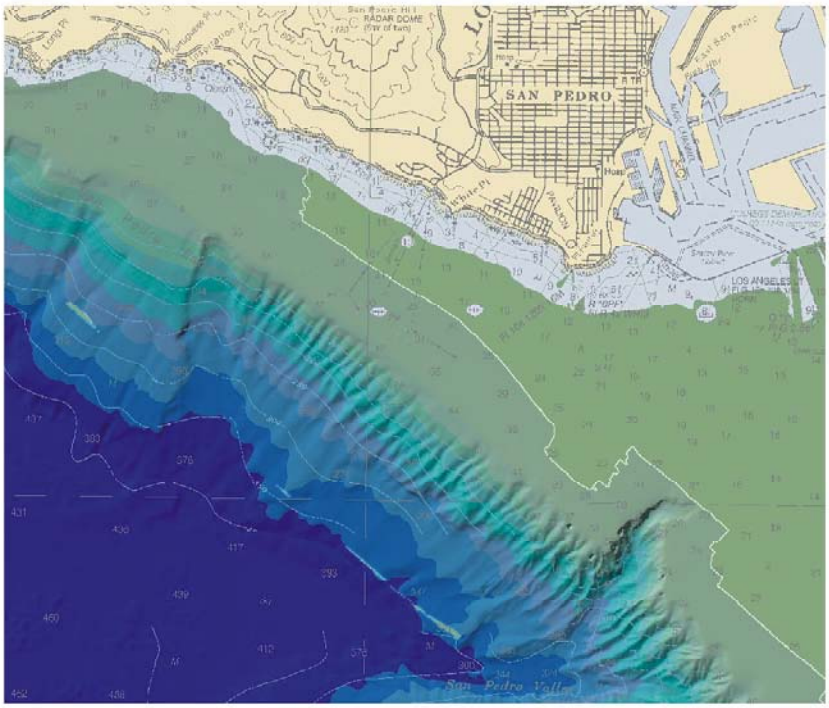
Project Work Plan
for the
Palos Verdes Pilot Capping Project:
Baseline Monitoring Activities



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Revision 03

February 2001

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SAIC Report Number 486

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Project Work Plan Approvals

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Vance S. Fong, EPA Project QA Officer	Date
Ellie Nevarez, Corps of Engineers Project Manager	Date
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OVERVIEW

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA), Region IX is currently evaluating alternatives for restoration of contaminated sediments on the Palos Verdes (PV) Shelf off the coast of Los Angeles, California. One restoration alternative under consideration is *in-situ* capping, which involves placement of a covering or cap of clean material over contaminated sediment, thereby isolating the contaminated material. EPA is collaborating with the U.S. Army Corps of Engineers (USACE) to conduct a Pre-Design Data Collection and Studies related to the capping alternative.

This Project Work Plan addresses the baseline monitoring portion of the pilot capping project. Tasks associated with monitoring during subsequent phases of the project will be described in supplements to this document. The following sections provide a brief site description, site history, project overview, project objectives, organization and responsibilities, and Project Work Plan overview.

2.0 SITE DESCRIPTION

The PV Shelf is located within the Southern California Bight (an area of the coastal Pacific Ocean between Point Conception, California and Cape Colnett, Baja California), offshore from Point Fermin to Point Vicente on the PV peninsula (Figure 2-1. The Palos Verdes Shelf contains contaminated sediments that are present on the continental shelf and continental slope. The continental shelf in this region is narrow, with a width of 1.5 to 4 kilometers (km) and a bottom slope of 1 to 4 degrees. A shelf break (i.e., a zone of transition from the relatively flat shelf to the steeper slope) occurs at water depths of 70 to 100 meters (m). The continental slope extends seaward from the shelf, with a width of approximately 3 km and a mean slope of 13 degrees (Lee, 1994a), to a depth of approximately 800 m.

In general, the PV Shelf region is characterized by (1) hard-bottom habitat from shore to at least 20 m deep; (2) soft-bottom habitat over most of the remainder of the shelf and slope region to at least 600 m depth; and (3) pelagic or water column zones. The exception to this pattern is the hard-substrate, artificial reef habitat represented by the Joint Water Pollution Control Plant (JWPCP) outfall pipes that extend primarily over soft bottom to approximately 60 m depth, some scattered hard-bottom areas on the shelf, and more extensive hard-bottom areas along parts of the shelf break. General oceanographic, geological, and biological conditions, and distributions of effluent-affected (EA) sediments, on the PV Shelf and slope are described briefly in the following sections.

2.1 Physical Oceanographic and Geological Conditions

Dominant circulation patterns in the Southern California Bight include the southward-flowing California Current, the northward-flowing California Countercurrent, and seasonal influences by the northward-trending Davidson Countercurrent (Drake et al. 1994; Hickey, 1992). Surface and bottom waters are typically separated in spring through fall by a pycnocline (a zone having strong vertical gradients in seawater density) occurring at depths of 10 to 30 m. Currents below the pycnocline on the shelf generally flow to the northwest, parallel to bathymetric contours. In contrast, surface currents flow predominantly southeastward, although they shift to a westerly flow in late autumn and winter when westerly winds weaken (Hickey, 1992).

Currents in the vicinity of the JWPCP outfalls vary seasonally as a result of changes in wind patterns and periodic storms, typically in winter or early spring. Average current velocities near the bottom are 7-10 centimeters per second (cm/sec) throughout the year (LACSD, 1995). Storm waves generated during winter typically have maximum heights of 3 to 4 m, although wave heights up to 7 m were observed during major storms occurring in the 1980s (LACSD, 1995).

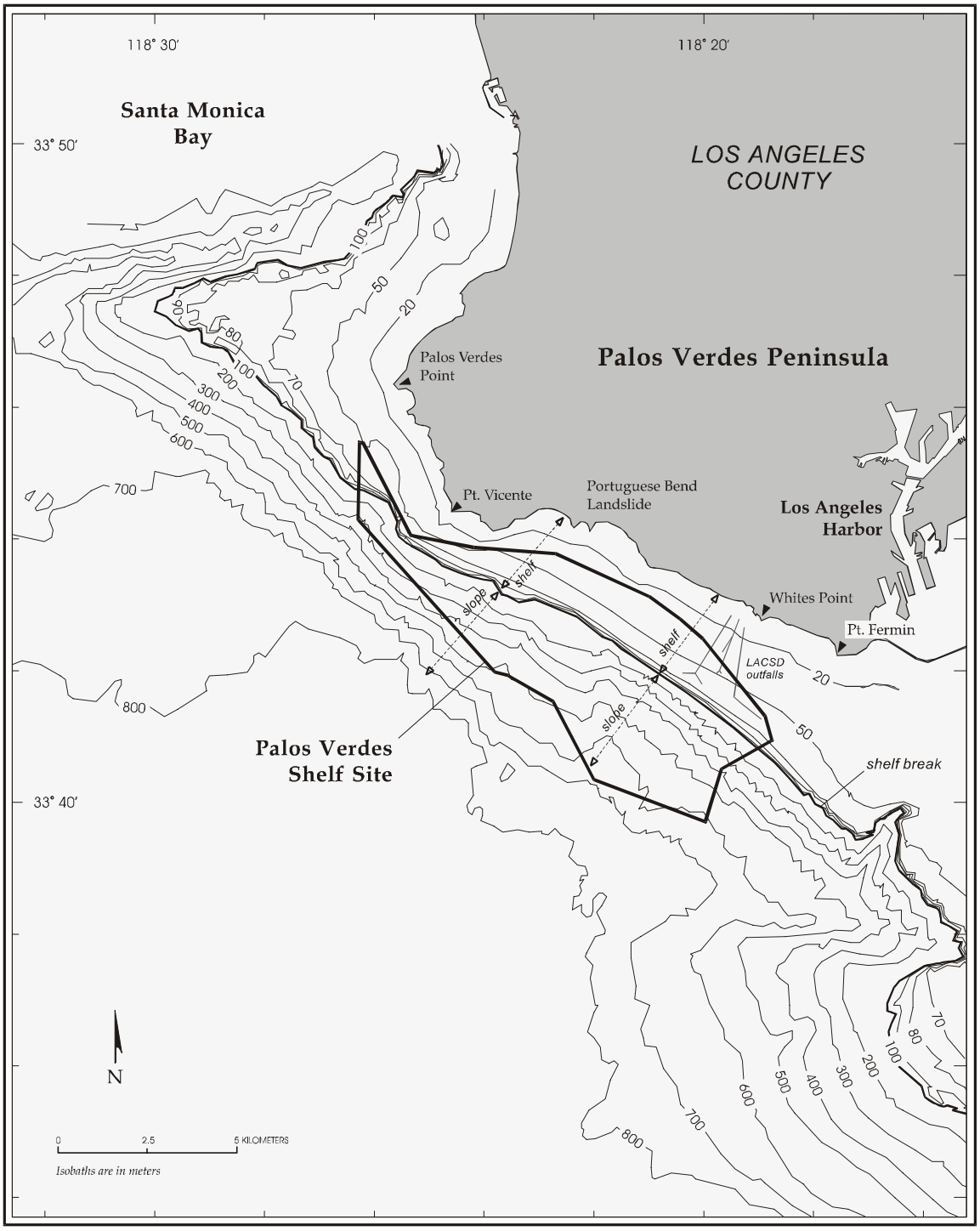

Figure 2-1. Palos Verdes Shelf Site Map

Sediment transport follows the predominant direction of the near-bottom flow, extending northwestward along the shelf (Drake et al. 1994). This is also reflected in the alongshore shape of the EA sediment deposit and resulting contaminant "footprint", extending away from the JWPCP outfalls.

The Portuguese Bend landslide and the JWPCP effluent discharge have dominated the recent supply of solids to the PV Shelf. Since 1988, the rate of erosion from the Portuguese Bend landslide has decreased as a result of stabilization projects, which reduced movement to about 10 percent of former rates. Redondo Canyon and San Pedro Canyon bound the PV Shelf to the northwest and southeast, respectively, and limit sediment transported from adjacent shelf areas. Los Angeles-Long Beach Harbor and its breakwater obstruct nearshore sediment transport (Drake et al. 1994).

The thickness of naturally occurring shelf sediments varies, ranging from 32 m on the southeastern part of the shelf to less than 10 m near Pt. Vicente. As a result of near-bottom currents, a patchy, thin sediment layer with areas of bare rock occurs at the shelf break (Palermo, 1994). Similar bedrock outcrops also occur over the seafloor to the east of the outfall and over the Redondo Shelf to the west (Lee, 1994a). Less than one meter of sediment covers the Redondo Shelf (Drake et al. 1994).

2.2 Biological Environment

Diverse marine habitats and biological communities typify the PV Shelf and slope and the broader Southern California Bight region.

<u>Soft-Bottom Subtidal Habitats</u>

Soft-bottom habitats grading from sand to mud typify the majority of the sea bottom deeper than approximately 20 m off Palos Verdes. Key inhabitants include infaunal and epifaunal invertebrates, both of which live in close association with the sediments and typically are resident (especially infauna) in discrete areas as adults. Numerous bottom-feeding fish also are characteristic of these habitats, but typically are much more motile than the invertebrates. Some fish species migrate over a broad depth range.

Infaunal Community - The infaunal community (invertebrates living in soft sediments) on the shelf and slope is dominated by deposit feeders, primarily polychaete worms and small bivalves, but includes the full range of feeding types, including particle/suspension feeders and predators, representing numerous phyla (LACSD, 1995). This community represents an important food source for many fish species and other invertebrates.

Based on results from surveys conducted by the Los Angeles County Sanitation District (LACSD, 1995), the greatest number of individuals occurs in the outfall area (>10,000 individuals per square meter (individuals/m^2)), although the number of organisms is also high (>7,500 individuals/m^2) at locations off Point Vicente, Long Point, and Portuguese Bend at depths ranging from 30 to 152 m. Fewer individuals (<2,500 individuals/m^2) occur in the deeper (i.e., 305 m) areas of the slope. Biomass is enhanced near and offshore of the outfall as a result of discharges of organic material. In general, the number of taxa and diversity are highest on the shelf and lowest on the slope. Diversity is also lower northwest of the outfall, in the general area of highest chemical contamination, although temporal trends have shown an increase in diversity in this area.

Epifaunal Invertebrate Community - Spatial patterns in the epifaunal community are primarily related to depth, sediment type, and effects from the wastewater discharge (Stull, 1995). Analysis of southern California trawl data from 1971 to 1984 classified the Palos Verdes samples as having a unique low diversity assemblage. In the 1980s, the unique assemblage declined and was replaced by an assemblage that was more typical of shelf assemblages in other areas of the Southern California Bight (Stull, 1995). The distribution and diversity of the epibenthic macroinvertebrates have increased since the 1970s. Some of the changes may be attributed to improved habitat quality, although other environmental variables such as El Niño events have had significant effects on these populations (Stull, 1995).

Fish Community - Trawl catches of fish on the PV Shelf have varied greatly over time. Conditions which may have influenced these changes include variations in water temperature, El Niño events, advection of water masses having varied physical and chemical characteristics, upwelling of deep waters onto the shelf, kelp coverage, food availability, habitat variability, and contaminants from the outfall (LACSD, 1995).

Nearshore Hard-Bottom Habitats

Hard-bottom habitats in the PV region exist primarily in the region from shore to approximately 20-m depth, although scattered outcrops and reefs also occur in some deeper shelf areas. Within these habitats the most diverse communities, including numerous epifaunal invertebrates, fish, and plant (algae and surfgrass) species, are associated with kelp beds. These communities are generally at shallower water depths than the principal areas of chemically contaminated sediment on the PV Shelf.

Kelp Community - The giant kelp (*Macrocystis pyrifera*) is a keystone species that provides refuge and a source of food for many fish and invertebrate species, although the extent of kelp beds has been extremely variable over time. In 1911, kelp canopy coverage near Palos Verdes was estimated to be over 1,500 acres (LACSD, 1995). By the late 1950s, giant kelp had disappeared from Palos Verdes rocky subtidal areas

attributed, in part, to wastewater discharges that introduced toxicants, buried the substrate, and reduced water clarity (Stull, 1995). Transplantation efforts helped to re-establish kelp in the vicinity of the PV peninsula, although the kelp beds suffered severe damage during winter storms in 1983 and 1988. Kelp beds near Palos Verdes were estimated at 1,124 acres in 1989, but declined to 300 acres in 1993. This may have been due to El Niño events and overgrazing by sea urchins (LACSD, 1995). In addition, the Portuguese Bend landslide also contributed to increased sedimentation and turbidity, which continued to impact some kelp bed populations (LACSD, 1995; Stull, 1995).

Pelagic Habitats

The pelagic environment, which includes the water column from near the bottom to the sea surface, provides habitat for many species of plankton, invertebrates, fish, seabirds, and marine mammals.

2.3 Distribution of EA Sediments

The JWPCP outfalls discharge treated municipal and industrial wastewater at a depth of approximately 60 m on the PV Shelf, offshore from Whites Point. Effluent-affected (EA) sediments in the area of the outfalls and those transported away from Whites Point by ocean currents and deposited on the ocean floor serve as the main repository for contaminants. Contaminated sediments on the shelf are characterized by two layers: an EA deposit covering "clean" native sediments that were present prior to the start of sewage discharges from JWPCP ocean outfalls. The EA sediments are comprised of a surface layer of more recently deposited and moderately contaminated materials covering a buried layer of highly contaminated materials that were deposited prior to 1980.

