than about 15–20 cm.
9. When the corer has been pounded to the necessary depth, start retrieving the corer slowly at first until it is free of the sediment, and then

more rapidly until the nose piece is above the water. Slow the rate of retrieval until the nose piece clears the deck, and stop when there is 6 in. of clearance. Have two bolted rubber stoppers on top of one single stopper next to the hole in the deck and lower the corer onto the rubber stoppers until they are completely inside the nose piece. *Caution:* When guiding the corer onto the stopper, keep hands away from the area between the nose piece and the deck.

10. Cover the hole and tie-off the hammer rope to a cleat. With two people supporting the corer in a vertical position, release some, but not all, tension on the main retrieval cable. Disconnect the impact plate from the corer by removing the 0.5-in. bolt. Increase tension on the main retrieval line until the impact plate is free of the corer. *Caution:* When the impact plate is free of the corer, it is able to swing, so it should be stabilized immediately. This can be a problem when the boat is rocking. With tension on the main cable, untie the hammer rope and lower the slide hammer assembly to the deck. Connect the shackle to the top of the corer with the 0.5-in. bolt, and connect the main cable to the shackle.
11. Lift the corer about 1 ft with the main cable. With one person holding the corer barrel so it does not turn, unscrew the nose piece slowly. When it is unscrewed, be prepared to support the weight of the liner and sample by holding the nose piece and the stoppers from the bottom, then lower the nose piece and liner to the deck. While stabilizing the liner and corer, lift the corer until it is free of the liner. Lower the corer onto the deck, and cover the hole. For cores 1.5 m and longer, see Note 3.
12. Remove the nose piece from the liner by pushing down and rocking it slowly from side to side. The single stopper will come off with the nose piece, but the others should remain in place. Watch carefully that the other stoppers do not slip. In moving the liner with the sample, always support the liner from the bottom so the stoppers cannot slip.
13. Process the sample as described in the *Sample Extrusion and Sectioning* section.

GRAVITY CORING

This method uses gravity to force the corer into the sediment. It is designed for use in soft sediment that is typically found in more than 20 ft of water. However, it may be used in shallower waters if the sediment is soft. The gravity corer is illustrated in Figure 104-2. The weight can be adjusted using any combination of six 60-lb weights and one 30-lb weight (in addition to the barrel, which weighs 10 lb/ft) to achieve the necessary

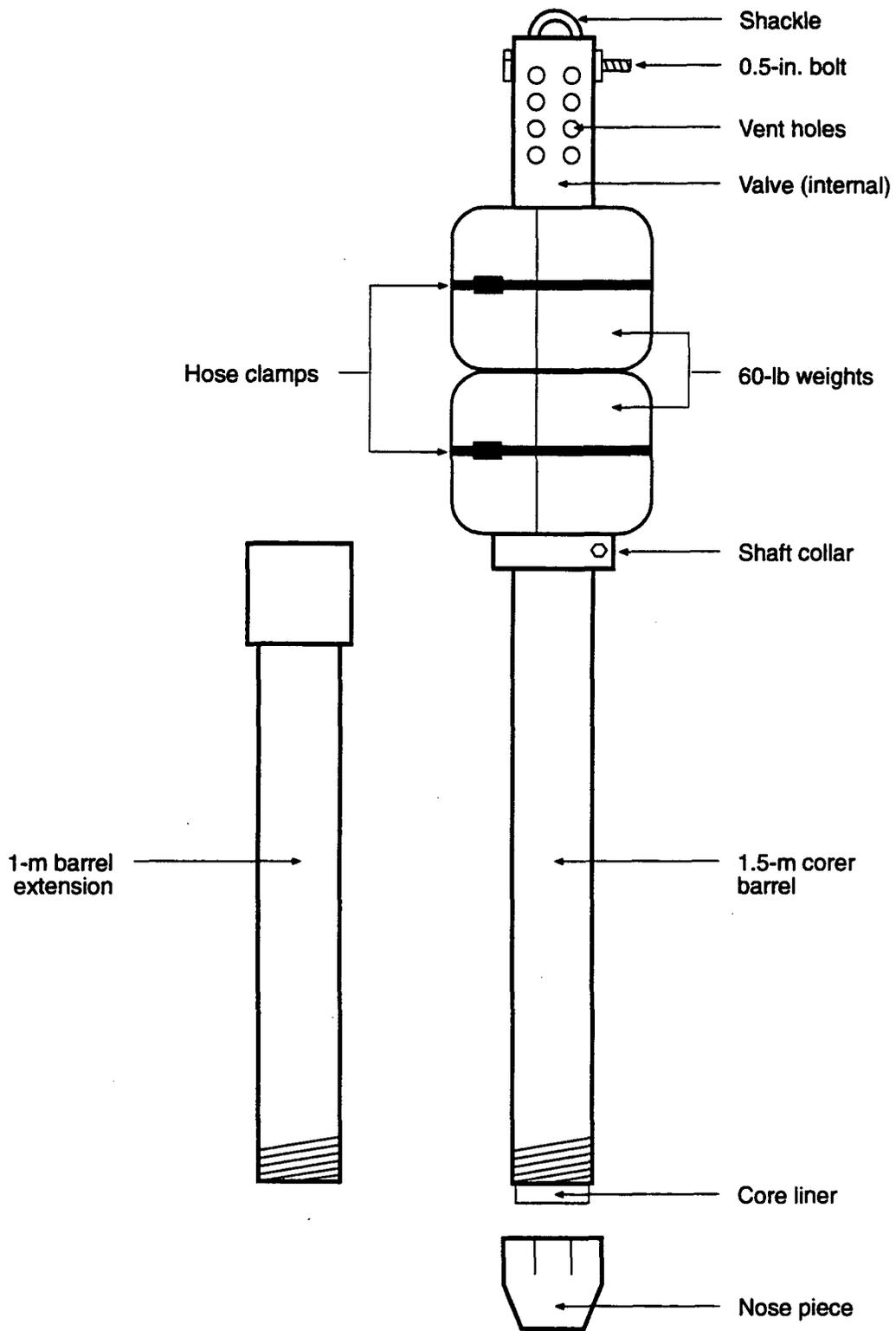


Figure 104-2. Diagram of 3-in. diameter gravity corer.

penetration. This gravity corer is not designed for free-fall into the sediment. Because gravity coring is much faster than slide-hammer coring and water depths are usually greater, boat drift is not a problem and anchoring is not necessary.

1. With the corer laying on the deck, insert the liner into the corer barrel until it contacts the bottom of the valve seat; about 0.75 in. of liner should protrude from the corer barrel. Wrap the threads with Teflon[®] plumber's tape where the nose piece screws in. Screw on the nose piece, making sure the liner seats on the lowest shoulder inside the nose piece (about 1 in. from the bottom edge of the nose piece). Tighten as much as possible by hand.
2. Add the appropriate amount of weight to the corer and secure it with a hose clamp. Slide the weights upward until the top of the top weight is a few inches below the vent holes. Slide the shaft collar upwards until it contacts the bottom of the bottom weight and tighten so it will not slip when it supports all the weights. It is a good idea to wrap a few layers of duct tape right below the shaft collar so that if it slips, it will become wedged on the tape.
3. Attach the shackle to the top of the corer with the 0.5-in. bolt, and connect the retrieval cable to the shackle.
4. While supporting the corer so that it does not swing freely, raise it with the winch. Watch the weights to see that they do not slip. Lower the corer at any rate that is practical until the nose is about 10 ft above the sediment, then reduce the rate to about 1 ft/second. This reduces the shock wave preceding the corer and helps retrieve a good interface. Let the line go slack for about 5 seconds (see Note 4).
5. Pull the corer slowly at first to break it loose from the sediment. Raise the corer up through the water column at a rate that is practical until the top of the corer approaches the surface, then slow the retrieval rate to about 1 ft/second. As soon as the nose clears the water surface, stop retrieval, push a double rubber stopper up into the corer, and support the stoppers so they are not pushed out by the sample. Have another stopper ready on the deck. Raise the corer and lower it onto the other stopper to push the double stopper further into the liner. *Caution:* When guiding the corer onto the stopper, keep hands away from the area between the nose piece and the deck.
6. Lift the corer about 1 ft with the main cable. With one person holding the corer barrel so that it does not turn, unscrew the nose piece slowly. When it is unscrewed, be prepared to support the weight of the liner and sample by holding the nose piece and the stoppers from the bottom, then lower the nose piece and liner to the deck. While stabilizing the liner and corer, lift the corer until it is free of the liner. Lower the

corer onto the deck, and cover the hole. For cores 1.5 m and longer, see Note 3.