The spatial distributions of 1,1,1-trichloro-2,2-bis (p-chlorophenyl) ethane (DDT), DDT metabolites, and polychlorinated biphenyl (PCB) concentrations and contaminant masses in shelf and slope sediments were evaluated extensively as part of the Trustees' site investigation for the NRDA (Lee, 1994a,b). The EA sediment deposit is characterized by a lower density and finer grain size than the native sediment. It ranges in thickness from 5 centimeters (cm) to greater than 60 cm, and is underlain by firmer native shelf sediments. The total volume of the EA deposit is over 9 million cubic meters, with approximately 70 percent of this volume lying on the shelf and the remainder on the slope. Virtually all of the deposit is contaminated with DDT (and its metabolites) and PCBs. Sediments containing total DDT concentrations greater than 1 mg/kg (part-per-million; ppm) in the region of the Palos Verdes Shelf cover a seafloor surface area of approximately 42 square kilometers. The areas of the shelf and slope with surficial (top 0 to 4 cm) sediment concentrations of p,p'-DDE, the primary DDT metabolite, exceeding 5 ppm and 10 ppm are approximately 12 km^2 and 3 km^2, respectively.

The highest DDT concentrations in surface sediments occur near the JWPCP outfall, and then decrease with increasing distance from the outfall (Figure 2-2. Concentrations decrease rapidly from the outfall in northeasterly and southeasterly directions, whereas horizontal changes to the northwest of the outfall, in the direction of predominant current flow, are relatively smaller. Sediments from nearshore locations in water depths less than approximately 30 meters generally contain DDT concentrations below 1 mg/kg. Spatial and vertical distributions of PCB are generally similar to those for DDT, although the magnitude of the total PCB concentrations is consistently lower than that of DDT. Maximum total DDT and PCB concentrations in the buried layer exceed 200 mg/kg and 40 mg/kg, respectively. On the shelf, these peak concentrations occur at depths of 30-40 cm in the sediment, while on the slope they are much closer to the sediment surface. Concentrations in the surface layer on the shelf are relatively lower than the peak concentrations but still significantly elevated compared to other locations within the Southern California Bight. This vertical distribution of contaminant concentrations generally reflects the history of effluent deposition, with some post-depositional alterations due to physical and biological mixing.

Results from studies conducted as part of the LACSD compliance monitoring program, the Trustees' NRDA investigation, and other regional and site-specific programs have provided considerable evidence for biological uptake and accumulation of DDT and PCB in the vicinity of the PV Shelf. In particular, studies by Young et al. (1989) and Schiff and Allen (1997) demonstrated that lipid-normalized concentrations of DDT and PCB in tissues of a flatfish from the PV Shelf were directly proportional to the respective organic carbon (OC)-normalized concentrations in shelf sediments, suggesting a benthic coupling for contaminant transfer to biota (Spies, 1984). Concentrations of DDT in whole fish collected during 1997 from the PV Shelf were up to three orders of magnitude higher than in fish from other parts of the Bight (Allen et al., 1999). Fish collected during the 1980s and 1990s from the PV Shelf contained concentrations of DDT and PCB that were up to severalfold higher than the respective Food and Drug Administration (FDA) action and tolerance levels. DDT and PCB concentrations in some species also exceed guidelines issued by Office of Environmental Health Hazard Assessment (OEHHA) for human consumption of seafood.

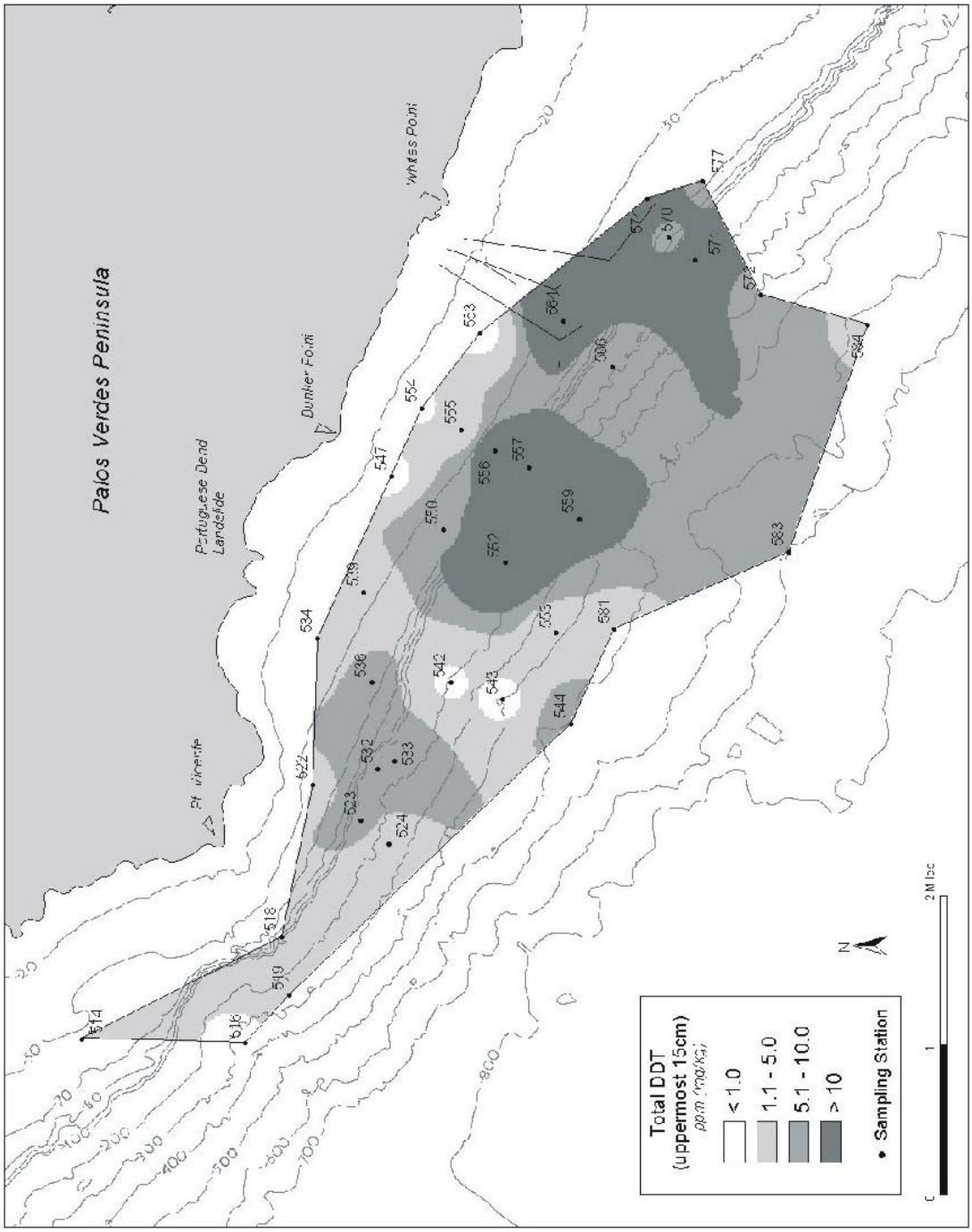

Figure 2-2. Total DDT footprint based on USGS measurements (concentrations averaged over the uppermost 15 cm).

3.0 SITE HISTORY

LACSD initiated wastewater discharges in 1937 at depths of 30 to 45 m from an outfall at Whites Point. Wastewater from the JWPCP was later discharged through submarine outfalls located approximately 3 km offshore from Whites Point to a water depth of 63 m (Drake et al. 1994). The JWPCP outfalls have discharged approximately 4 million tons of suspended solids since 1937, 50 percent of which was discharged from 1964 and 1976. Starting in 1947, Montrose Chemical Corporation produced DDT at a manufacturing plant in Los Angeles County. Wastes from the manufacturing process, containing DDT residues, were discharged to the JWPCP until 1971, and a large amount of the DDT was subsequently released with the effluent from the JWPCP to the ocean. Similarly, PCBs were discharged to the municipal sewage system from several sources within the Los Angeles area and subsequently released to the marine environment with wastewater from the sewage treatment plant. Peak annual mass emissions of effluent solids (167,000 metric tons), DDT (21.1 metric tons), and PCB (5.2 metric tons) occurred in 1971. Subsequent improvements to treatment processes and better source control, along with cessation of these discharge practices by Montrose Chemical Corporation and others, reduced the mass emissions and supply of organochlorines to the marine environment (Eganhouse and Venkatesan, 1993). DDT discharges declined to 0.03 tons per year in 1985 (Drake et al. 1994). By 1995, the solids mass emission was less than one fifth of that discharged in 1971, and trace contaminant discharges were a few percent of 1971 values (Stull, 1995). The heavily contaminated sediment in the area of the outfalls has been gradually buried by less contaminated effluent and natural sediment.

As of 1992, the site contained an estimated 100 metric tons of DDT and 10 metric tons of PCB (Lee, 1994a). These mass estimates are lower than those calculated previously based on sampling conducted during the 1980s. This suggests that contaminant concentrations and masses are decreasing with time, although accurate determinations of these changes are difficult to make given the high spatial variability in contaminant distributions. Additionally, rates of change over time in concentrations of DDT in surface sediments have been smaller than reductions in mass emission rates from the JWPCP. This also implies that contaminants in historically deposited sediments are being remobilized and contribute to concentrations in the more recently deposited materials.

4.0 PROJECT OVERVIEW

USACE (Palermo et al., 1999) evaluated *in-situ* capping alternatives at the Palos Verdes site for EPA. The evaluation included prioritizing areas of the PV Shelf to be capped, determining appropriate cap designs, developing an equipment selection and operations plan for placement of the cap, developing a monitoring plan to ensure successful cap placement and long term cap effectiveness, and developing preliminary cost estimates.

USACE (Palermo et al., 1999) considered two primary capping alternatives: (1) placement of a thin cap (design thickness of 15 cm) that would reduce potentials for biological remobilization of sediment contaminants by shallow-burrowing benthic organisms, as well as reduce contaminant concentrations in surficial sediments and contaminant flux into overlying waters; and (2) placement of an isolation cap (design thickness of 45 cm) which would be of sufficient thickness to effectively isolate contaminated sediments from the majority of benthic organisms, reduce contaminant bioaccumulation, and effectively prevent contaminant flux for the long term within those areas of the site covered by a cap. The area considered for capping lies on the shelf between the 40- and 70-m depth contours (this area was defined as two separate capping prisms: prism A centered over the “hot spot”, and prism B located northwest of the “hot spot"). Cap placement on the slope was considered infeasible due increased potential for flow failure under seismic loading. Capping operations would be undertaken in an incremental fashion, until the total selected area was capped. Since the area that could be capped is large (on the order of several square kilometers), cap placement cells measuring 300 m by 600 m were defined for purposes of managing the placement of material and monitoring.

EPA Region IX recently entered into an interagency agreement with the USACE, Los Angeles District (LAD) to provide technical support for the implementation of a pilot study for cap placement. The pilot study will consist of controlled operations for placement of capping material within four pilot capping cells on the PV Shelf and associated monitoring prior to, during, and following the placements. The pilot study will include tasks related to pre-design data collection and studies. Operational aspects for the pilot include selection of appropriate placement areas, capping materials, and placement techniques. The associated monitoring program for the pilot study is designed to evaluate the following: areal extent and thickness of the cap; mixing of cap and contaminated sediments; resuspension of contaminated sediments during cap placement; short term cap benthic recolonization of the cap; and short term physical and chemical characteristics of the cap and underlying sediments immediately after capping and following initial sediment consolidation.

Palermo et al. (2000) developed an Operations and Monitoring Plan for the Pilot Cap Study to be conducted in Summer of 2000. Fredette (2000) developed a companion document that specifies monitoring

activities that will be conducted during the Pilot Cap Study in Summer 2000. These two documents present a technical approach/design that was developed by EPA and LAD, following the work of Palermo et al. (1999). The reader should refer to these documents for justification of the sampling design and analytical techniques addressed in this Project Work Plan.

5.0 PROJECT OBJECTIVES

The overall objective of the field pilot study is to demonstrate that a cap can be placed on the shelf as intended by the design, and to obtain field data on the short-term processes and behavior of the cap as placed.

Specific objectives addressed by the pilot capping project include (Palermo 2000):

- Demonstrate that an appropriate cap thickness can be placed with an acceptable level of variability in cap thickness.
- Demonstrate that excessive resuspension of existing sediments and excessive mixing of cap and contaminated sediments can be avoided.
- Demonstrate that excessive losses of cap materials can be avoided.
- Determine, to the degree possible, the effect of variable cap material type, bottom slope, water depth, and placement method (e.g., conventional versus spreading) on cap thickness and sediment displacement and resuspension.
- Demonstrate the effectiveness of the cap with respect to short-term isolation of contaminants during the initial phase of sediment consolidation.
- Demonstrate the ability to monitor cap placement operations.
- Evaluate and modify, where needed, all operational and monitoring approaches.
- Improve the knowledge-base contributing to decisions on implementation of a full-scale cap.

The general objectives of the baseline monitoring task, described in this version of the Project Work Plan, are to characterize the existing physical and chemical conditions within the four proposed pilot capping cells. These objectives are described in greater detail in the Data Quality Objectives of this Project Work Plan.

Construction of the pilot cap is anticipated to occur over a period of several weeks to months, and the associated monitoring effort is designed to address short term processes. The pilot study would therefore meet several objectives related to capping operations and processes occurring during and shortly after cap placement. Site monitoring will involve characterizing the cap material and evaluating conditions on the seafloor and in the water column prior to, during, and following cap placement operations (defined as baseline, interim, and post cap monitoring, respectively). A full-scale monitoring program, which would be conducted during construction of a full-scale cap on the PV Shelf and in the years to follow, would additionally include activities aimed at long-term processes not easily observed during the relatively short time period available for the pilot study. This could include, for example, erosion during storm events or migration of contaminants due to diffusive processes.

6.0 ORGANIZATION AND RESPONSIBILITIES

Science Applications International Corporation (SAIC) will support USACE LAD and EPA with oceanographic monitoring and data compilation for the pilot capping project. The team organization for the pilot study baseline monitoring is illustrated in Figure 6-1. Dr. Scott McDowell, based in Newport, RI, will serve as SAIC's Project Manager. In this role, he will serve as the main SAIC point-of-contact with LAD and affiliated agencies (e.g., EPA Region IX, WES, et al.) and he will have ultimate responsibility for the timeliness and technical quality of all SAIC project deliverables. Dr. McDowell will provide managerial and technical oversight of the project and direct the activities of the SAIC team. He also will be responsible for SAIC's budget, scheduling and contractual issues. Assisting him with these latter functions will be Ms. Mary Magee (Project Administrator) and Ms. Christine Lepore (Contract Officer), who are both based in Newport, RI.

The baseline monitoring effort is logistically complex because it involves sampling using four different techniques (sediment-profile imaging, sub-bottom profiling, side-scan sonar, sediment coring), as well as sample analyses and data reduction within a short time period. Mr. John Evans, based in San Diego, will serve as SAIC's Logistics Coordinator. Mr. Evans is well-suited for this role because he is based locally, experienced with all sampling techniques, and familiar with the sampling requirements and local logistical resources. As Logistics Coordinator, Mr. Evans will assist the Project Manager in locating and hiring suitable survey vessels, locating suitable shoreside support facilities, scheduling and staffing of surveys, and shipping and tracking of discrete samples.

SAIC's Project Team also includes a QA/QC Officer and Project Safety Officer. Dr. Ted Turk will serve as the QA/QC Officer. In this role, he will prepare and update, as necessary, the Quality Assurance Project Plan, interact with the Project Manager and Team Leaders to develop quality assurance requirements and procedures, monitor strict adherence to the QA requirements and procedures, conduct technical audits as necessary, organize and oversee reviews of program deliverables, and report to the Project Manager on adherence to the QAPP. Dr. Turk holds a Ph.D. in marine ecology and has over 20 years of experience in conducting a wide range of marine environmental studies, including contaminated sediment investigations, RI/FS, and baseline ecological and human health risk assessments. He managed environmental investigations for a proposed full secondary ocean outfall from the City of Los Angeles' Hyperion Treatment Plant, and several RI/FS and baseline risk assessments for contaminated sediment sites in Puget Sound and Wisconsin. Dr. Turk is familiar with all of the QA/QC requirements entailed in the proposed program, and will not be directly involved in data collection and analysis for the baseline monitoring program.

Mr. John Nakayama is the Project Health and Safety Officer for the baseline monitoring. The Project Health and Safety Officer will be responsible for ensuring that the requirements of the Health and Safety Plan are rigorously followed by all SAIC field personnel and subcontractors, and that all necessary personal protective equipment, health and safety training, and supplies are available to the field team. In addition, the Safety Officer will ensure that subcontractors are both informed of the applicable provisions of SAIC's Health and Safety Plan and have a health and safety program to protect their employees and those of SAIC. The responsibilities of the Project Safety Officer are described in detail in the Health and Safety Plan.

SAIC's project organization identifies Team Leaders for each of the major logistical/technical areas, including sediment cores, sediment profile imaging, side-scan sonar, subbottom profiling, and data management. Each of these technical areas is further broken down into the logical components of field sampling, and sample/data analysis and reporting. Task leaders are responsible for assisting Dr. McDowell with coordination of sampling, sample analyses (as appropriate), data management, and reporting for each of the task (sampling technique) areas. Additionally, task leaders are responsible for tracking progress of the individual elements, and reporting the status, as well as any problems and corrective actions, to Dr. McDowell.

The baseline monitoring program will also utilize subcontractor laboratories for geotechnical and chemical analyses of sediment samples that will be extracted from sediment cores. Chemical analyses of sediment core samples will be performed by Woods Hole Group (Falmouth, MA). Helder Costa will be the laboratory coordinator. Geotechnical analyses of sediment core samples will be performed by Applied Marine Sciences (League City,TX). Ken Davis will be the laboratory coordinator.

As mentioned, SAIC’s role is to provide technical support to USACE and EPA on specific tasks as requested by USACE. Overall program management will be performed by USACE, and final decisions regarding study design, program objectives, and analyses and interpretations of the data collected for the baseline monitoring program will be performed by USACE. Additionally, quality assurance oversight, including document review and approval, external audits of contractors, and reviews and assessments of project data and data quality, will be performed by USACE.

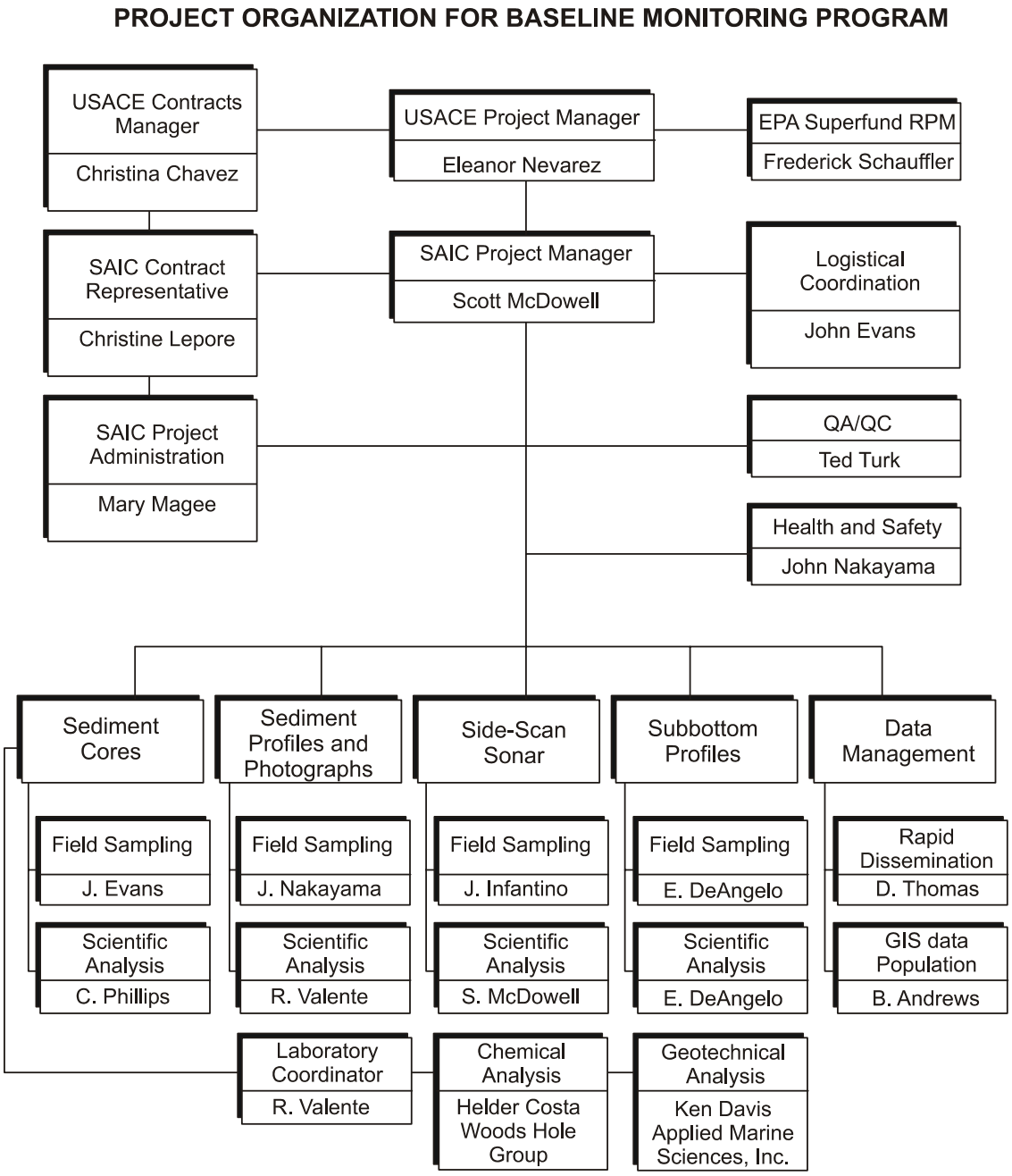

Figure 6-1. SAIC Organization Chart for the Pilot Study Baseline Monitoring.

7.0 PROJECT WORK PLAN OVERVIEW

This Project Work Plan is comprised of the following sections: Data Quality Objectives, Field Sampling Plan, Quality Assurance Project Plan, and Health and Safety Plan. The Project Work Plan presently addresses only the baseline monitoring portion of the pilot capping project. It is anticipated that a separate, stand-alone document will be prepared to address the monitoring techniques and analytical procedures that will be used during the interim and post-capping activities of the Pilot Cap Project in Summer of 2000.

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Project Work Plan
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DATA QUALITY OBJECTIVES

Prepared for:

U.S. Army Corps of Engineers
Los Angeles District
Environmental Construction Branch

U.S. Environmental Protection Agency
Region IX
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February 2001

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1.0 INTRODUCTION

Data Quality Objectives (DQOs) are qualitative and quantitative statements that clarify the study objectives, define the most appropriate type of data to collect, determine the most appropriate conditions under which to collect data, and specify acceptable levels of decision errors that are used to establish the quantity and quality of data needed for decision-making (US EPA, 1994).

The overall objectives of the Palos Verdes Pilot Capping Project are presented in the Overview section of this Project Work Plan. The monitoring will include baseline, interim and post-cap phases or increments. One basic objective of the baseline phase of the monitoring is to characterize existing conditions in selected areas of the EA deposit in order to evaluate future changes resulting from cap placement. Although the EA deposit has been characterized through extensive previous sampling (e.g., Lee, 1994), the baseline monitoring effort is necessary to establish conditions in four proposed cap placement cells immediately prior to the pilot capping operation (Palermo et al., 1999). The locations of the four proposed cells are shown in Figure 1-1.

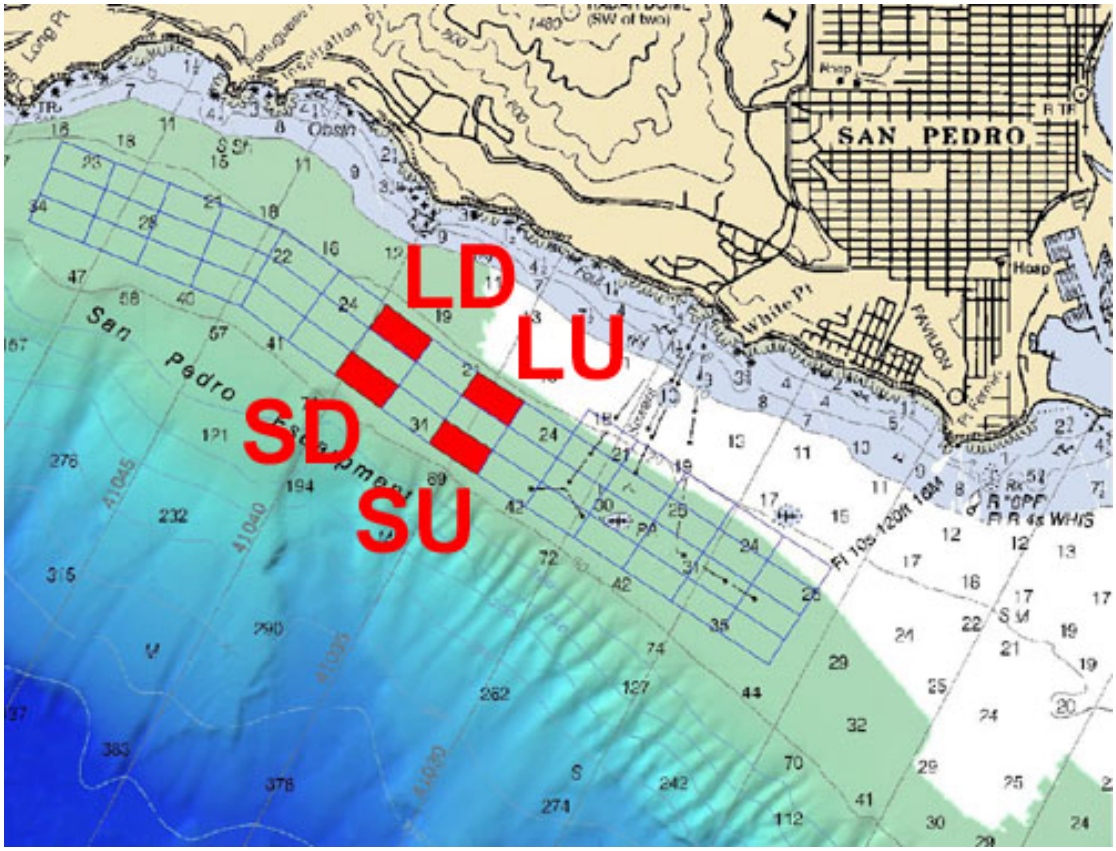

Figure 1-1. Map of the Palos Verdes shelf showing the locations of the four proposed cap placement cells.

The pilot study will involve placing cap material under carefully controlled conditions in each of the four placement cells. A second basic objective of the baseline monitoring is to provide information that will be used to determine the suitability of these proposed placement cells and finalize their locations prior to commencing the capping operations. The rationale for the number of pilot cells required for the pilot study and the location of these cells on the PV Shelf is provided in Palermo et al. (1999) and Palermo (2000). Palermo (2000) identified the following as desirable features of the pilot placement areas:

- To the extent possible, placement locations for the pilot should be representative of the overall range of conditions within the total capping prism for a potential full scale remediation.
- Physical bottom material type in the pilot placement areas should be clearly distinguishable from capping material.
- The thickness of EA sediment in the pilot placement areas should be sufficient to measure the degree of mixing of cap and contaminated sediment and the effects of advection due to consolidation. Sufficient thickness is defined as greater than 10 cm.
- The level of surficial EA sediment contamination (upper few cm) for the pilot placement areas should be sufficiently elevated to allow water column measurements of contaminants (DDT and/or PCBs) for evaluating resuspension and transport. Sufficiently elevated has been defined by the USACE (Palermo 2000) as concentrations of contaminants (DDE) in excess of 10 mg/kg.

Each of these represents a "problem statement" useful for formulating monitoring objectives (Table 1-1). The monitoring objectives are in turn useful for formulating DQOs for each of the four sampling techniques to be employed in the baseline monitoring (Table 1-1). It is important to note that the objectives of the baseline monitoring are largely qualitative in nature, involving physical, chemical and biological characterization of surface and subsurface sediments in the four placement cells prior to pilot capping activities. The DQOs presented below reflect the qualitative nature of the baseline monitoring objectives.

Interpretations of data collected for the baseline program, comparisons with results from past studies, and evaluations of monitoring objectives will be performed by USACE. Further, USACE in consultation with EPA will determine what actions would be taken in the event that the USACE concludes that the pilot placement areas do not possess the desired chemical and physical features summarized in Table 1-1.

Table 1-1. Baseline Monitoring Objectives and Techniques.

Problem Statement	**Monitoring Objective**	**Monitoring Technique(s)**
Placement locations should be representative of the overall range of conditions within the total potential capping prism for a possible full scale remediation.	Determine physical and biological characteristics of sediments in the proposed placements cells.	1) Sediment profile imaging 2) Sub-bottom profiling 3) Side-scan sonar 4) Coring for sediment chemical and physical parameters
Physical bottom material type in the pilot placement areas should be clearly distinguishable from capping material.	Determine physical and biological characteristics of sediments in the proposed placement cells with sufficient accuracy to permit distinctions between ambient sediments and capping material.	1) Sediment profile imaging 2) Sub-bottom profiling 3) Coring 4) Side-scan sonar
Thickness of EA sediment in the pilot placement areas should be sufficient (defined as ≥ 10 cm) to potentially measure the degree of mixing of cap and contaminated sediment and the effects of advection due to consolidation.	Confirm that the thickness of EA sediments, defined as concentration of p,p'-DDE exceeding 1 mg/kg dry wt., exceeds 10 cm in the proposed placement cells.	1) Sediment profile imaging 2) Sub-bottom profiling 3) Coring
The level of surficial EA sediment contamination by p,p'-DDE (upper few cm) for the pilot placement areas should be sufficiently elevated (i.e., >10 mg/kg) to allow water column measurements of this contaminant for evaluating resuspension and transport.	Determine concentrations of p,p'-DDE in the sediments of the proposed placement cells.	1) Coring

2.0 DQOs FOR BASELINE SEDIMENT PROFILE IMAGING AND PLAN VIEW PHOTOGRAPHY

Sediment profile imaging is a benthic sampling technique in which a specialized camera is used to obtain vertical cross-section photographs (profiles) of the upper 15 to 20 cm of the seafloor. This is a reconnaissance survey technique used for rapid collection, interpretation and mapping of data on physical and biological seafloor characteristics. This technique has been used in estuarine, coastal and deep-sea environments worldwide for almost 20 years. Measurements obtained from sediment-profile images are used to characterize surface sediment types and layering, evaluate benthic habitat quality, map disturbance gradients, and follow ecosystem recovery after disturbance abatement. This technique is commonly referred to as sediment-profile imaging (SPI) or sediment vertical profile sampling (SVPS).