7. Remove the nose piece from the liner by pushing down and rocking it slowly from side to side. The single stopper will come off with the nose piece but the others should remain in place. Watch carefully that the other stoppers do not slip. In moving the liner with the sample, always support the liner from the bottom so the stoppers cannot slip.
8. Process the sample as described in the *Sample Extrusion and Sectioning* section.

MAINTENANCE AND TROUBLESHOOTING

Cleaning the Ball Valve

The ball valve should be cleaned 1) at a minimum on each day of sampling, 2) if there is evidence that sediment entered the valve, and 3) whenever coring is conducted in near-shore zones where the sediment is sandy. A diagram of the valve is shown in Figure 104-3. To clean the valve, remove the 0.5-in. bolt from the top of the corer barrel and disconnect the impact plate or the shackle. Before removing the thin ball retaining wire, make sure the ball cannot roll overboard. Then remove the wire, reach in the corer, and remove the ball. Inspect the ball for materials or scratches that may prevent seating or sealing. Wipe off the ball with a paper towel, and place it in a clean place. Do not drop the ball because this will scratch the surface and prevent the ball from seating properly. Also, be careful not to damage the O-ring seal by placing any tools in the valve assembly. Wash out the valve with a hose to remove the majority of dirt. Using a paper towel, reach inside the top of the corer, wipe off the valve seat, and inspect the towel for dirt. Take a small quantity of Vaseline[®] (about the volume of a typical pencil eraser) and rub it on the ball. If the valve needs to be replaced, remove the two valve retaining wires and slide the valve out.

Insufficient Sample

The corer may not collect enough sample because of 1) inadequate penetration, 2) good penetration but too much compaction, or 3) adequate penetration but loss of sample during retrieval. Solutions to these problems are as follows:

- **Inadequate Penetration**—Add more weight to the corer or pound it in farther.

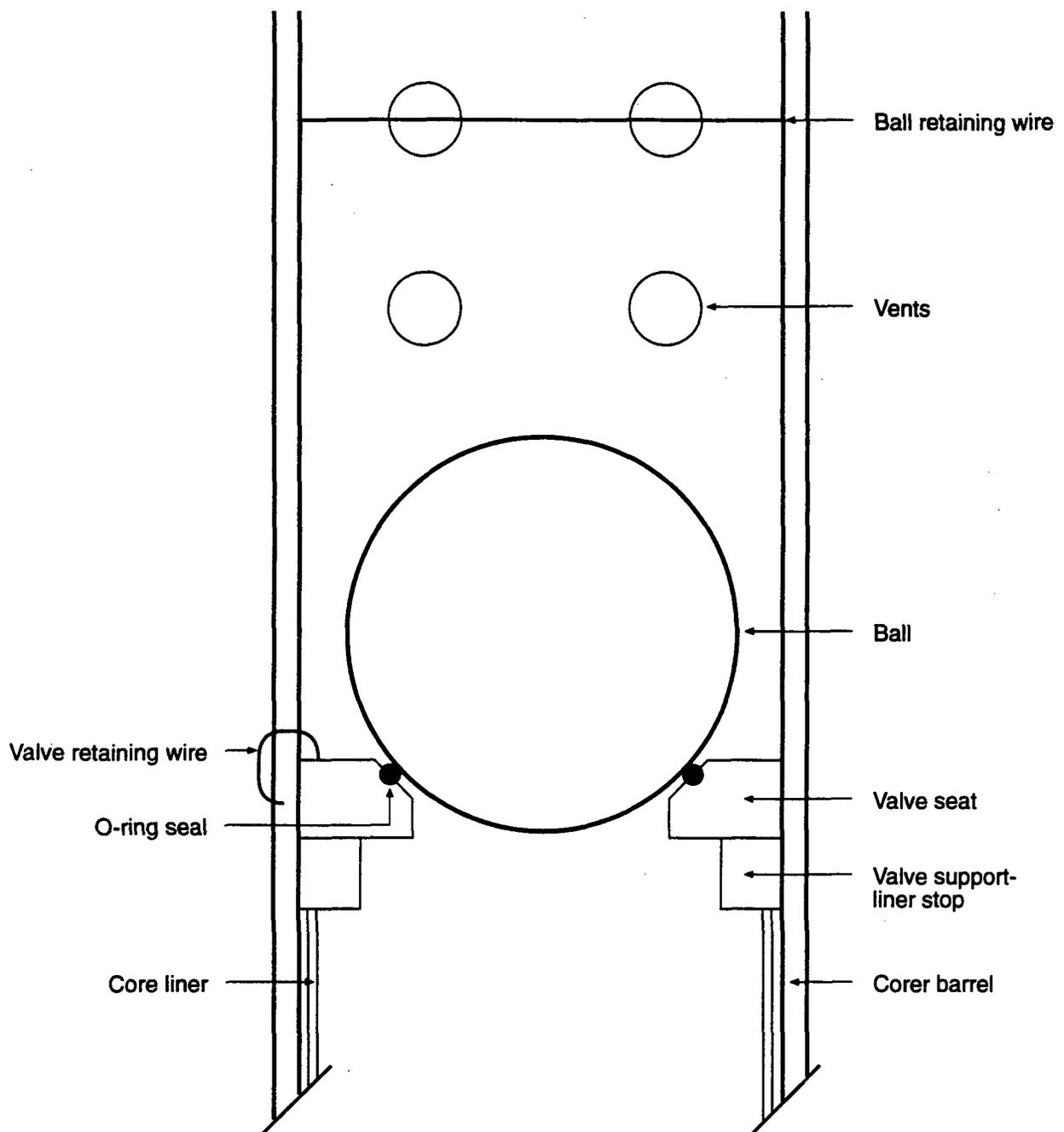


Figure 104-3. Cross section of ball valve.

- **Too Much Compaction**—Add an extension and more weight to get more penetration.
- **Loss of Sample During Retrieval**—Sample slipping out the bottom of the corer is caused by a loss of suction. There are several places at which suction can be lost: the valve seat, the valve assembly, the nose piece, and couplings between the barrel and extensions. To reduce sample loss, clean the valve seat/O-ring and grease the ball as described above. Make sure the valve assembly is sealed. Use Teflon[®] plumber's tape on the threads and duct tape on the outside of the couplings and nose piece.

Penetration of the corer can be measured by putting white Velcro[®] tape on the outside of the corer. Velcro[®] tape can also be used on the inside of the liner during testing to see how far up inside the liner the interface moves, how much sample slips out the bottom, and how much compaction occurs.

SAMPLE EXTRUSION AND SECTIONING

Sediment samples are extruded from the core liner using a hydraulic or mechanical extruder and are cut into desired section thicknesses using a calibrated sectioning tube. A diagram of the hydraulic extruder and sectioning apparatus is shown in Figure 104-4. The extruder can be used for 2- to 3-in.-diameter cores and can be used vertically or horizontally.