Typical parameters measured from sediment-profile images include sediment grain size, depth of the apparent redox potential discontinuity (RPD, a measure of oxygen penetration into the bottom), thickness of dredged material or other depositional layers, benthic infaunal successional stage, and presence/absence of methane gas bubbles. A summary metric called the Organism-Sediment Index (OSI) is calculated for each image and is used to numerically score benthic habitat quality.

Plan view (i.e., horizontal plane) photographs of approximately 0.3 m^2 of the seafloor surface will be obtained in conjunction with the sediment profile images. The plan view photographs are acquired with a downward-looking camera and strobe light system attached to the sediment profile camera frame. The photographs are taken immediately prior to landing of the frame on the bottom, providing an undisturbed record of the sediments before penetration of the sediment profile camera prism. A plan view photograph typically is obtained for each sediment profile image acquired.

The plan view image analysis consists of qualitative descriptions of key sediment characteristics (e.g., sediment type, bedforms and biological features) based on careful scrutiny of the projected 35-mm slides. Biological features (e.g., shells, shell debris, tubes, and burrow openings) and, where possible, the epifaunal or infaunal organisms themselves, are identified and enumerated. Additional details on field and laboratory methods for REMOTS® sediment-profile imaging and sediment plan view photography are provided in the Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP).

These photographic techniques will be used to address several of the baseline objectives, as summarized in Table 2-1 and discussed below.

Table 2-1. DQOs for Baseline Sediment Profile and Planview Imaging

Monitoring Objective	Data Requirements	Monitoring Approach	Field Decision Criteria/ Performance Specifications
Determine physical and biological sediment characteristics in each of the four pilot placement cells.	Full suite of measurement parameters: Grain size major mode RPD depth Thickness of depositional layers Infaunal successional stage Organism-Sediment Index Presence of epifauna Planview surface features	Collect sediment-profile images/planview images at each of 25 sampling stations located in each of the four pilot placement areas. Sampling is to occur immediately prior to (within one week) the pilot capping operations.	Navigational accuracy should be ±1 to 3 m. Three replicate images suitable for analysis must be collected at each station (100% completeness goal).
Determine physical and biological characteristics of sediments in the proposed placement cells with sufficient accuracy to permit distinctions between ambient sediments and cap material (dependent also on characteristics of cap material) .	Physical: Sediment grain size Sediment color Sediment fabric RPD depth Biological: Infaunal successional stage	Same as above.	Sediment grain size, color, fabric and RPD should be clearly distinguishable in each image. Agreement between sediment-profile image and sediment coring grain size results should be 90% or greater.
Confirm that the thickness of EA sediments exceeds 10 cm in the proposed placement cells.	Thickness of EA sediment layer in each image. Overall average EA sediment layer thickness for all images.	Same as above.	Measure EA sediment layer thickness in each image to the nearest 1 cm.

During interim and post-capping phases of the monitoring program, sediment-profile/plan view imaging will be used on the Palos Verdes pilot capping project to monitor the thickness of cap material, examine any mixing of cap material and underlying contaminated sediments, and evaluate recolonization of the cap material by benthic organisms.

One of the objectives of the baseline sediment profile/plan view imaging surveys is to determine the physical and biological characteristics of the existing surface sediments in each of the four pilot placement cells. This baseline characterization is necessary to assess the present conditions of the placement cells and to provide a basis for evaluating subsequent changes expected through time as a result of cap material placement. Evaluations of the representativeness of the four cells relative to the EA footprint, based on analyses and interpretations of the sediment profile imaging and plan view camera results, will be performed by USACE. Although sediment profile/planview imaging surveys of the wider area have not been conducted previously, there are several measurements obtained from the images that can be compared to sediment grain size and infauna/epifauna data collected by other studies.

The bases for these comparisons, and adequacy of other data sources used for these comparisons, would be developed by USACE.

To address the first objective, both sediment profile and plan view photographs will be obtained at 25 stations in each of the 4 pilot placement cells. The stations will be arranged in a cross-shaped pattern centered within each of the rectangular placement cells (Figure 2-1). Stations also are located outside the cell boundaries to allow detection of the anticipated spread of cap material on the bottom. Station spacing outside the cell is relatively greater than that inside the cell. Stations outside the cell are placed in a radial array relative to the center of the cell to facilitate detection of the anticipated spread of cap material on the bottom. The rationale for the station spacing is provided in Palermo (2000) and Fredette (2000).

Three sediment profile and plan view images will be obtained at each station. Primary DQOs for this sampling effort relate to navigational accuracy and sampling completeness. To meet the objectives of characterizing present conditions as a basis for comparisons with changes following capping, sampling must occur with a high degree of positional accuracy. As described in the FSP, a differential GPS system will be used for vessel navigation during all surveys. The accuracy of this system is on the order of ±1 to 3 m.

> **Data Quality Objective**: Vessel positioning accuracy for the baseline and all subsequent sediment profile imaging surveys should be ±1 to 3 m.

To meet the objective of fully characterizing sediment conditions within each placement cell, it is important that a complete set of images is obtained.

> **Data Quality Objective**: Three replicate sediment profile and corresponding plan view images should be collected at 100% of the baseline monitoring stations and analyzed for the full suite of measurement parameters to characterize existing physical and biological sediment conditions.

SAIC's sediment profile imaging field procedures and associated QA/QC are designed to ensure that the 100% completeness goal is met. These procedures are described in detail in the FSP and QAPP. Briefly, back-up camera systems and a complete inventory of spare parts will be available to avoid loss of data due to mechanical or electronic equipment malfunction. The film will be developed and reviewed immediately following the completion of each day's field work. This will serve to identify any images that were missed due to over- or under-penetration of the sediment profile camera prism at a given station. This same-day developing and review of the images will allow stations to be re-occupied on the following field day and the missed images obtained. The sediment profile camera penetration can be adjusted by adding weights, lowering the "stops" or adding "snow shoes" to allow successful image acquisition.

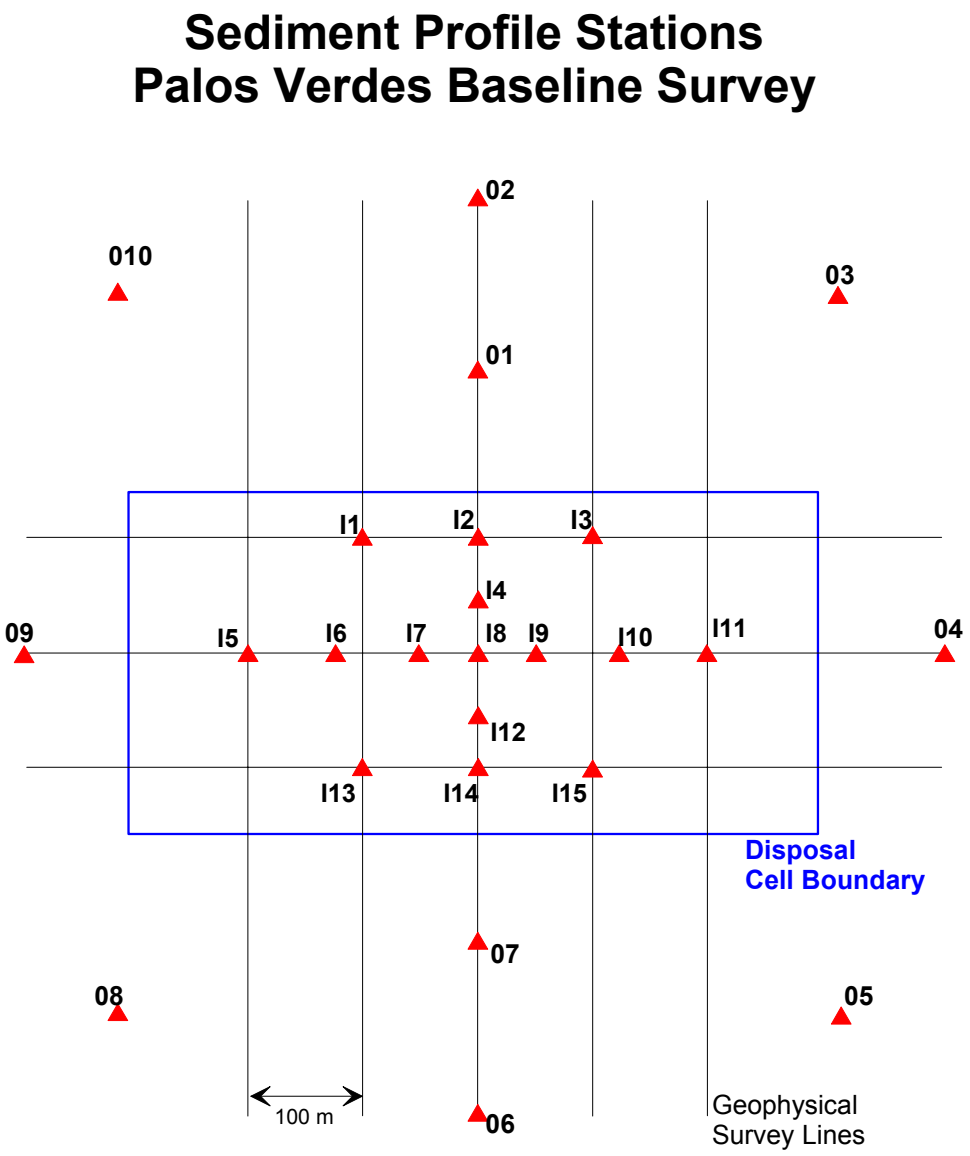

Figure 2-1. Schematic representation of the distribution of sediment profile imaging stations that will be occupied in each of the four experimental capping cells.

A second monitoring objective is to characterize the physical conditions of bottom materials in each pilot placement area with sufficient accuracy and sensitivity to distinguish existing sediments from the capping material following cap placement (Table 2-1). The physical characteristics which are likely to be key discriminators include grain size, color, fabric and depth of the RPD. If the capping material is different from the existing EA sediments in any of these physical parameters (for example, has a slightly different color or differs from the EA sediment by at least one grain size class (phi) interval), then it is expected that the sediment profile images will have sufficient resolution to detect such differences. As noted in Table 2-1, this objective is also dependent on the characteristics of the capping materials. Analyses and characteristics of the capping materials are not addressed in the baseline monitoring program.

Detailed methods for determining grain size and apparent RPD depth in sediment profile images are presented in the FSP and QAPP. Briefly, the sediment grain size major mode and range are estimated visually from the photographs by overlaying a grain size comparator which is at the same scale. Grain size major mode is expressed in phi units representing Udden-Wentworth size classes (equal to or less than coarse silt up to granule and larger sizes). The lower limit of optical resolution of the photographic system is about 62 microns (4 phi), allowing recognition of grain sizes equal to or greater than coarse silt.

The major modal grain size assigned to each sediment profile image is the dominant grain size as estimated by area within the imaged sediment column. In images that show layering of different grain sizes (e.g., sand over mud), the determination of dominant major mode depends on how much area of the photograph is represented by one versus the other. These textural assignments may or may not correspond to traditional sieve analyses depending on how closely the vertical sampling intervals are matched between the core sample and the depth of the imaged sediment.

In the PV Shelf pilot study, core samples will be obtained from a subset of the baseline sampling stations, subsampled into 4 cm increments, and analyzed for grain size by traditional sieve analysis (described below). This provides an opportunity to "ground-truth" the sediment profile imaging grain size results, with the following objective:

> **Data Quality Objective**: For the determination of sediment grain size major mode, the sediment profile imaging results should agree with the core subsampling results at 90% or more of the stations where both sets of results are obtained.

It is expected that the grain size major mode determined by visual examination of the sediment profile images will closely match the more-definitive sieve analysis of the sediment comprising the upper 15 to 20 cm of each core. Achieving this DQO will serve to verify the ability of sediment profile imaging to accurately detect gradations in grain size useful for distinguishing between the existing ambient sediments and the cap material.

Sediment color and fabric (e.g., degree of sorting, consolidation state) are additional physical properties that may be of potential use in distinguishing between ambient sediments and cap material. Through the use of color film, subtle differences in these parameters can be detected and used as distinguishing factors. Furthermore, in marine sediments, a distinct color change is typically associated with the change in redox state between aerobic, near-surface sediments and underlying anaerobic sediments. The boundary between the lighter colored surface sediments and darker underlying sediments is measured in sediment profile images as the apparent RPD. When sediments are capped, the light-colored, aerobic surface sediments above the RPD can persist for several months as a distinct sediment horizon at depth. This horizon can serve as a benchmark against which to measure the thickness of the depositional cap layer. Therefore, the presence/absence and depth of the RPD in each pilot placement area is another measurement of potential use in distinguishing ambient sediments from cap material (Table 2-1).

RPD depths in a given area can vary over time scales of weeks to months in response to a number of factors (e.g., organic loading rate, near-bottom dissolved oxygen levels, degree and depth of bioturbation). If the baseline sediment profile imaging surveys were to occur too far in advance of the capping operations, natural temporal changes in the RPD might go undetected and interfere with use of this measurement as a "benchmark". To avoid this problem, the baseline sediment profile imaging surveys will occur within one week of the pilot capping operations.

A final objective of the baseline monitoring is to confirm that the thickness of effluent-affected (EA) sediments in each of the four pilot placement cells is at least 10 cm. Past investigations have demonstrated that the thickness of the EA deposit in many areas is likely to be greater than the maximum imaging depth of the sediment profile camera (20 cm). In such cases, the sediment profile camera will at best be capable of providing a minimum estimate of the deposit thickness (e.g., > 20 cm). Other survey techniques, mainly sub-bottom profiling, will be of greater use in determining the true maximum thickness of the deposit and the spatial variation in this thickness. However, if there are distinct layers of EA sediments less than 20 cm thick, they potentially will be detected in the sediment profile images and measured:

> **Data Quality Objective**: If distinct EA sediment layers are visible in the sediment profile images, their thickness should be measured to the nearest 1 cm. Average EA sediment layer thickness at each station will be calculated and compared to the minimum 10 cm objective.

The computer image analysis system used for sediment profile images is capable of making linear measurements of depositional layer thickness with a precision of 1 cm or less. Where such layers occur at each sampling station, they will be described and measured.

3.0 DQOs FOR BASELINE SUB-BOTTOM PROFILING

Sub-bottom seismic profiling is a standard technique for determining boundaries between sedimentary layers of different acoustic impedance. In a sub-bottom profiling survey, the vessel is directed over the seafloor along consecutive lanes or transects, in a manner similar to that used for bathymetric surveys. Acoustic signals are sent to the seafloor and received back on a continuous basis. Sediments having different geotechnical characteristics (i.e., bulk density) will have different acoustic impedances, and therefore sound will reflect from the boundary between layers of sediment having different densities. The depth of sound penetration and the degree of vertical resolution are dependent on the frequency and pulse width of the seismic signal, and the characteristics of the penetrated material.

Details on field and analysis methods for sub-bottom profiling are provided in the FSP and QAPP. Overall, sub-bottom profiling will be used on the Palos Verdes pilot capping project initially to determine the thickness of the EA deposit and later to provide a measure of cap material thickness. The baseline monitoring objectives for sub-bottom profiling are summarized in Table 3-1 and discussed below.

One objective of the baseline sub-bottom monitoring is to determine the physical characteristics of the existing surface sediments in each of the four pilot placement cells. The basline sub-bottom profiling results also will provide a benchmark against which future expected changes resulting from cap material placement can be evaluated. The second baseline objective represents a refinement of this goal: the sediment physical characteristics need to be determined with sufficient resolution to facilitate distinguishing between ambient sediments and cap material in the future (Table 3-1). Sufficient resolution for sub-bottom profiling is defined as the ability to detect a minor difference in the density of the capping material versus the underlying EA sediment.

To address the first two objectives listed in Table 3-1, sub-bottom profile data will be collected continuously along a series of 8 transects encompassing each of the pilot placement cells and their surroundings (Figure 3-1). The survey transects are evenly spaced 100 m apart to provide uniform spatial coverage of the area. Rationale for this transect spacing is provided in Palermo (2000) and Fredette (2000). Three transects are positioned horizontal to each rectangular pilot placement cell; these are intersected by five vertical transects (Figure 3-1). The points of intersection all occur within the rectangular boundaries of the placement cells and coincide with stations where both cores and sediment profile images will be obtained.

Table 3-1. DQOs for Baseline Sub-bottom Profiling

Monitoring Objective	Data Requirements	Monitoring Approach	Field Decision Criteria/Performance Specifications
Determine physical characteristics of sediments in the proposed placement cells.	Acoustic signature Thickness of EA sediment depositional layer(s) above native sediments. Presence of sub-layers	Collect continuous sub-bottom profiling records along a series of 8 intersecting survey transects in each of the four pilot placement areas.	Navigational accuracy should be ±1 to 3 m. Completeness goal is 100% (obtain continuous sub-bottom records from all survey lanes). At points where survey transects intersect, measurements of layer thickness should agree within ±20 cm. Coring and sub-bottom results should agree within ±20 cm.
Determine physical characteristics of sediments in the proposed placement cells with sufficient accuracy to permit distinctions between ambient sediments and cap material.	Same as above.	Same as above.	Same as above.
Confirm that the thickness of EA sediments exceeds 10 cm in the proposed placement cells.	Same as above.	Same as above.	Measure EA sediment layer thickness with a resolution of ±20 cm.

Continuous sub-bottom records will be obtained along each survey transect. A comparison of the results obtained along each transect will provide an indication of the degree of variability in sub-bottom characteristics within and surrounding each pilot placement cell. As with sediment profile imaging, one of the DQOs for sub-bottom profiling relates to the positioning accuracy of the survey vessel.

> **Data Quality Objective**: Vessel positioning accuracy for the baseline and all subsequent subbottom profiling surveys should be ±1 to 3 m.

As previously indicated, this DQO will be addressed through the use of a differential GPS navigation system for all survey work. Details on the use of this system are provided in the FSP.

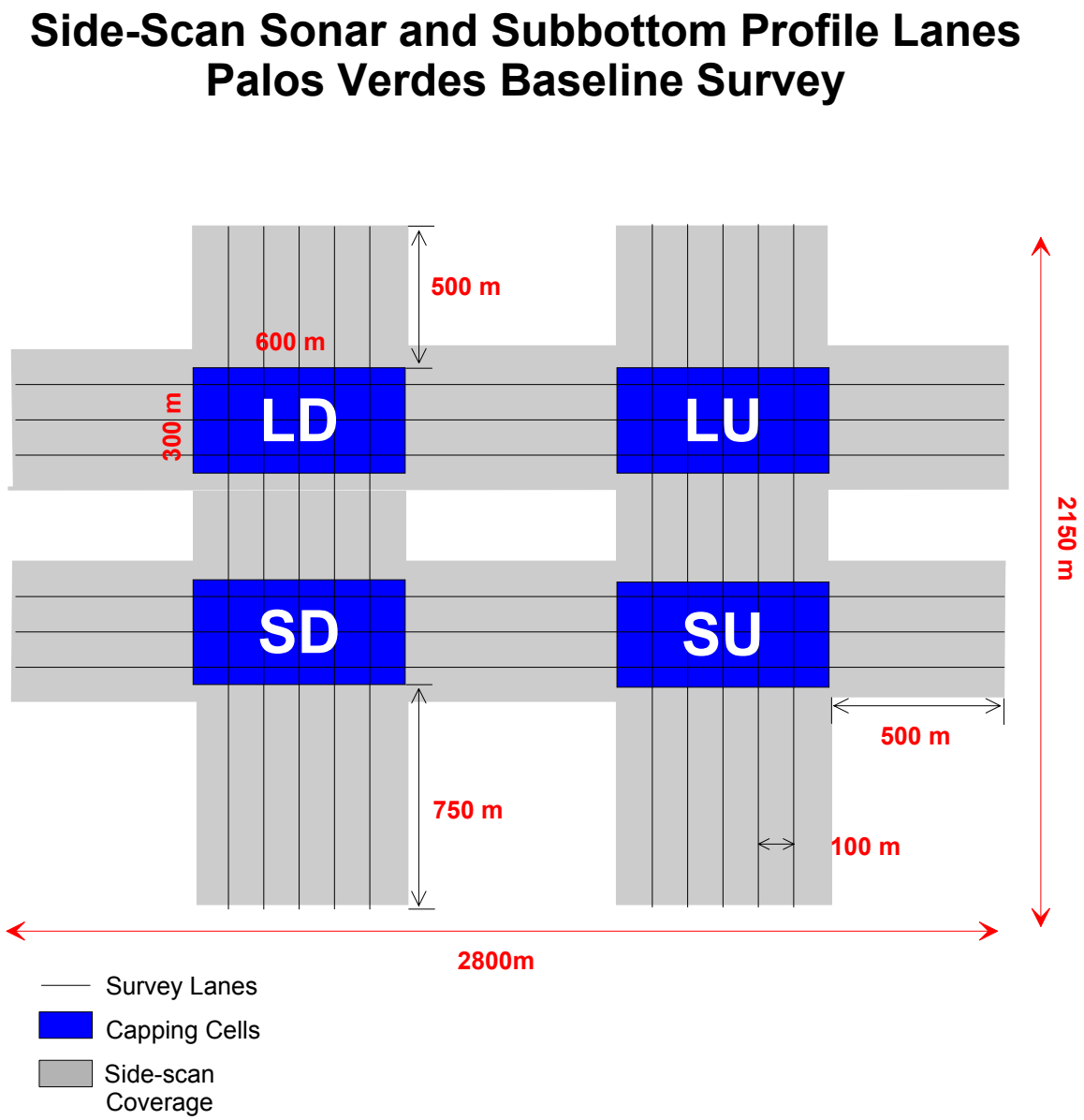

Figure 3-1. Schematic representation of survey lanes and nominal side-scan sonar coverage over four capping cells for the pilot cap study.

Another DQO for this sampling effort relates to completeness. To meet the objective of characterizing sediment conditions (including the degree of spatial variability) within and around each placement cell, it is important that a complete sub-bottom record is obtained along each of the 8 survey transects.

> **Data Quality Objective**: Continuous sub-bottom records should be obtained at 100% of the baseline monitoring survey lanes to fully characterize physical sediment conditions and any variability in sub-bottom profiles within each placement cell.

SAIC's procedures for ensuring that the 100% completeness goal is met are described in detail in the FSP and QAPP. One of the advantages of the intersecting survey transects is that "duplicate" sub-bottom profile records will be obtained at the points of intersection. This duplication provides a means to check on the precision (repeatability) and degree of resolution of the survey method. It is expected that there will be high degree of agreement between results for the two different survey transects at each point of intersection. Specifically, both records should show the same features (i.e., sub-bottom reflectors) are present, and there should be reasonable agreement in the measured thickness of these layers. The resolution of the sub-bottom technique in the study area (water depths ranging from 40 to 70 m) is expected to be on the order of ±20 cm. The degree of agreement between "replicate" measurements cannot be expected to be any better than this minimum resolution. Therefore, the following DQO is established:

> **Data Quality Objective**: At the intersection points of the sub-bottom survey lanes, the two records should show the same number and pattern of sub-bottom reflectors. Measurements of sub-bottom layer thickness from the two records should agree within ±20 cm.

Sediment coring and sediment profile imaging data will be obtained at the sub-bottom points of intersection. If there are any discrete depositional layers on or near the sediment surface with thickness less than about 20 cm, both coring and sediment profile imaging should detect them. This provides a means to independently confirm the sub-bottom results. Distinct sediment horizons or depositional layers greater than 20 cm also may be detected through core sampling, depending on the depth of core penetration. The results of the baseline sub-bottom survey can be compared qualitatively with both the sediment profiling and coring results. The following DQO is established:

> **Data Quality Objective**: The thickness of any sediment layers measured by sub-bottom profiling should be within ±20 cm of that measured by either sediment profile imaging or coring.

A final objective of the baseline sub-bottom monitoring is to confirm that thickness of EA sediment in each of the four pilot placement cells exceeds 10 cm. Past investigations have demonstrated that the EA sediment deposit is characterized by a lower density and finer grain size than the native sediment. The EA sediment deposit is known to range in thickness from 5 cm to greater than 60 cm and is underlain by firmer native shelf sediments (Lee, 1994).

The difference in density between the EA sediment and underlying native sediment should be detectable by the sub-bottom acoustic technique, allowing the EA sediment thickness to be determined. The following DQO is established:

> **Data Quality Objective**: The thickness of the EA sediment deposit within and around each pilot placement cell should be determined to a resolution of at least 20 cm.

4.0 DQOS FOR BASELINE SIDE-SCAN SONAR

Side-scan sonar is a standard survey technique used to generate 2-dimensional maps of seafloor features. The system consists of a vessel-based data acquisition system linked to a "towfish" which contains acoustic transmitting and receiving circuitry. The towfish is towed behind the survey vessel along predetermined survey lanes. Acoustic signals projected from both sides of the towfish are used to obtain information on seafloor characteristics at 90-degree angles from the vessel track. Physical objects as small as 0.5 m in size and small scale sedimentary features (e.g., rock outcrops, sand ripples, trawl scour marks, etc.) can be clearly delineated from the side-scan records. Additional details on field and analysis methods are provided in the FSP and QAPP.

One objective of the baseline side-scan sonar survey is to determine the physical characteristics of the existing surface sediments in each of the four pilot placement cells. The second objective is to characterize sediment physical features with sufficient resolution to facilitate distinguishing between ambient sediments and cap material in the future (Table 4-1). Sufficient resolution is defined as the ability to detect a subtle difference in optical reflectance with the naked eye while viewing and interpreting the sidescan records.

To address the two objectives identified in Table 4-1, side-scan sonar data will be collected continuously along a series of 8 survey lanes (transects) encompassing each of the pilot placement cells and their surroundings (Figure 3-1). The survey transects are spaced 100 m apart to provide uniform spatial coverage of the area. Three transects are positioned horizontal to each rectangular pilot placement cell; these are intersected by five vertical transects (Figure 3-1). The points of intersection all occur within the rectangular boundaries of each placement cell and coincide with stations where both cores and sediment profile images will be obtained. In order to acquire side-scan data beyond the boundaries of the each cell, the survey lanes will extend from 500 to 750 m beyond the cell boundaries.

The side-scan sonar system will be configured to collect seafloor imagery data 100 m to either side of the towfish, resulting in a total swath coverage of 200 m along each survey lane. With the 100-m lane spacing established for each cell, side-scan data coverage within each cell will be approximately 200%. Continuous side-scan records will be obtained along each survey transect. A comparison of the results obtained along each transect will provide an indication of the degree of variability in sediment surface features within and surrounding each pilot placement cell.

One of the DQOs for the side-scan sonar survey relates to the positioning accuracy of the survey vessel:

> **Data Quality Objective**: Vessel positioning accuracy for the baseline and all subsequent side-scan sonar surveys should be ±1 to 3 m.

As previously indicated, this DQO will be addressed through the use of a differential GPS navigation system, details of which are provided in the FSP.

Table 4-1. DQOs for Baseline Side-scan Sonar Surveys

Monitoring Objective	Data Requirements	Monitoring Approach	Field Decision Criteria/Performance Specifications
Determine physical seafloor characteristics in each of the four pilot placement cells.	Broad-scale features of the sediment surface, including: Sediment type (e.g., sand, mud) Small-scale boundary roughness (e.g., ripples, bedforms) Rock outcrops Anthropogenic features (trawl scars, fish traps, wrecks)	Collect continuous side-scan sonar records along a series of 8 intersecting survey transects in and around each of the four pilot placement cells.	Navigational accuracy should be ±1 to 3 m. Completeness goal is 100% (obtain continuous records from all survey lanes). Lanes spaced 100 m apart to provide 200% bottom coverage. Duplicate records should be in agreement with respect to type and location of seafloor features. Characterization of sediment type should agree qualitatively with coring and sediment profile imaging results.
Determine physical characteristics of sediments in each of the proposed placement cells with sufficient accuracy to permit distinctions between ambient sediments and cap material.	Same as above.	Same as above.	Same as above.

Another of the DQOs for this sampling effort relates to completeness. To meet the objective of characterizing sediment conditions (including the degree of spatial variability) within and around each placement cell, it is important that a complete side-scan sonar record be obtained along each of the 8 survey lanes.

> **Data Quality Objective**: Continuous side-scan sonar records should be obtained at 100% of the baseline monitoring survey lanes to fully characterize physical sediment conditions and any broad-scale variability in sediment surface features within each placement cell.

SAIC's procedures for meeting the 100% completeness goal are described in the FSP and QAPP. One of the advantages of the proposed 200% bottom coverage, as well as the intersecting survey lanes, is that "duplicate" side-scan sonar records will be obtained over relatively broad areas. This duplication provides a means to check on the

precision (repeatability) and degree of resolution of the survey method. Duplicate records should agree closely in terms of both the type(s) of surface features present and the location of these features. The following DQO is established:

> **Data Quality Objective**: Duplicate side-scan sonar records will be compared. There should be 100% agreement between the two records in the sediment type determination and the identification of surface features. The two records should agree within ±10 m with respect to the location (coordinates) of specific targets or features.

Data on surface sediment type (i.e., grain size) at the side-scan sonar lane points of intersection will be obtained from both the sediment coring and sediment profile imaging surveys. These data can be used as an independent check or ground truth of the side-scan sonar interpretation. The sediment type determinations for the baseline side-scan sonar survey will be compared against both the sediment profiling and coring results. The following DQO is established:

> **Data Quality Objective**: At 90% of the stations, there should be agreement between the sediment-profile imaging and coring grain size results versus the sediment type determination obtained through side-scan sonar interpretation.

5.0 DQOs FOR BASELINE SEDIMENT CORING

Sediment coring is a useful method for addressing the objectives of the baseline survey, as shown in Table 5-1. Sediment cores can provide data on many physical and chemical characteristics of surface and near-surface sediments. First, cores can be visually inspected to identify texture, color, debris, the presence of strata within the length of the core, and other parameters. Second, sediment from within the cores can be tested for physical and chemical parameters. In addition, cores can be divided into sections, and each section tested separately, to determine vertical patterns in characteristics as a function of distance below the sediment surface. For this program, sediment cores will be collected using a gravity corer. A minimum penetration depth of 20 cm from the sediment surface has been defined in the Monitoring Plan (Fredette, 2000). This depth is considered adequate to determine the extent of mixing between ambient sediments and capping material after the latter is placed.