1. With no core liner attached to the extruder, submerge the inlet hose of the extruder in a bucket of water or overboard into the lake. Pump water through the system rapidly to clear all air out of the hose, valves, pump, and socket. Observe the water coming out of the socket and pump until no air bubbles come out.
2. Rinse grit from the bottom of the core liner so that the liner will slip smoothly onto the socket. With the shaft collar loosened and already around the socket, lift the core liner onto the socket and push it down onto the socket with a twisting motion. While holding the liner down, pump water through the socket slowly to remove air bubbles at the base of the rubber stoppers. While still holding the liner down, slip the shaft collar up and around the liner, and tighten it very tightly with the hexagonal wrench. Push gently on the pump to check for leaks. Pump until the sediment-water interface is level with the top of the core liner.
3. Place the calibrated sectioning tube on the top of the liner. Hold it down so it seats firmly on the liner, and pump until the desired sample

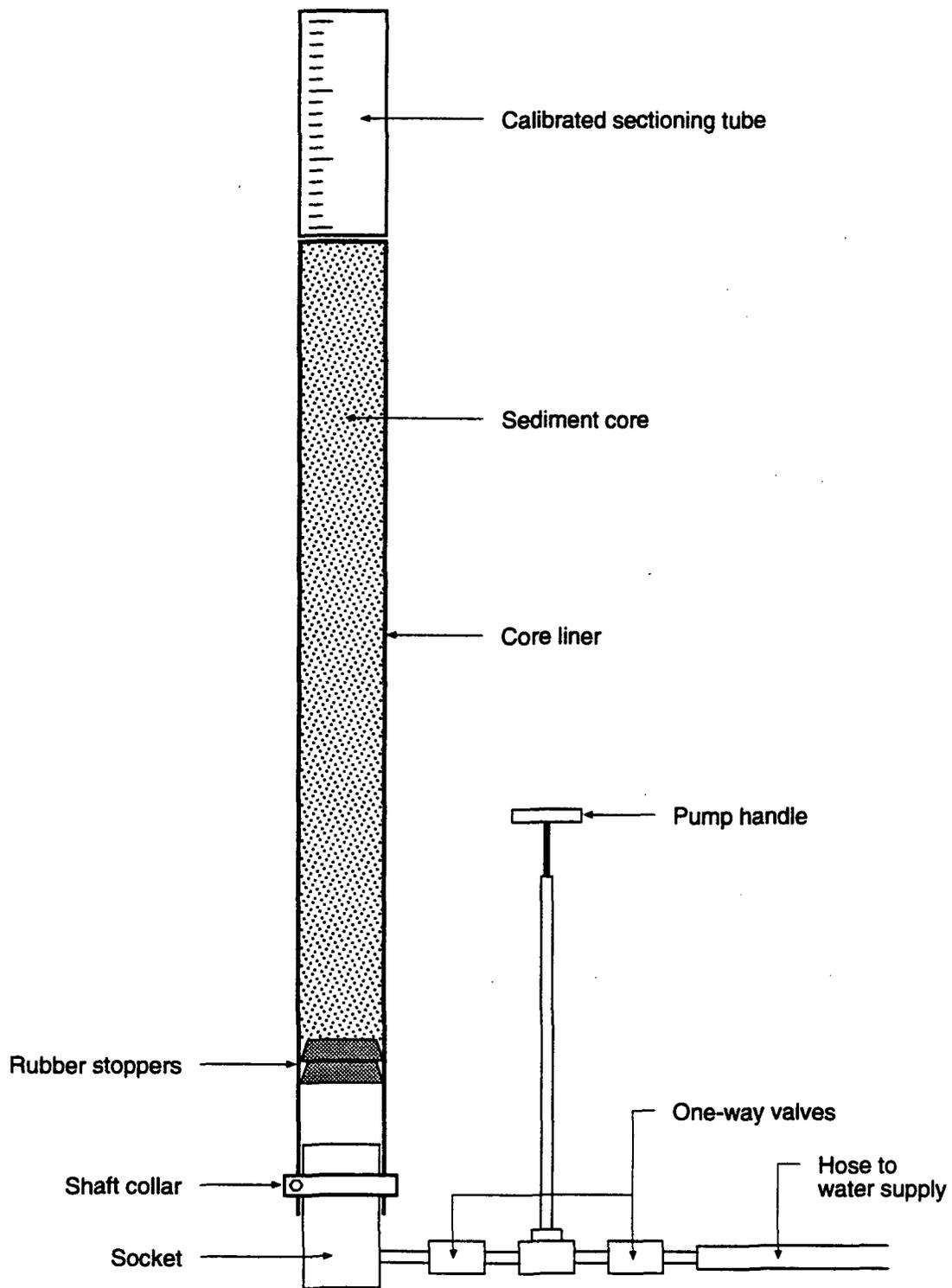


Figure 104-4. Diagram of core extruder and extrusion tube.

thickness is extruded into the tube. The extruder will extrude about 1 in. of sample per pump. With one person holding the liner steady, another person holds the sectioning tube and cuts the extruded sample by inserting the semicircular cutter between the liner and the tube. Cut the core and slide (do not lift), the cutter, and the tube horizontally off the top of the liner. Hold the cutter and tube firmly together. Invert the tube, and slide the cutter out to discharge sample into the mixing bowl.

4. Repeat Step 3 until the lowest desired depth is collected. Pump the remainder of the sample out of the liner along with the rubber stoppers.

Notes

1. The eyebolt at the top of the hammer guide may become unscrewed from the pounding vibrations and should be checked at each station prior to coring.
2. For long cores that require more than one piece of liner, butt the ends of the two pieces of liner squarely together and tape them securely so there are no leaks. Do not use too many layers of tape or the liner will not fit into the barrel.
3. For cores 1.5 m and longer, the tripod is not tall enough to lift the corer so that the barrel will clear the top edge of the liner when removing the liner. To remove the liner in this case, upon unscrewing the nose piece, lower the nose piece and liner into a pail that has a rope securely tied to the handle. While the corer is raised by the winch, lower the pail through the hole in the deck and into the water (if necessary) until the top edge of the liner clears the bottom edge of the barrel. Then lift it back onto the deck.
4. If the sediment is too hard for the amount of weight on the corer and the corer does not penetrate significantly, the corer will contact the bottom, tip over, and fall sideways. When this happens, the line will initially go slack, then quickly snap to the side, with the tension increasing. In this case, try doubling the weight; if this does not work, try using the slide hammer.
5. Periodically check the water level in the bucket. If air gets into the system, pumping becomes less efficient. At the end of each day, unscrew the cap at the top of the pump, lift the pump handle to remove it, wipe the O-rings with a paper towel, and grease the O-rings with Vaseline[®]. Avoid using water with coarse particles because they may interfere with proper valve function.

SOP 130

**Geochronological Dating of
Sediment Using Pb-210 and
Cs-137**

STANDARD OPERATING PROCEDURE

GEOCHRONOLOGICAL DATING OF SEDIMENT USING Pb-210 AND Cs-137

SOP 130

INTRODUCTION

This standard operating procedure (SOP) describes the method for processing sediment core samples for use in determining the sediment accumulation rate using Pb-210 or Cs-137. This SOP should be used in conjunction with SOP 103, which describes sediment coring procedures using a box corer, or SOP 104, which describes sediment coring procedures using slide hammer and gravity corers. This SOP is also suitable for use in conjunction with other methods for collecting deep sediment cores other than those described in SOPs 103 and 104, such as those collected by a submersible vibracore system or piston corer.

Before any sampling begins, an informed decision is needed to determine whether the sampling locations are suitable for Pb-210 and Cs-137 dating. The following sections provide information on the factors that should be considered in making this decision and on the methods for calculating sediment accumulation rates based on Cs-137 and excess Pb-210 in the sediments. Guidelines for selecting where and how deep to collect a sediment core, the thickness of the sampling intervals, and which intervals to analyze and analytical techniques are also described.

Pb-210 ACTIVITY

Pb-210 is a naturally occurring radioactive isotope from the U-238 decay series, with a half-life of 22.3 years. The radium isotope Ra-226 in soils decays to yield Rn-222, which is an inert gas that decays through a series of short-lived isotopes to Pb-210. A fraction of the Rn-222 atoms escape from soil particles into the atmosphere where they decay to Pb-210 and are eventually deposited into sediment. The activity of Pb-210 with depth in the sediment reaches steady state when the decay rate of Pb-210 is equal to the production of Pb-210 in the sediment. The depth at which steady state occurs must be determined; the Pb-210 activity at this depth is then subtracted from the Pb-210 activity in near surface sediments. It is only the "excess" Pb-210 in the near surface sediment (from atmospheric deposition) that can be used in dating sediments.