The general strategy for the sediment coring is to take sediment cores at nine specified locations in each of the four proposed placement cells for the pilot capping program (Figure 5-1).). In addition, each core will be sectioned into 4-cm thick sections for physical and chemical testing (minimum of five such sections in a 20-cm core). Based on knowledge of the site and experience with coring programs, it is expected that the number and location of cores, and the 4-cm sectioning of each core, will provide sufficient data to characterize existing sediment conditions in these cells (Palermo et. al., 1999; Palermo, 2000; Fredette, 2000). The DQOs for sediment coring for each of the relevant objectives are described below and summarized in Table 5-1.

During the initial baseline sediment coring survey, and in later surveys during and following cap placement, the sampling must occur with a high degree of positional accuracy.

> **Data Quality Objective**: Vessel positioning accuracy for the baseline and all subsequent coring surveys should be ±1 to 3 m.

As previously indicated, this DQO will be addressed through the use of a differential GPS navigation system for all survey work. Details on the use of this system are provided in the FSP.

Table 5-1. DQOs for Sediment Coring

Investigation Objectives	Data Requirements	Investigation Strategy	Field Decision Criteria/ Performance Specifications
Determine physical characteristics of sediments in the proposed placement cells.	**Testing** Grain size Bulk density **Visual** Grain size Texture Color Odor Visible stratification or lenses Debris Sheen or presence of oil Organic material	Collect 9 gravity cores in each of the 4 pilot cells. Section each core into 4-cm sections for testing. Visual inspection of cores. Description of core using core log.	Navigational accuracy should be ±1 to 3 m. Minimum core penetration: 20 cm based on the study design requirement for sampling the upper 20 cm layer. Fingers at bottom of corer closed. Overlying water is present and clear. No significant disturbance of sediment surface. Use Unified Soil Classification System for visual description. Identifiable strata, changes in appearance, notable features to be measured from core surface to nearest 1 cm. If inspection indicates compaction or smearing or mixing between strata precludes meeting this specification, qualify data accordingly or resample.
Determine physical characteristics of sediments in the proposed placement cells with sufficient accuracy to permit distinctions between ambient sediments and cap material (dependent also on characteristics of the cap materials).	Same as above. Sufficient accuracy is defined as being able to discern, with the naked eye, a difference between the ambient sediments and cap material for the above "visual" parameters. Also, being able to quantify a significant difference between the two based on the above testing parameters.	Same as above.	Same as above.
Confirm that the thickness of EA sediments (defined as p,p'-DDE exceeding 1 ppm) exceeds 10 cm in the proposed placement cells.	Concentration of p,p'-DDE in mg/kg (ppm) dry weight.	Same as above for core sampling and testing.	Same as above for core penetration and recovery. Adequate sediment volume for testing (100 g wet). Decontamination of sampling tools between samples to prevent cross contamination and use of clean subsampling techniques. Determine core sections with p,p'-DDE concentrations exceeding 1 ppm dry wt. See QAPP for methods, detection limits, and other QA limits.
Determine concentrations of p,p'-DDE in surface sediments of the proposed placement cells.	Concentration of p,p'-DDE in mg/kg (ppm) dry weight.	Same as above for core sampling and testing.	Same as above for core penetration and recovery, and clean sampling techniques. See QAPP for methods, detection limits, and QC criteria.

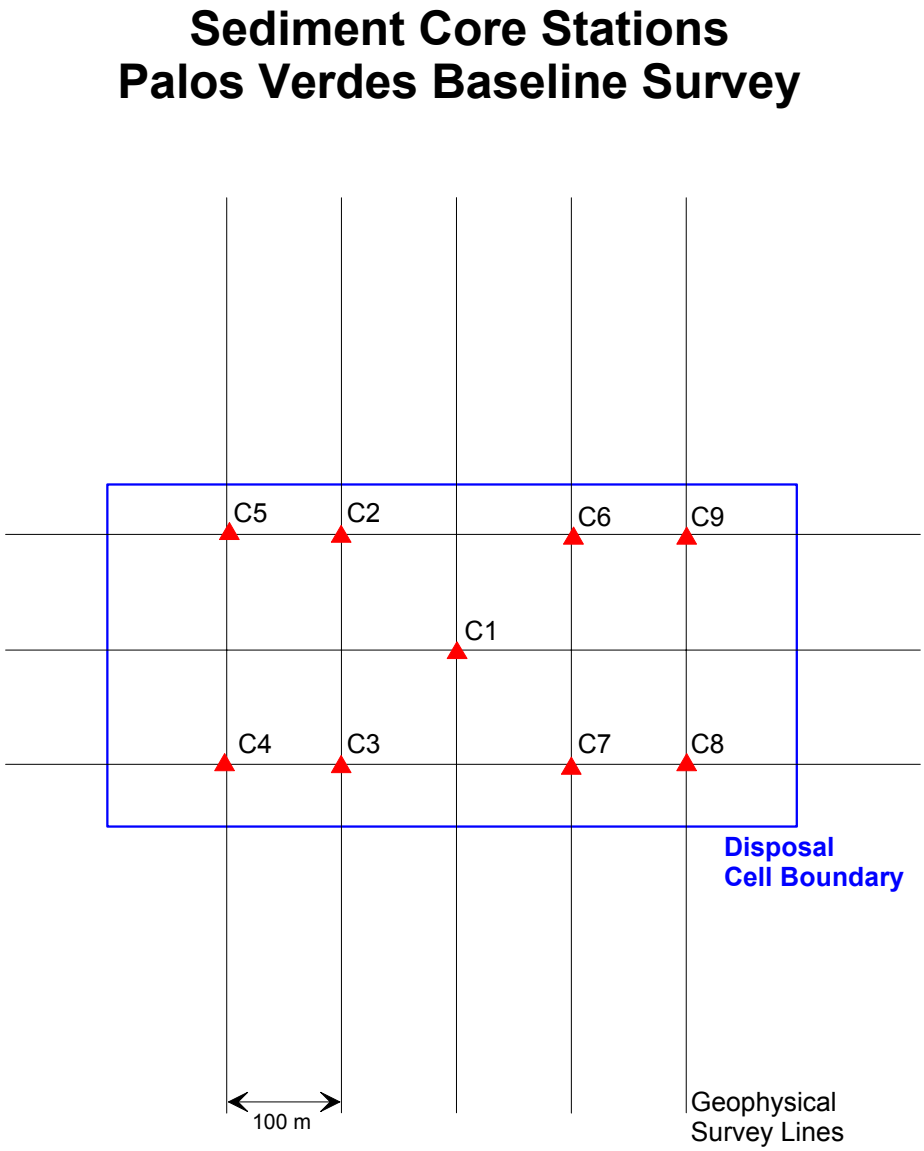

Figure 5-1. Schematic representation of the distribution of core sampling stations that will be occupied in each of the four capping cells.

Data Quality Objective: Collect sediment cores at least 20 cm in length at nine specified locations in each of the proposed placement cells, subsample into 4-cm sections, and test for grain size and bulk density, as a baseline for distinguishing ambient sediments from capping material post placement.

The rationale for nine cores per cell and a minimum core length of 20 cm is provided above. The 4-cm core sections are specified in the Monitoring Plan (Fredette, 2000) for the Pilot Capping Project. This thickness will be used because it provides adequate resolution of vertical layering of sediment properties. Two key physical parameters that will be used to characterize the existing sediments in the cells are grain size and bulk density. Grain size is the primary parameter that will be used to distinguish ambient sediments from cap material after placement of the cap material. Cap material is expected to be coarser than ambient sediments. For this program, a precise method for measuring grain size (Plumb 1981, sieve and pipette method) will be used. This method determines, on a dry weight basis, the percentage of a sediment sample that falls within each of a series of grain size classes. This method maximizes the likelihood of detecting a difference in grain size between ambient sediments and cap material. As discussed in Section 2.0 above, the grain size results for the core subsamples, determined by the sieve and pipette method, will be used to provide a visual check on the sediment profile imaging results.

Bulk density (mass divided by volume) is another parameter used to distinguish sediment units physically. Bulk density is a measure of the density of any entire sediment sample, including water. Sediments with high water content typically have lower bulk density than sediments with low water content. Water content is affected by grain size and the length of time over which the sediment has consolidated. Finer or recently deposited sediments tend to have lower bulk density than coarser or more consolidated sediments. Additional information on the physical characteristics of surface sediments will be obtained from visual inspection of the cores, as described below.

> **Data Quality Objective:** Collected cores will be subsampled into 4 cm sections and analyzed for p,p'-DDE as a baseline for determining the effectiveness of the cap in containing contaminants.

The isomer p,p'-DDE is being analyzed because it is the dominant form of DDT present on the Palos Verdes Shelf, and it provides a useful proxy for total DDT and total PCBs (Lee, 1994). Because p,p'-DDE is known from previous site investigations to be present in the EA sediment deposit at concentrations of 1 ppm or greater, it will be readily quantifiable using standard analytical techniques (e.g., gas chromatography/electron capture detection or gas chromatography/mass spectrometry), without significant analytical problems (e.g., interferences) that could affect data accuracy, precision, or comparability.

The concentrations of p,p'-DDE in surface sediments of the capping cells will be determined just prior to capping, through chemical testing of the sediment core samples. Sectioning of the core samples into 4 cm-thick sections prior

to testing will allow analysis of vertical patterns of this contaminant in the sediment column. The QAPP describes the detection limits and other QA control limits for the chemical analysis. During field sampling, it will be important to effectively decontaminate the sampling equipment between sample collections in order to prevent cross contamination of samples. For the same reason, it will also be important to use clean sampling techniques when subsampling the cores. These techniques are addressed in the FSP (sections 3.4.6 and 3.4.7) and QAPP (section 3.5).

Adequate sample volume (mass) is an important issue for low-level chemical testing. A 4 cm-thick section of a 3.5-inch (inside diameter) core would contain approximately 600 g (wet) of sediment. It is estimated that a sample mass of 100 g (wet) will be sufficient for the proposed chemical tests, including quality assurance samples. Therefore, a single core is expected to provide adequate sample volume for all proposed testing at each sampling location.

> **Data Quality Objective:** Collected cores will be subsampled into 4 cm sections to test for p,p'-DDE. This will confirm that the thickness of the EA sediments exceeds 10 cm in the proposed placement cells.

Lee (1994) indicated that within the effluent-affected (EA) sediment layer, the concentration of p,p'-DDE is consistently greater than 1 ppm (mg/kg) dry weight. This concentration therefore will be used to define EA sediment in the present investigation. The thickness of EA sediment in the proposed capping cells must be sufficient (defined as > 10 cm) to measure the degree of mixing of cap and contaminated sediment and the effects of advection due to consolidation (Palermo, 2000). Sediment coring will be used to determine the thickness (depth) of EA sediments in each of the four proposed capping cells. Using 4-cm sections, the layer thickness will be resolvable to the nearest 4 cm, except in the situation where the depth of the EA layer exceeds the length of the sediment core (i.e., >20 cm).

> **Data Quality Objective:** If distinctive sediment layers (strata) or other notable features are present within the sediment cores, their depth and thickness should be measured to the nearest 1 cm.

The purpose of this DQO is to assist in interpreting 1) the data on vertical trends in sediment physical and chemical characteristics collected under other DQOs (above), and 2) the interface between ambient sediments and cap material post capping, including any mixing between the two. The principal method by which this will be done is visual inspection of the collected cores. This inspection will provide qualitative physical information about the cores that will supplement the quantitative data collected under other objectives. Visual inspection will assist in identifying strata in the sediment column based on observations of grain size, texture, color, odor, debris, organic material, and other parameters using the Unified Soil Classification System (USCS). The distance from the sediment surface to interfaces between strata and other notable features will be measured to the nearest 1 cm. Visual observations will be correlated with data from the physical and chemical testing of core sections to determine if

there are measurable differences among the strata in the tested parameters. In addition, strata identified though inspection of sediment cores will be compared to those identified through sediment profile imaging (Section 2-0). For the same sampling location, the depth to strata interfaces should match within 2 cm (1 cm error for each method).

If the visual inspection indicates that significant compaction of the core, or smearing or mixing of the strata, has occurred, this will be used in interpretation of the physical and chemical testing data. If compaction can be measured and is significant, depth information for physical and chemical testing results will be adjusted accordingly. If smearing or mixing of strata is visible, this will indicate that some mixing between 4-cm sections may have occurred. This will necessitate either re-sampling or qualification of the coring results.

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Project Work Plan
for the
Palos Verdes Pilot Capping Project:
Baseline Monitoring Activities

FIELD SAMPLING PLAN

Prepared for:

U.S. Army Corps of Engineers
Los Angeles District
Environmental Construction Branch

U.S. Environmental Protection Agency
Region IX
Superfund Division (SFD-7-1)

April 2003

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1.0 OBJECTIVES AND SCOPE

1.1 Objectives of the Pilot Capping Project

The U.S. Environmental Protection Agency (EPA), Region IX is currently evaluating alternatives for restoration of contaminated sediments on the Palos Verdes (PV) Shelf off the coast of Los Angeles, California. One restoration alternative under consideration is *in-situ* capping, which entails placement of a cap of clean material over contaminated sediment, thereby isolating the contaminated shelf sediments. EPA is collaborating with the U.S. Army Corps of Engineers (USACE) to conduct pre-design data collection studies related to this capping alternative. Palermo et al. (1999) evaluated various scenarios for *in-situ* capping at the PV site. This evaluation included prioritizing areas of the PV Shelf to be capped, determining appropriate cap designs, developing an equipment selection and operations plan for placement of the cap, developing a monitoring plan to ensure successful cap placement and long-term cap effectiveness, and developing preliminary cost estimates.

Recently, Palermo et al. (2000) developed an Operations and Monitoring Plan for a Field Pilot Study of capping on the PV Shelf. This Plan outlines a pilot capping study to be conducted in Summer of 2000 using cap material to be dredged from the Queen's Gate navigation channel and/or suitable borrow sites (to be determined by USACE). The pilot study consists of controlled operations for placement of cap material within selected areas on the PV Shelf, and associated monitoring prior to, during, and following the placements. The pilot study will include tasks for pre-design data collection and operational design refinement. Operational aspects for the pilot study include selection of appropriate placement areas, capping materials, and placement techniques. The associated monitoring program for the pilot study is designed to evaluate the following topics: areal extent and thickness of the cap; mixing of cap and contaminated sediments; resuspension of contaminated sediments during cap placement; short-term benthic recolonization of the cap; and short-term physical and chemical characteristics of the cap and underlying sediments immediately after capping, and following initial sediment consolidation.

Fredette (2000) developed a companion document to the Palermo (2000) Operations and Monitoring Plan that specifies monitoring activities to be conducted during the pilot capping project. The Field Sampling Plan presented herein addresses the baseline monitoring activities specified by Fredette (2000). Consequently, this Field Sampling Plan does not provide statistical analyses justifying the sampling design for each measurement type.