The sediment accumulation rate can be calculated using either the constant initial activity or constant rate of supply models (Appleby and Oldfield 1983). Both models assume that the input of Pb-210 is constant through time and that the Pb-210 is retained in the sediment and not influenced by strong physical mixing, bioturbation, or diagenesis. If the excess Pb-210 activity decreases exponentially with depth in the sediment in accordance with the usual radioactive decay law, the constant activity model is appropriate for determining the sedimentation rate. If the excess Pb-210 activity shows departures from an exponential decrease with depth, the constant rate of supply model should be used to determine sedimentation rates.

In a disturbed environment, the constant rate of supply model is the recommended method for determining sedimentation rates. This approach derives chronological dates from the integrated activity of Pb-210 and will not lead to underestimation of the true age of the sediment because of the apparent accelerated sediment accumulation resulting from disturbance of the sediment. The validity of the results from this calculation can be confirmed by measuring the activity of Cs-137 in the sediments (an independent dating technique) and understanding the historical contaminant input to the sediment. Prior knowledge of the distribution of contaminants in the sediment with depth will also assist in determining the depth of the sediment core and the number and thickness of sediment depth intervals to analyze for Pb-210.

Cs-137 ACTIVITY

The half-life of Cs-137 is 30.2 years and, like Pb-210, Cs-137 provides a measure of recent sediment history. Cs-137 was injected into the stratosphere by atmospheric testing of nuclear weapons during the late 1950s and early 1960s. Roughly half of the Cs-137 was produced between 1962 and 1964, and therefore, 1963 is often used as a marker for the peak fallout of Cs-137 in sediments. A smaller, secondary peak in the sediment below the 1963 peak is associated with the appearance of Cs-137 in 1957. Cs-137 inventories in sediment are not at steady state because the Cs-137 activity in air varies with time and Cs-137 is sporadically deposited to the sediment.

Physical processes that disturb the sediment may obscure the Cs-137 signal and cause significant uncertainty in dating the sediment. The rate of sedimentation should never be based solely on the activity of Cs-137. Instead, Cs-137 may be useful for confirming other dating methods such as Pb-210 or historical contaminant distributions.

SAMPLE LOCATION

Finding a site where the assumptions inherent in the model calculations hold true in a disturbed environment is difficult. A quiescent area should be selected with no obvious signs of physical disturbances. Again, information on the contaminant history of the sediment is useful for selecting an appropriate site location. Using Pb-210 activity for dating

sediments from rivers and streams is not recommended because these environments are high energy, although quiescent backwater areas within river systems may be suitable.

SAMPLE EXTRUSION AND SECTIONING

The depth of the core and the thickness of the sample intervals will depend on the sampling environment. For example, in Rhode Island salt marsh cores, supported levels of Pb-210 were found at depths ranging from 20 to 120 cm and accretion rates varied from 0.20 to 0.60 cm/year (Bricker et al. 1989). Cores collected in the Sabine estuary in Texas reached background levels at a depth of 30 to 50 cm (Ravichandran et al. 1995).

The best guidelines to follow are to collect the deepest core possible with a gravity/push core device or, at minimum, a 120-cm core with a mechanically driven core device. It is critical that the sediment-water interface be minimally disturbed by the core sampling. After a core has been deemed acceptable (see SOP 103 or 104 for acceptance criteria), the upper portion of the sediment core should be divided into thinner sections than the lower portion. Typically, a 60-cm gravity core from an area of low to moderate sediment accumulation can be sectioned into a total of 25 intervals. The top 30 cm should be sliced into 2-cm intervals and the bottom 30 cm sliced into 3-cm intervals. Deeper parts of the core below 60 cm can be sliced into 5-cm intervals. In areas where little (or slow) deposition may be occurring, sediment intervals of 1 cm may be appropriate in the 0-5 or 0-10 cm portion of the core. See SOP 103 or 104 for core extrusion methods and sample handling guidelines.

Visual inspection of the core before extrusion can assist the field team in deciding how to section the core. Fine particles play an important role in scavenging Pb-210 and will lead to accumulation of Pb-210 activity in the fine fraction of sediment. Changes in the grain-size distribution within a single core will result in a nonlinear Pb-210 activity profile with depth and will invalidate the assumption of constant flux of Pb-210 into the sediment. The activity of Pb-210 can be adjusted for changes in grain-size distribution by normalizing the Pb-210 activity to the percentage of fine particles ($<63 \mu\text{m}$) in the bulk sediment (Ravichandran et al. 1995). Core horizons with large portions of gravel and sand need not be divided into sections or analyzed. If the different sediment horizons are not visible through the core liner, the core tube can be cut lengthwise with an oscillating saw and the sediment scooped out with a spoon. Collecting sediment from the smear zone along the core liner should always be avoided.

Not all intervals sectioned from a sediment core require analysis. The objective of the analysis is to generate an adequate profile of Pb-210 activity with depth. The profile can be generated if every other interval in the upper portion of the core and approximately every third interval in the lower portion of the core are submitted for analysis. The choice of which intervals to submit for analysis depends on sediment composition (especially grain-size distribution), sampling location, and depth of core. Only subsurface intervals

should be submitted for Cs-137 analysis because the objective is to find the depth that correlates with the 1963 peak in activity.

SAMPLE ANALYSIS

Both Pb-210 and Cs-137 are gamma emitters and can be analyzed on a gamma detector provided a sample volume of approximately 100 g is available from each interval and there is adequate time (analysis time varies from 8 to 24 hours for Pb-210).¹ The activity of Pb-210 can also be measured more rapidly and indirectly by the activity of its daughter product, Po-210, and determined by alpha spectrometry (Krishnaswami and Sarin 1976). Approximately 2–3 g of sediment is required for this method; however, the analytical procedures are more complicated and costlier. It is recommended that a well-established laboratory with good calibration records for its detectors analyze the samples and assist with the interpretation of the results.

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¹ A discussion of this method can be found in Graustein and Turekian (1986).



Appendix E

Example Field Data Forms

PTI ENVIRONMENTAL SERVICES OFFICIAL SAMPLE SEAL		SAMPLE NO.	DATE	DATE
		SIGNATURE		
		SEAL BROKEN BY		
		DATE		

PTI ENVIRONMENTAL SERVICES	_____	Sample No.
	_____	Preservative
	_____	Sampler
	_____	Date/Time
	_____	SITE NAME
	_____	1301
	_____	Tag No.

Example label and custody seal.



Appendix F

**Toxicity Identification
Evaluations**

TOXICITY IDENTIFICATION EVALUATIONS

Toxicity identification evaluations (TIEs) will be used to evaluate the potential contribution of conventional variables (i.e., total ammonia and total sulfide) to the observed sediment toxicity in Ward Cove. TIEs involve various manipulations of water, effluent, or sediment samples to isolate the chemicals or groups of chemicals that may be responsible for any observed toxicity. TIEs are usually conducted after a sample has been determined to be toxic and are one method of establishing cause and effect relationships between chemicals and adverse biological effects.

The TIE analysis will focus on total ammonia and total sulfide for several reasons. First, results for the Phase I sampling effort (PTI 1997) suggest that ammonia may be an important factor in sediment toxicity. The use of a more comprehensive TIE approach is not appropriate for this site because elevated levels of a wide variety of different types of chemicals are not observed throughout most of Ward Cove and the excessive cost of the comprehensive approach is not warranted. Because total ammonia and total sulfide are elevated in parts of the Cove, they may be responsible for most or all of the toxicity observed in parts of the Cove during Phase I, especially for areas in which concentrations of other chemicals of potential concern (CoPCs) were not substantially elevated. In addition, these two chemicals are most likely being produced in the sediments as by-products of the degradation of organic matter, which is also present at elevated levels. The chemical properties of ammonia and sulfide will be important considerations in evaluating the suitability of various remedial alternatives, including natural recovery. There are unique natural recovery considerations associated with chemicals produced *in situ* (e.g., production rate, relationship to biological oxygen demand [BOD]) that will need to be evaluated in greater detail if either or both of these chemicals are responsible for sediment toxicity in large portions of the Cove. For example, if it is found that total ammonia or total sulfide is the primary cause of toxicity in a specific portion of Ward Cove, the options for treatment, handling, and disposal of the affected sediments may differ from the options suitable for other CoPCs.

The ability of TIE and specialty testing (e.g., ammonia purging methods) to provide information regarding the effect of total ammonia and total sulfide on sediment toxicity will determine the applicability and usefulness of the test results. For example, if ammonia is clearly determined to be the cause of sediment toxicity over a defined area of the Cove, a well-defined strategy to address ammonia toxicity can be developed. Alternatively, if the results are conflicting or weak (e.g., infer that perhaps a portion of the sediment toxicity can be attributed to ammonia), a more general strategy suitable to chemical mixtures will be applied. The Phase I data suggest there may be three characteristic subareas in Ward Cove with different chemical features. As discussed below, the TIE analysis will be applied to each of the areas to address potential differences in chemical composition.

Although TIEs have been used successfully to evaluate effluents and receiving waters, their use with sediment is relatively new and somewhat experimental, especially for marine sediments. Although a considerable amount of recent work has been done in developing TIE procedures for freshwater sediments (e.g., Ankley et al. 1990; Schubauer-Berigan et al. 1995; Frazier et al. 1996; Whiteman et al. 1996), relatively few studies have addressed TIE procedures for estuarine and marine sediments (Ho 1996, pers. comm.; Swartz 1996, pers. comm.; U.S. EPA 1996). Using sediment collected from Ward Cove in May 1997, a preliminary TIE study will be conducted to evaluate the feasibility of using various TIE approaches for definitive testing of Ward Cove sediments to be collected in July. This appendix presents an overview of the planned preliminary and definitive TIE testing. It includes discussions of the areas of Ward Cove that will be evaluated and the specific TIE procedures that will be used to conduct those evaluations. Detailed descriptions of the TIE methods that will be used in both assessments will be prepared as addenda to the field sampling plan (FSP) and will be submitted in the future.

SUBDIVISION OF THE AREA OF FOCUS

For the TIEs, the primary area of focus (AOF) identified in Ward Cove during the Phase I assessment (PTI 1997) will be divided into the following three subareas based on the kinds of CoPCs found to exceed their sediment quality values at various stations:

- **Subarea 1**—Subarea 1 is located downcurrent from the Ketchikan Pulp Company (KPC) facility along the northern shoreline of Ward Cove (Figure F-1). The primary CoPC in this subarea is total ammonia, which was the only CoPC that exceeded its $WCSQV_{(2)}$ ¹ value at Stations 12 and 13 (Figure F-2). A secondary CoPC in this subarea is cadmium, which exceeded its $WCSQV_{(1)}$ value at Stations 12 and 13 (Figure F-3). Other than total ammonia and cadmium, no other CoPC exceeded a sediment quality value in Subarea 1.
- **Subarea 2**—Subarea 2 is located approximately 250–500 m offshore from the KPC facility (Figure F-1). The primary CoPC in this subarea is total sulfide, which was the only CoPC that exceeded its $WCSQV_{(2)}$ value at both Stations 16 and 17 (Figure F-2). BOD exceeded its $WCSQV_{(2)}$ value at Station 16. Secondary CoPCs in this subarea are total organic carbon (TOC), BOD, and chemical oxygen demand (COD), which exceeded their $WCSQV_{(1)}$ values at Station 16 and/or 17 (Figure F-3). Other than the four conventional variables identified above, no other CoPC exceeded a sediment quality value in Subarea 2.

¹ $WCSQV_{(1)}$ is the Ward Cove sediment quality value analogous to sediment quality standard. $WCSQV_{(2)}$ is the Ward Cove sediment quality value analogous to minimum cleanup level.

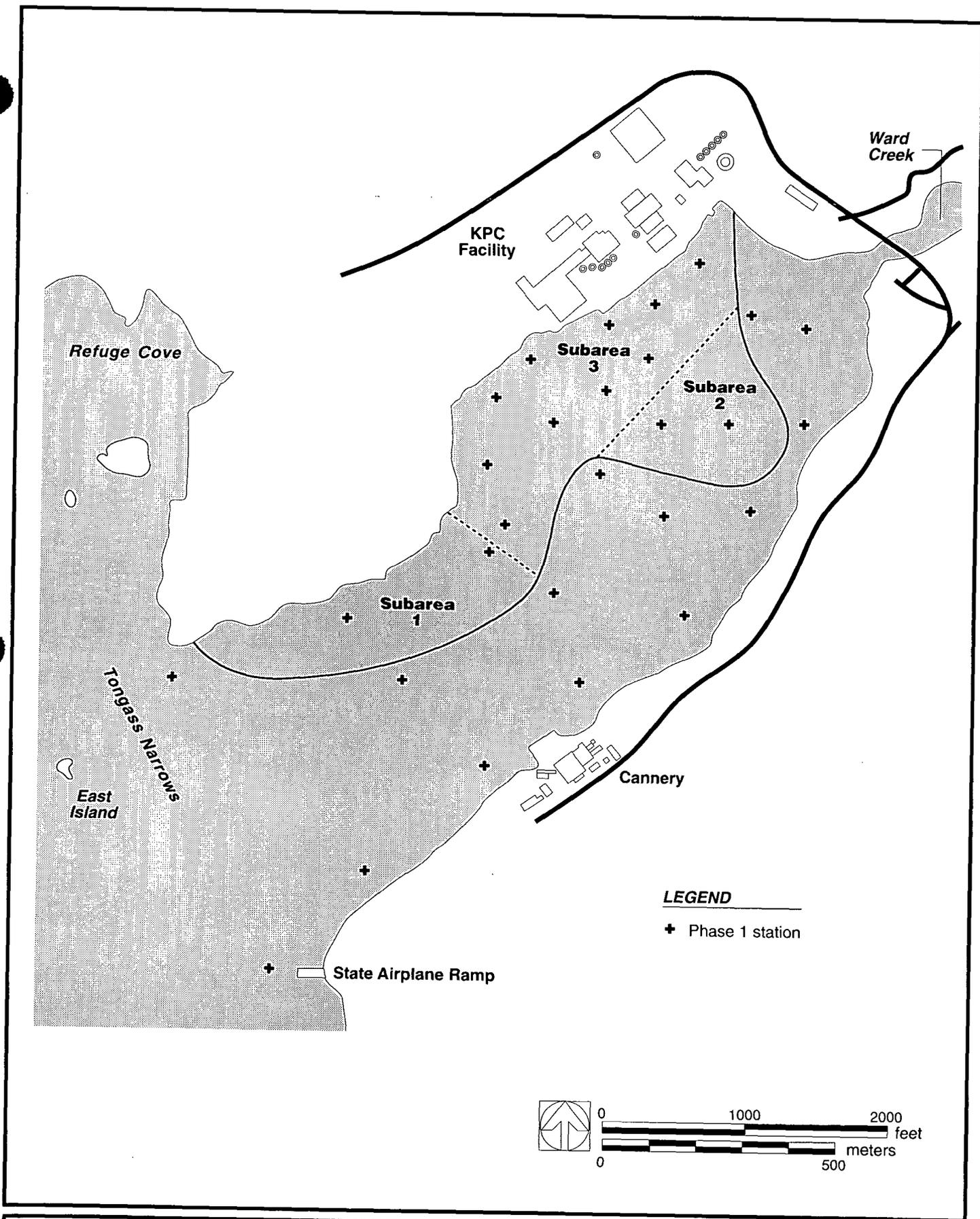
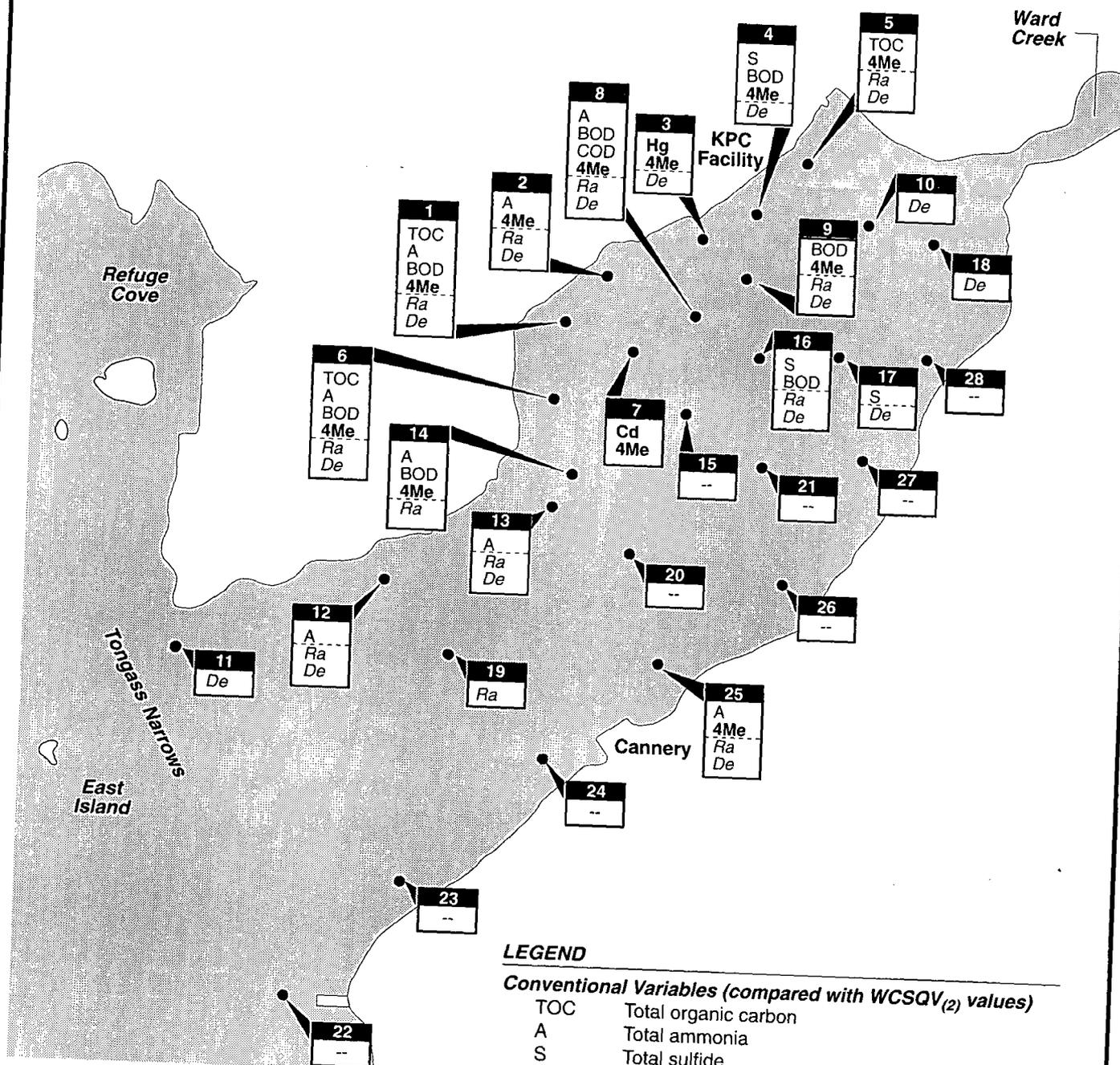