Tasks associated with field sampling during subsequent (post-baseline) phases of the capping project will be described in a separate document. This Field Sampling Plan, essentially one chapter of the Project Work Plan, addresses the following activities associated with the baseline field sampling activities that will commence in April 2000:

- Project Organization and Responsibilities
- Field Activities
- Sample Activity Documentation and Chain of Custody Procedures
- Control of Investigation-Derived Wastes
- Field Quality Control
- Field Data Management, Validation, and Corrective Actions
- Schedule of Baseline Project Activities

1.2 Scope of Baseline Field Sampling Activities

As indicated above, this Field Sampling Plan addresses the baseline sampling activities of the pilot capping project which entail the following measurement technologies:

- Sediment Profile Imaging and Plan View Photography
- Sediment Coring
- Side-Scan Sonar Surveying
- Subbottom Profile Surveying

Data Quality Objectives and the Quality Assurance Project Plan for the baseline monitoring activities are addressed in separate chapters of the Project Work Plan. Likewise, the Health and Safety Plan for the pilot capping project is provided in the Project Work Plan.

2.0 ORGANIZATION AND RESPONSIBILITIES FOR FIELD ACTIVITIES

The Overview of this Project Work Plan describes SAIC project organization for the Pilot Cap Monitoring Program. The present section identifies SAIC personnel who have been assigned key responsibilities for field sampling, data management, and scientific analysis during the baseline program (Figure 2-1).

2.1 Project Manager for USACE Los Angeles District

The USACE Los Angeles District (LAD) is responsible for overall management of the Palos Verdes Pilot Cap Monitoring Program. Ms. Ellie Nevarez, the LAD's Project Manager, will be responsible for: providing monitoring objectives via definitive Statements of Work; leading the inter-agency technical review committee for the Palos Verdes Monitoring Program; and review/approval of all deliverables produced by the monitoring contractor. Ms. Nevarez will be the contractor's single point of contact within the LAD for all matters of a technical or schedule nature. Contractual issues will be addressed between contract representatives at SAIC and within the LAD.

2.2 SAIC Project Manager

Dr. Scott McDowell, SAIC's Project Manager for the Palos Verdes Pilot Cap Monitoring Program, will have overall responsibility for the baseline sampling program. In this capacity, he will be the primary point of contact with the LAD's Project Manager, as well as with other USACE and EPA participants on the Pilot Cap Program. Dr. McDowell has extensive experience with management of multidisciplinary oceanographic field programs, as well as specific, recent experience on complex monitoring programs associated with Corps-managed dredge material capping projects in New York and Boston.

As Manager of SAIC's Marine Environmental Sciences and Information Management Division, Dr. McDowell can commit the necessary human resources and equipment from multiple SAIC facilities to accomplish the baseline monitoring program. His key responsibility for the sampling program is to ensure that SAIC conducts all field sampling activities according to the Data Quality Objectives, Field Sampling Plan, and Quality Control requirements outlined in the Project Work Plan for the Pilot Cap Project. Progress during the baseline survey operations will be communicated to the LAD Project Manager on a daily basis. If problems are encountered, and/or if circumstances arise that have an impact on the schedule or completeness of the measurements, such matters will be addressed on a near real-time basis, corrective actions will be implemented, and the LAD Project Manager will be contacted immediately, apprised of the situation, and given the opportunity to propose alternatives measures.

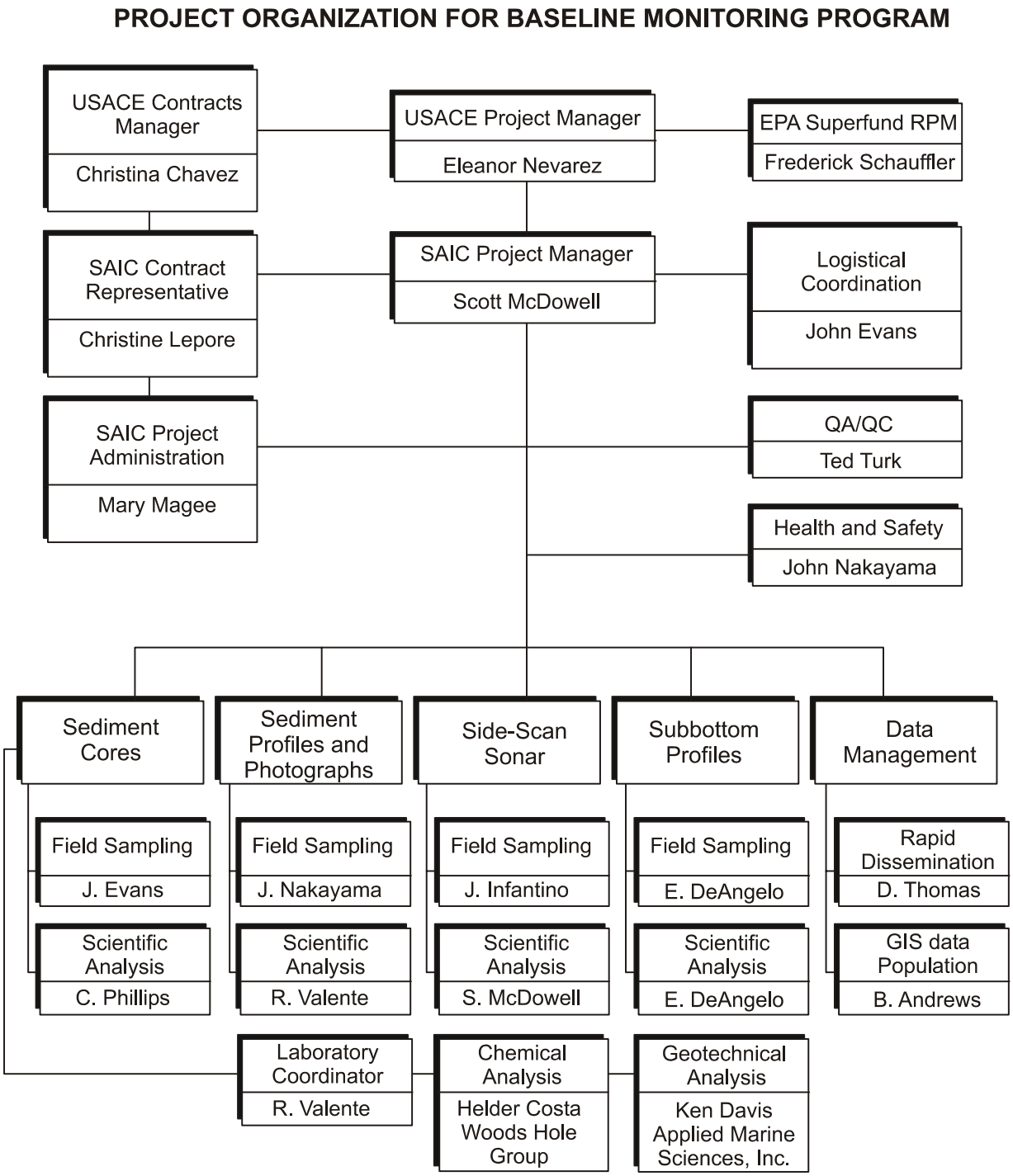

Figure 2-1. SAIC Organization Chart for the Pilot Study Baseline Monitoring.

2.3 Additional Project Management Support

The SAIC Project Manager will be supported by Ms. Christine Lepore for contract administration and Ms. Mary Magee for fiscal support with project administration and subcontract management. Both individuals have considerable experience assisting Dr. McDowell with management of contracts under which SAIC has conducted multidisciplinary oceanographic monitoring programs for multiple USACE Districts and the USAE Waterways Experiment Station.

Technical support for QA/QC and Health & Safety issues of the baseline monitoring program will be provided by Dr. Ted Turk and Mr. John Nakayama, respectively. Dr. Turk has been involved with various technical aspects of the Palos Verdes program over the past three years and consequently, has a thorough understanding of both the scientific/engineering objectives and the measurement technologies to be utilized during the baseline monitoring activities.

Mr. John Nakayama, the designated Project Health and Safety Officer for the baseline program, is experienced with Health and Safety aspects of marine environmental measurement programs. He has assumed the role of Safety Officer in the past for numerous marine sampling programs in California and Washington. His principal responsibilities for this project are given below:

- Obtain a qualified technical review of the Health and Safety Plan (HSP)
- Ensure that all personal protective equipment specified in the HSP is available for use at the site
- Ensure that subcontractors are provided a copy of the HSP and return the completed acknowledgement form
- Ensure that a qualified Site Safety Officer is designated for each planned field activity.
- Complete the Project Debriefing Questionnaire upon completion of the field work.

2.4 Logistics Coordinator

One of the most important elements in the successful conduct of the baseline sampling program centers around field logistics, including: scheduling of field personnel, survey vessels and specialized equipment; accessibility of shore-based mobilization facilities; and prearranged shipment of samples to subcontracted analytical laboratories. Mr. John Evans has been assigned this role for the baseline monitoring program based on his demonstrated experience providing similar logistical coordination on numerous oceanographic monitoring programs along the central and southern California coast. On recent programs in the Los Angeles area, Mr. Evans has used the same vessels, shore facilities, and equipment that will be utilized for the baseline monitoring program. This local experience will ensure that the baseline monitoring activities meet all schedule and Data Quality Objectives.

Mr. Evans will be responsible for conducting “readiness review” meetings as part of the mobilization effort for each field surveying effort. At a minimum, a meeting will be conducted with the field team on the day prior to initiation of a

sampling task (e.g., sediment coring) to assess staff and equipment readiness. Any potential problems will be discussed with the SAIC Project Manager to identify mitigative solutions.

2.5 Sediment Profiling and Plan View Photography

Mr. Ray Valente has been designated as lead scientist for the sediment profiling and plan view photography elements of the baseline monitoring program. In this role, he will oversee field sampling plans to ensure that they meet specific Data Quality Objectives, monitor the quality of all associated data, and develop all scientific results as input to project deliverables. Mr. Valente is well qualified for this role based on over 15 years experience managing sediment profile sampling programs in various coastal environments. Under the direction of Mr. Valente, Mr. John Nakayama will be the field leader for the sediment profile field operations. Mr. Nakayama will be responsible for mobilizing staff and equipment according to the baseline project schedule, conducting the field measurements according to the sampling plan, and documenting field sampling operations. During the field surveys, Mr. Nakayama will be assisted by additional field technicians and the survey navigator, Ms. Pickle. Mr. Valente will be responsible for approving release of the data to the project data base.

2.6 Sediment Coring

Mr. Charles Phillips has been designated as lead scientist for the sediment coring element of the baseline monitoring program. In this role, he will oversee field sampling plans to ensure that they meet specific Data Quality Objectives, monitor the quality of all associated data, and develop all scientific results as input to project deliverables. Mr. Phillips is well qualified for this role as he has managed numerous monitoring projects off southern and central California involving field collection of sediment cores, management of subcontract laboratories for analysis of chemical contaminants, and scientific interpretation of chemical and biological results from core samples.

Under the direction of Mr. Phillips, Mr. John Evans will be the field leader for the coring operations. Mr. Evans will be responsible for mobilizing staff and equipment according to the baseline project schedule, and conducting the coring operations according to the sampling plan. He will also be responsible for documentation of field sampling operations and determining whether sediment core samples meet the minimum requirements specified in the data quality objectives. During the field surveys, Mr. Evans will be assisted by additional field technicians and the survey navigator, Ms. Pickle.

Analyses of sediment cores by subcontractor laboratories will be coordinated by Mr. Valente. He will also coordinate sediment chemistry data validation, which will be performed by SAIC (TBD), and evaluate the vane shear measurement data generated by SAIC. Ms. Pam Walters will be responsible for evaluating geotechnical data (grain size, Atterberg limits, bulk density) generated by Applied Marine Sciences.

2.7 Side-Scan Sonar Surveying

Mr. Jason Infantino has been designated as the field engineer and data analyst for the side-scan sonar element of the baseline monitoring program. In this role, he will lead and document the field sampling activities and conduct the post-survey processing of the digital side-scan data. Mr. Infantino is well qualified for this role as he has recently conducted other side-scan measurement programs using state-of-the-art digital side-scan technology. During the field surveys, he will be assisted by additional field technicians and the survey navigator, Ms. Pickle.

Dr. Scott McDowell will be responsible for scientific interpretation of the side-scan data. Additionally, he will: ensure that all measurements meet the specific Data Quality Objectives; monitor the quality of all associated data; and formulate scientific results as input to project deliverables. Dr. McDowell will be responsible for approving release of side-scan sonar data to the project data base.

2.8 Subbottom Profile Surveying

Mr. Ed DeAngelo has been designated as lead scientist and field engineer for the subbottom profiling element of the baseline monitoring program. In this role, he will lead the field sampling activities to ensure that all measurements meet the specific Data Quality Objectives; document field sampling operations; monitor the quality of all associated data; and develop all scientific results as input to project deliverables. Mr. DeAngelo is well qualified for this role as he has recently conducted other subbottom profile measurements for *in situ* dredge material capping programs using state-of-the-art digital technology. During the field surveys, he will be assisted by additional field technicians and the survey navigator, Ms. Pickle. Dr. McDowell will be responsible for approving release of the subbottom profiling data to the project data base.

2.9 Data Management

One of the critical elements for successful conduct of the baseline program is the assurance that key survey results and data be provided to the LAD Project manager and other members of the Palos Verdes Project Team in a timely fashion, as specified by the Project Work Plan. Immediately following data transcription (where applicable) and processing, each data set and/or data product will be subjected to quality review by the lead scientist for the specific measurement type (see Figure 2-1 for lead scientist assignments). This review will include assessment of data quality, accuracy, and completeness as addressed in further detail in the Quality Assurance Project Plan. The extent of this data review will vary among the types of scientific information to be acquired during the baseline monitoring activities. For example, for the digital photographs of sediment cores, 100% of the photos will be reviewed by the lead scientist prior to transfer to the project data archive. Similarly, 100% of the laboratory results from the geotechnical and chemical analyses will be reviewed by the lead scientist or qualified designee. Laboratory data

quality for sediment core samples will also be evaluated using a formal data validation process by SAIC. Field data will be reviewed for accuracy and completeness by the chief scientist for each of the respective sampling tasks.

In contrast to the limited volume of data that will be derived from the sediment cores, millions of data points will be acquired by the side-scan sonar and subbottom profiling systems. For these remotely sensed data types, quality review of all (individual) data points would be prohibitive; more appropriate and effective review will entail review of preliminary, two-dimensional data products and identification of data points that may have been caused by problems with the data acquisition system. At the recommendation and prior approval of the lead scientist, these erroneous data points will be removed and documented by the data analyst, then a new two-dimensional data product will be generated for final review by the lead scientist.

Following acceptance of the processed data by the respective lead scientists, all data will follow two paths for data dissemination: data population within the DAN-LA GIS with data updates via CD-ROMs; and more rapid dissemination of data and information via a password-protected, Palos Verdes Monitoring Project Website (PV-Web).

During the baseline field measurement activities, Mr. Brian Andrews will be co-located with the SAIC field team to facilitate custody of the field data and preliminary results (side-scan sonar and subbottom profile data products, sediment core photographs, sediment profile images and plan view photographs, etc.) from the baseline survey activities. Upon receipt of preliminary data products, Mr. Andrews will post the key data files on SAIC's electronic data archive to be established for the Palos Verdes Project. Note that this data archive will be accessible by SAIC employees from any location nationwide, but the archive will be password protected to guarantee data security and prevent access by unauthorized interrogators.

Ms. Diane Thomas, residing in Newport, Rhode Island, will be responsible for cataloging the preliminary data products, survey reports, and other pertinent survey information posted by Mr. Andrews. She will then facilitate electronic links to these multidisciplinary data files and graphical products on the PV-Web, which will provide all members of the Palos Verdes Project Team with direct electronic access to the results from the baseline monitoring surveys, within a few days after completion of data processing.