Figure F-1. Subareas of the primary AOF in Ward Cove that will be evaluated in Phase 2 using TIE testing.



Note: Synoptic data were collected at all stations. No exceedances of sediment quality values were found for *Leptocheirus plumulosus* survival and *Neanthes* sp. growth rate.

-- No exceedance of a sediment quality value was found.

LEGEND

Conventional Variables (compared with WCSQV₍₂₎ values)

- TOC Total organic carbon
- A Total ammonia
- S Total sulfide
- BOD Biochemical oxygen demand
- COD Chemical oxygen demand

Metals and Organic Compounds (compared with MCUL values)

- Cd Cadmium
- Hg Total mercury
- 4Me 4-Methylphenol

Sediment Toxicity Tests (compared with MCUL values)

- Ra *Rhepoxynius abronius* survival
- De *Dendraster excentricus* normal survival



Figure F-2. Distribution of exceedances of MCUL and WCSQV₍₂₎ values in Ward Cove in 1996.

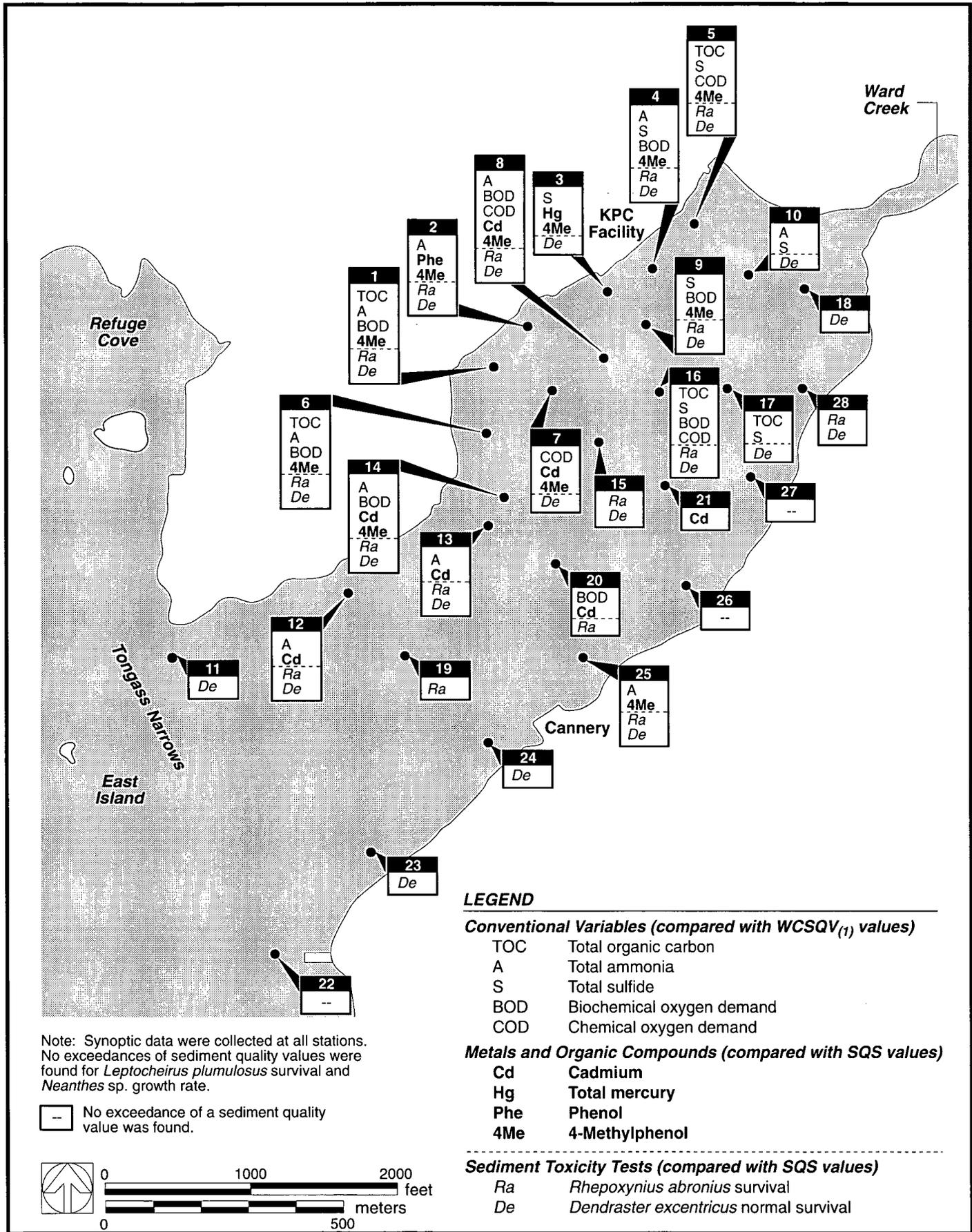


Figure F-3. Distribution of exceedances of SQS and WCSQV₍₁₎ values in Ward Cove in 1996.

- **Subarea 3**—Subarea 3 is located immediately offshore from the KPC facility (Figure F-1). Unlike Subareas 1 and 2, numerous CoPCs exceeded sediment quality values in Subarea 3. Minimum cleanup level (Washington State MCUL) and WCSQV₍₂₎ values were exceeded by cadmium, total mercury, TOC, BOD, COD, total ammonia, total sulfide, and 4-methylphenol at various stations (Figure F-2). All of those CoPCs can be considered primary CoPCs in Subarea 3. In addition, sediment quality standard (Washington State SQS) and WCSQV₍₁₎ values were exceeded for all of the CoPCs identified above, as well as for phenol (Figure F-3). Subarea 3 therefore represents an area affected by complex mixtures of chemicals.

As noted previously, the primary focus of the TIEs will be to evaluate the potential contributions of total ammonia and total sulfide to observed sediment toxicity in Subareas 1–3. Concentrations of both of these conventional variables were elevated in all three subareas. As described above, ammonia is the primary CoPC in Subarea 1, total sulfide is the primary CoPC in Subarea 2, and both of these variables are primary CoPCs in Subarea 3. Although total sulfide did not exceed a sediment quality value in Subarea 1, concentrations of this CoPC were somewhat elevated in Subarea 1 (2,200–4,300 mg/kg), relative to the WCSQV₍₁₎ value of 4,300 mg/kg. In a similar manner, total ammonia did not exceed a sediment quality value in Subarea 2, but concentrations in that subarea (11–81 mg/kg) were somewhat elevated relative to the WCSQV₍₁₎ value of 88 mg/kg. Based on the above patterns, it is clear that total ammonia and total sulfide may have contributed to the observed sediment toxicity in all three subareas.

TIE PROCEDURES

The methods used to evaluate the toxicity of total ammonia and total sulfide will be based on modifications of the TIE procedures used by the U.S. Environmental Protection Agency (EPA) to conduct TIE testing of marine effluents and receiving waters (U.S. EPA 1996). Several of these procedures have been successfully modified for application to marine sediments (Ho et al. 1996, unpublished). In addition, another procedure recommended by U.S. EPA (1994) for evaluating ammonia toxicity as part of dredged material testing (i.e., purging procedure) will be used in the present study. Although the purging procedure has not been specifically identified as a TIE procedure by U.S. EPA (1996), it is identified as a specialty test and will be grouped with the EPA-designated TIE procedures in the present document because it will be conducted in conjunction with the TIE procedures on the same sediment samples from Ward Cove in July and August. Thus, all subsequent references to a TIE study include both TIE and purging procedures.

As noted previously, a preliminary TIE study will be conducted using sediments collected from Ward Cove in May 1997 to evaluate the feasibility of using various TIE approaches for definitive testing of Ward Cove sediments to be collected in July and August. The preliminary testing will be a “dry run” of all the TIE procedures planned for use during

definitive testing in July. The primary objectives of the preliminary testing are to 1) evaluate the feasibility of controlling ammonia and sulfide concentrations in sediment samples from Ward Cove, 2) evaluate the feasibility of applying the TIE procedures to *Rhepoxynius abronius* (a species for which TIE procedures rarely have been used in past studies), and 3) allow the analytical laboratory to gain experience in conducting these procedures.

During the preliminary testing, surface sediment (0–10 cm) from Subareas 1 and 2 will be evaluated. These two subareas will be evaluated during preliminary testing because they represent the two subareas affected primarily by total ammonia and total sulfide, respectively. Because the TIE results from these two areas should not be substantially affected by the presence of CoPCs other than total ammonia and total sulfide, the results will be particularly useful for evaluating the performance of the TIE procedures and the various test species. By contrast, because sediments from Subarea 3 are affected by numerous CoPCs, the TIE results may be more difficult to interpret. Although sediments from Subarea 3 will not be evaluated during preliminary testing, they will be evaluated during definitive testing in July.

The TIE and purging procedures that will be used during preliminary testing are the following:

- **Purging Procedure (whole sediments)**—The purging procedure has been recommended for evaluating whether toxicity is due to elevated concentrations of ammonia in pore water (U.S. EPA 1994). It is applied to toxicity tests conducted on whole sediments, such as the 10-day amphipod test using *Rhepoxynius abronius*. As part of this procedure, the overlying water in each test chamber is aerated to saturation and replaced at a rate of two volumes per day until ammonia concentrations in pore water decline below 20 mg/L. Once ammonia concentrations in pore water reach the target level, the test organisms are introduced to the test chambers and the tests are initiated. During the 10-day exposure period, pore-water ammonia concentrations are monitored regularly and if they exceed 20 mg/L, exchange of the overlying water is initiated at a rate of two volumes per day. Results from the purged samples are compared with results for unpurged samples to evaluate the toxicity contribution of ammonia.
- **Aeration Procedure (pore water)**—The aeration procedure has been recommended for evaluating whether toxicity is due to elevated concentrations of volatile organic substances such as sulfide or volatile hydrocarbons in pore water (U.S. EPA 1996). Because concentrations of volatile substances are relatively low in Ward Cove, this procedure can be used to focus on the potential effects of sulfide in Ward Cove sediments.

The aeration procedure is applied to toxicity tests conducted on pore water that is extracted from sediment samples by centrifugation (e.g., at 5,000 g for 30 minutes). As part of this procedure, 10- to 20-mL aliquots of pore water are placed in small test chambers and aerated. Test organisms are then added to the chambers for an exposure period of 72–96 hours. Results from the aerated samples are compared with results for unaerated samples to evaluate the toxicity contribution of volatile substances.

- ***Ulva lactuca* Procedure (pore water and whole sediments)**—The *Ulva lactuca* procedure has been recommended for evaluating whether toxicity is due to elevated concentrations of ammonia in pore water (U.S. EPA 1996; Ho et al. 1996, unpublished) and whole sediments (Ho et al. 1996, unpublished). As part of this procedure, the marine macrophyte *U. lactuca* (commonly called sea lettuce) is used to remove ammonia from the pore water because this species has the ability to take up, store, and utilize large amounts of ammonia. For example, it has historically been used to clean ammonia-rich effluents in aquaculture systems. This procedure can be complicated by the ability of *Ulva* to efficiently take up nonionic contaminants in addition to ammonia (Ho et al. 1996, unpublished). However, because the concentrations of nonionic contaminants such as polycyclic aromatic hydrocarbon (PAH) compounds are relatively low in Ward Cove, this procedure can be used to focus on the potential effects of ammonia in Ward Cove sediments.

For pore-water evaluations, pore water is extracted from sediments by centrifugation (e.g., at 5,000 g for 30 minutes). Small amounts of *Ulva* are then added to 10- to 20-mL aliquots of pore water in small test chambers, and the chambers are aerated gently for 5 hours. After 5 hours, the *Ulva* is removed, and the test organisms are added to the test chambers for exposure periods of 72–96 hours. Results from the treated samples are compared with results for untreated samples to evaluate the toxicity contribution of ammonia.

For whole-sediment evaluations, approximately 20 g of sediment is added to the test chambers, the chambers are filled with 60 mL of overlying water, and 5 g of *Ulva* is added to the chambers for 24 hours. After 24 hours, the *Ulva* is removed from the test chambers, and the test organisms are added to the chambers for periods of 72–96 hours. Results from the treated samples are compared to results for untreated samples to evaluate the toxicity contribution of ammonia.

The test species for the preliminary testing (and the rationale for their inclusion) are the following:

- *Rhepoxynius abronius*—This amphipod species will be evaluated primarily because it is known to be sensitive to sediment toxicity in Ward Cove (Jones & Stokes and Kinnetic 1989; EVS 1992; ENSR 1994, 1995; PTI 1997) and has exhibited a strong negative association with concentrations of total ammonia in Cove sediments, as well as in the overlying water of toxicity test chambers containing Ward Cove sediments (PTI 1997). The only drawback to using this species is that it has rarely been used in TIE testing. The adult life stage will be used for the TIE testing of Ward Cove sediments.
- *Ampelisca abdita*—This amphipod species will be evaluated primarily because it has been used in previous TIE testing and its responses to the various kinds of TIE manipulations are known (U.S. EPA 1996). Although *A. abdita* is found primarily on the east coast of the United States, it occurs on parts of the west coast (e.g., central California), and it is one of the amphipod species recommended for evaluating compliance with the Washington State Sediment Management Standards (Ecology 1995). The adult life stage will be used for the TIE testing of Ward Cove sediments.
- *Dendraster excentricus*—This echinoderm species will be evaluated primarily because it is known to be sensitive to sediment toxicity in Ward Cove (PTI 1997) and it has been used in previous TIE testing (U.S. EPA 1996). The embryonic life stage will be used for the TIE testing of Ward Cove sediments. However, because this life stage is planktonic, this species cannot be used for the purging procedure if purging is required after test initiation.

The details of the definitive testing in July will be determined after the results of the preliminary testing have been evaluated. It is anticipated that the definitive testing will include the following major components:

- **Station Locations**—One or two discrete stations will be sampled from each of the three subareas of the primary AOF in Ward Cove. Using information collected during the Phase 1 investigation, stations will be located in areas known to have significant sediment toxicity combined with elevated concentrations of total ammonia and/or total sulfide. To be representative of Subareas 1 and 2, sampling stations will likely be located in both the inner and outer parts of each subarea to represent the range of total ammonia and total sulfide concentrations found in each subarea. Because of the complexity of contamination in Subarea 3 and because the highest concentrations of most CoPCs are located

closer to the shoreline, the sampling station(s) in Subarea 3 will be located near the outer margin of the subarea where total ammonia and/or total sulfide may contribute to a larger portion of the observed sediment toxicity than near the shoreline. Sediments from discrete stations (rather than composited sediments of multiple stations) will likely be evaluated during definitive testing so that the TIE results can be related directly to the sediment chemistry and sediment toxicity results that are based on discrete stations in both Phase 1 and Phase 2. Based primarily on the distribution CoPCs determined in the Phase 1 investigation, six candidate stations can be identified for potential TIE testing in Phase 2 (Figure F-4). They include Stations 12 and 44 in Subarea 1, Stations 16 and 17 in Subarea 2, and Stations 7 and 34 in Subarea 3. The final selection of Phase 2 TIE stations will be made in the addenda to this FSP, which will be submitted to EPA after results of the preliminary TIE testing have been evaluated. All Phase 2 CoPCs and toxicity tests will be conducted at the final TIE stations, regardless of whether those stations were sampled originally in Phase 1.

- **Sediment Horizon**—To be consistent with the toxicity evaluations of surface sediments conducted in Phases 1 and 2, TIE testing will be conducted on samples from the top 10 cm of the sediment column.
- **TIE Procedures**—The TIE procedures used for definitive testing will be the same as those used for preliminary testing, unless modifications are warranted based on results of the preliminary testing.
- **Test Species**—The test species for definitive testing will be the same as those used for preliminary testing, unless modifications are warranted based on results of the preliminary testing. For example, if both amphipod species respond to the TIE procedures in a similar manner and thereby generate redundant information, *Rhepoxynius abronius* will likely be the only species used for definitive testing.

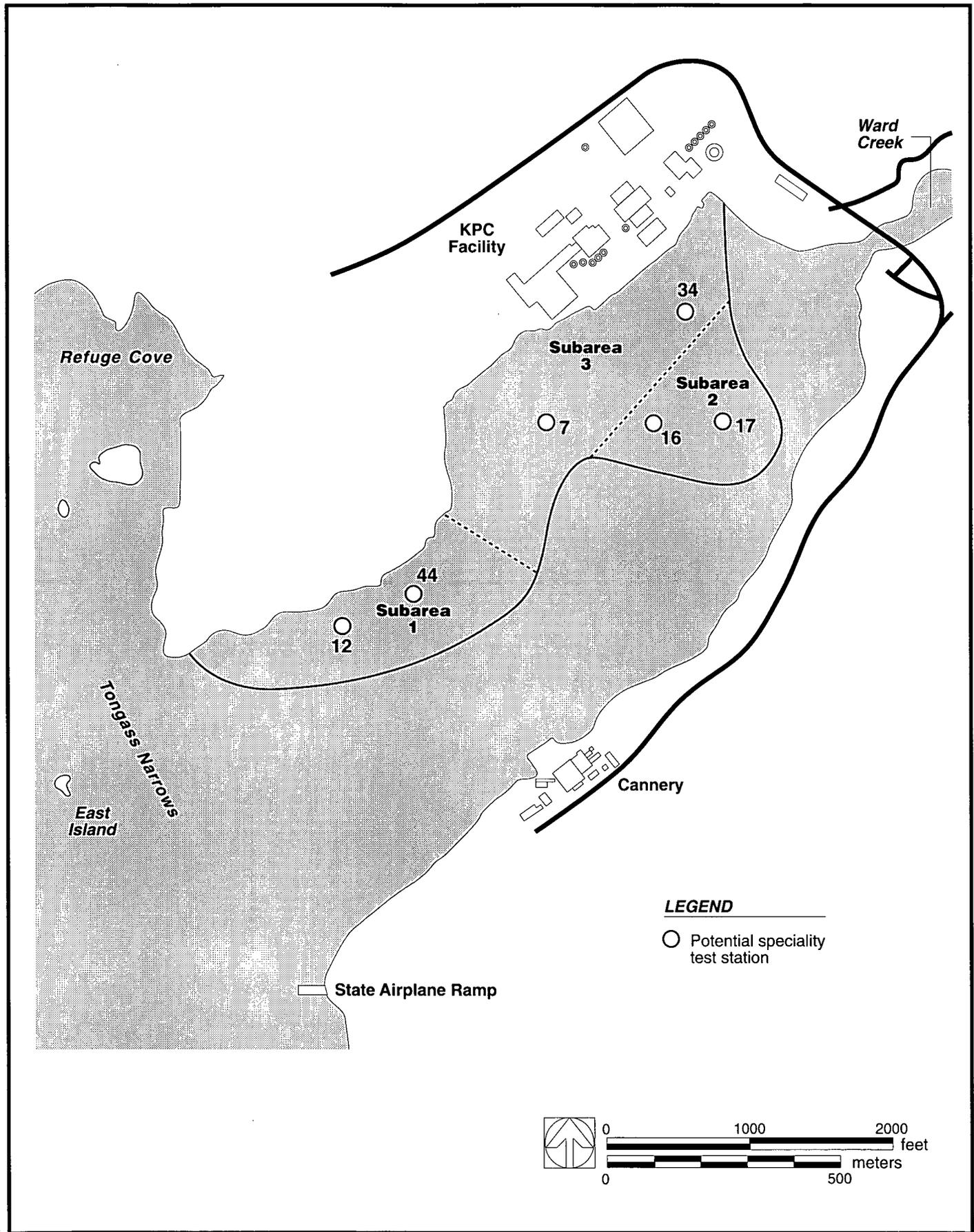


Figure F-4. Potential station locations in Ward Cove that may be evaluated in Phase 2 using TIE testing.

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