Mr. Andrews also will be responsible for transfer of all baseline data files to the team responsible for populating the DAN-LA database with information from the baseline surveys.

2.10 Navigation and Positioning

Ms. Kate Pickle will be responsible for vessel navigation and station positioning on all baseline monitoring surveys. With assistance from other support staff, Ms. Pickle will be responsible for the following tasks associated with navigation and record keeping:

- Calibrate the DGPS positioning system(s) prior to the baseline surveying,
- Install the positioning equipment aboard the survey vessel and conduct pre-survey operational tests,
- Input target positions for coring and sediment profiling stations,
- Input survey lanes for side-scan sonar and subbottom profiling surveys,
- Operate the positioning equipment during the surveys and perform routine maintenance,
- Maintain a Navigation Log documenting all sampling events,
- Ensure that all digital positioning data are recorded, archived, and stored in duplicate copies, and
- Provide the positioning data from each survey in a timely fashion to data analysts responsible for processing and analysis of the sediment profile, coring, side-scan sonar, and subbottom profile data.

2.11 Field Sampling Personnel

As indicated above, each of the field sampling efforts of the baseline program will be led by designated field leaders. On all surveys, the field leaders will be assisted by additional field engineers and technicians as necessary to accomplish the survey objectives. These individuals will be provided by SAIC offices in San Diego, CA, Bothell, WA, Newport, RI, and Baltimore, MD, depending upon the specific technical capabilities required for each survey element.

3.0 FIELD ACTIVITIES

Field activities performed for the Baseline Monitoring Program will be conducted by SAIC personnel, using facilities and equipment resources, and in accordance with procedures described in this Field Sampling Plan. The SAIC Program Manager will assign responsibilities for field activities to specific personnel, and the Program Manager, Logistics Coordinator, and Task Leaders may delegate specific tasks to other, experienced personnel as appropriate. The SAIC Program Manager will convene a pre-survey meeting with all SAIC key personnel to review assignments, schedules, contingencies, and equipment/supplies. Prior to the start of daily sampling activities, the chief scientist will convene a sampling overview that will address sampling objectives, schedules, assignments, and health and safety issues.

3.1 Vessels and Logistics

The Palos Verdes Pilot Cap Monitoring Program will utilize several facilities in the Los Angeles area including: research vessels, marine support facilities, offices, and lodgings. Field sampling activities and data processing activities will be consolidated as much as possible throughout the program to enable the highest quality results within the project's accelerated schedule requirements. Additionally, timely deliverables can more efficiently be made to the identified client locations as defined in the Scope of Work. For these reasons, the Southern California Marine Institute (SCMI) Fish Harbor Facility will be utilized for both vessel-based marine operations, as well as overall field survey-related support.

SCMI is a shared resource representing eight California State University campuses, the University of Southern California, and Occidental College which were merged to form the largest consolidated marine institute in California. SCMI provides additional laboratory space as well as convenient seaside access to their fleet of research vessels.

The SCMI Fish Harbor Facility is located at 820 South Seaside Avenue, Terminal Island, California. The facility is ideally located for the Pilot Capping Program marine survey activities due to its proximity to: the proposed cap sites, the site of the Queen's Gate dredging operation, and the local infrastructure. Figure 3-1 illustrates the relative locations of the SCMI, the Palos Verdes work site, Queen's Gate harbor entrance, and San Pedro Bay including Los Angeles and Long Beach Harbors. The SCMI Facility is located approximately 10 miles from the capping site or approximately 30 minutes steaming time via survey vessel.

3.1.1 Survey Vessels

Due to both the stringent schedule requirements and the technical complexity of the Baseline and Cap Monitoring Programs, several marine survey vessels have been identified for potential use during the sampling program. For the

baseline monitoring activities, we anticipate use of a single vessel, but during the monitoring in Summer of 2000, multiple vessels may be used simultaneously, depending upon the project scheduling requirements.

First consideration will be given to two survey vessels operated by SCMI: the R/V SEA WATCH and the R/V YELLOWFIN, both of which are available for charter and fully capable of conducting the planned sampling activities (e.g., station handling, deck equipment, etc.). Additionally, two other local vessels have been identified for potential use: the M/V TUNA, operated by Pacific Tugboat Service in San Diego, and the EARLY BIRD, operated by Seaventures in Dana Point. The latter two vessels can be employed as backup vessels in the event of scheduling conflicts with the primary SCMI vessels. The four vessels range from 36 to 75 ft in length, and are equipped with A-Frames, winches, and deck equipment. All vessels operate with experienced crews that specialize in multidisciplinary marine science surveys, and extensive experience working in the Southern California area using proposed coring, sediment vertical profiling, side-scan sonar and subbottom profiling technologies.

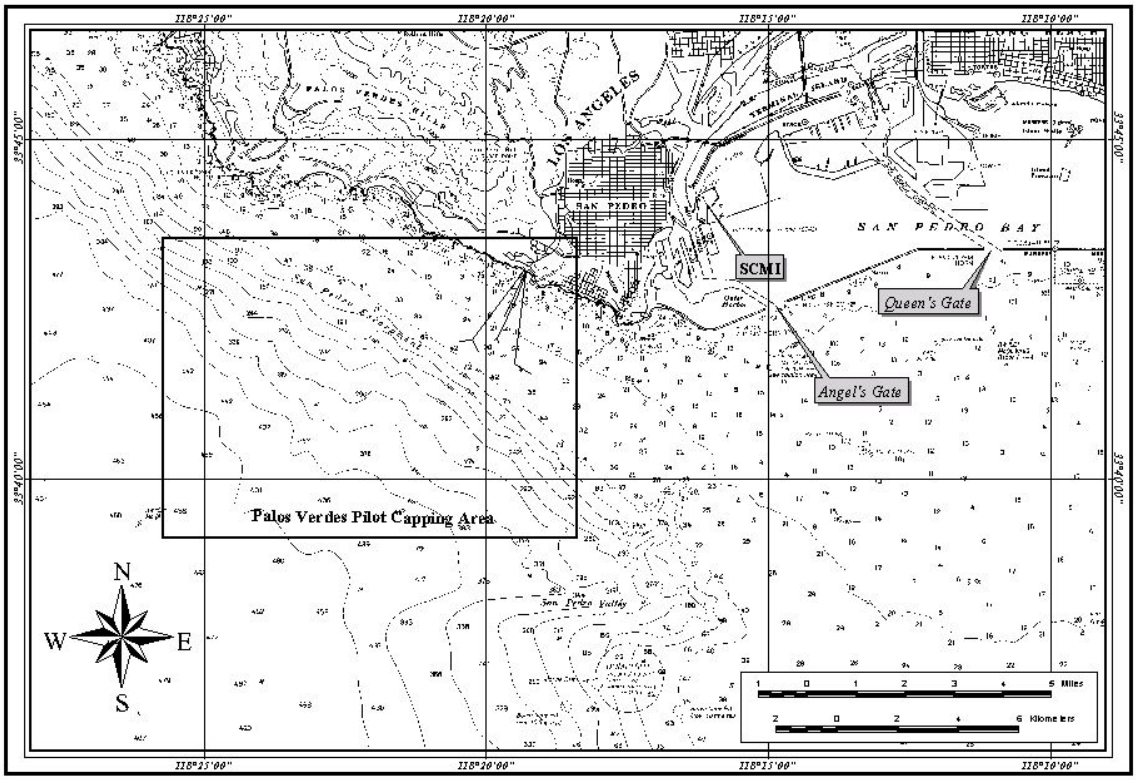

Figure 3-1. Palos Verdes Pilot Capping Area and locations of SCMI, Queen's Gate harbor entrance, and San Pedro Bay including Los Angeles and Long Beach Harbors.

Specifications for the four candidate vessels are given in Tables 3-1a through 3-1d. Note that vessels will not be required to provide electronic navigation equipment because SAIC will temporarily install DGPS navigation equipment for each survey.

3.1.2 Shore-Based Logistical Facilities

The SCMI Fish Harbor Facility will be utilized for vessel access, equipment mobilization and demobilization, and short-term storage of equipment and field supplies. The facility contains more than 13,000 square feet of usable space, including offices, classrooms, fully equipped laboratories, and a machine shop. Additionally, SCMI has 10,000 square feet of deep harbor space able to accommodate five research vessels.

SCMI utilizes the combined assets of personnel and well-equipped vessels to provide the capability of meeting a variety of research and educational needs in both coastal and offshore waters. Of particular interest to the capping program are the offices and research laboratories which can be used to: 1) split and log sediment cores, 2) process sediment core samples for shipment to analytical laboratories, 3) process sediment profile and plan view photographs for quick analysis of bottom characteristics and cap thickness during the monitoring effort, and 4) data processing and analysis of side-scan and subbottom profile data. Additional warehouse and staging areas will provide enhanced access for equipment mobilization and demobilization. SCMI's two primary research vessels give SAIC the added confidence of being able to perform marine survey tasks with a minimum of scheduling conflicts. Further, small boats including inflatables will help facilitating unforeseen or otherwise unplanned equipment and personnel exchanges, therefore maximizing labor resources in a demanding field program. These small vessels also could be used for transport of time-critical survey data to shore, prior to the end of the survey day.

Meeting rooms and offices will provide access for SAIC personnel to compile and process data prior to delivery to the Corps. The machine shop, fork lifts, and will be necessary for vessel mobilization activities, as well as facilitating necessary equipment testing and repairs. Finally, SCMI retains numerous pieces of scientific and electronic equipment available use on marine programs.

Table 3-1A. Specifications of Survey Vessel R/V SEA WATCH

Operator:	Southern California Marine Institute
Home Port:	Terminal Island, CA
Hull Construction / Year Built (Modified):	Plywood fiberglass / 1978
Dimensions:	65-foot LOA, 24-foot beam, 5-foot draft
Main Propulsion:	Twin 465 HP (12-71 Detroit) 920 S.H.P.
Speed:	10.5 knots cruising
Fuel Capacity:	1800 gallons
Water Capacity:	Not Available
Electronics:	Phone, 2 VHF Transceivers, 48 mile Furuno RADAR, Magnetic Compass, Recording fathometer; Furuno Cellular FE-881, Trimble 100A Loran-C, Magnavox MX 100 GPS and MX200 DGPS, Alden Weather Fax, kHz transducer
Deck Equipment:	Hydrographic davit on port quarter with 2,500' of 5/32" wire rope and lift capacity 400 lbs. Main drag winch aft on main deck with 4,000' of 3/8" IWRC wire rope and lift capacity of 1,800 lbs.; Stern `A' Frame maximum lifting capacity 2,500 lbs. 13' vertical clearance under block; 8' horizontal clearance between the frame; 7' horizontal clearance over the stern.
Special Equipment:	12 ft. Avon inflatable with 15 h.p. outboard, 17 ft Boston Whaler with 90 h.p. outboard, Flow through sorting table and Extensive list of portable scientific equipment is also available
Gross Tons / Net Tons:	97 / Not Available
Official Number:	297-291
Area of Operation:	Southern California Coastal
SCMI Contact Information:	Vessel Charters and Equipment Leases – Dan Warren Southern California Marine Institute 820 South Seaside Ave. Terminal Island, CA 90731 Phone: (310) 519-3172 Fax: (310) 519-1054 E-mail: cdwarren@csulb.edu SEA WATCH: http://www-bcf.usc.edu/~scmi/xseawatch.html

Table 3-1B. Specifications of Survey Vessel R/V YELLOWFIN

Operator:	Southern California Marine Institute
Home Port:	Terminal Island, California
Hull Construction / Year Built (Modified):	Aluminum / 1987
Dimensions:	76-foot LOA, 24-foot beam, 8.6-foot draft
Main Propulsion:	Twin 350 HP (8v92 GM Detroit) 720 S.H.P.
Speed:	10 knots cruising
Fuel Capacity:	4600 gallons
Water Capacity:	Makes 600 gallons per day
Electronics:	Cellular Phone, 2 VHF Transceivers, 1 - SSB Transceiver, Furuno Fathometer, 2,000 meters, Trimble GPS, Furuno and Raytheon Loran C, Raytheon 64 mile plotting radar, R41 Raster Scan 32 mile radar, Wood Freemen Autopilot, Navtac XL / Echo XL
Deck Equipment:	Hydrographic winch starboard mid ship with 1,500 meters 5/16" wire rope; lift capacity 500 lbs. at mid drum, One additional spool of 330 meters of 8 conductor 3/8" electromechanical cable, Articulating crane starboard mid ship; maximum lifting capacity 1,000 lbs. Main drag winch aft on main deck with 5,000 meters of 7/16" torque balanced galvanized wire rope; lift capacity of 5,000 lbs. at mid drum. Stern 'A' Frame maximum lifting capacity 2,500 lbs.
Special Equipment:	12 ft Avon inflatable with 15 h.p. outboard, 17 ft Boston Whaler with 90 h.p. outboard, Flow through sorting table and extensive list of portable scientific equipment is also available
Gross Tons / Net Tons:	109 / Not Available
Official Number:	537-119
Area of Operation:	Southern California Coastal
SCMI Contact Information:	Vessel Charters and Equipment Leases – Dan Warren Southern California Marine Institute 820 South Seaside Ave. Terminal Island, CA 90731 Phone: (310) 519-3172 Fax: (310) 519-1054 E-mail: cdwarren@csulb.edu YELLOWFIN: http://www-bcf.usc.edu/~scmi/xyellowfin.html

Table 3-1C. Specifications of Survey Vessel M/V TUNA

Operator:	Pacific Tugboat Service
Home Port:	San Diego, California
Hull Construction / Year Built (Modified):	Aluminum / 1970
Dimensions:	40-foot LOA, 16-foot beam, 3.5-foot draft
Main Propulsion:	500 horsepower twin engines thought Allison 1:1 transmissions to 28-inch propellers
Speed:	11 knots cruising
Fuel Capacity:	1,100 U. S. gallons
Water Capacity:	200 U.S. gallons
Electronics:	3 VHF Radios, SSB, Autopilot, Plotter, GPS, 16-mile Radar
Deck Equipment:	Deck-mounted drum winch with capstan and 600-foot wire rope. Upper-level pullmaster has 2,500 feet of 1/40-inch wire rope. Both winches fairlead to A-frame block and to articulating A-frame 12 feet high and 8 feet wide with 4,000-pound capacity.
Special Equipment:	Salvage equipment, including dive compressor, lift bags, and dewatering pumps.
Gross Tons / Net Tons:	28 / 19
Official Number:	528 294
Area of Operation:	Coastwise, California and Mexico
PTS Contact Information:	Vessel Charters – Bob Kinsella San Diego Towing and Marine Services, Inc. 2435 Shelter Island Drive San Diego, CA 92106 Phone: 619.222.7084 Fax: 619.222.6077 E-mail: bob@pacifictugboatservice.com TUNA: http://www.pacifictugboatservice.com/Pages/other_boats_available.htm

Table 3-1D. Specifications of Survey Vessel M/V EARLY BIRD

Operator:	Seaventures
Home Port:	Dana Point, California
Hull Construction / Year Built (Modified):	Plywood fiberglass / Not available
Dimensions:	36-foot LOA, 15-foot beam, 3-foot draft
Main Propulsion:	Not Available
Speed:	Not Available
Fuel Capacity:	Not Available
Water Capacity:	Not Available
Electronics:	Color Simrad Fathometer with 200 fathom capability, 48-mile Simrad Radar, Trimble and Northstar Differential GPS
Deck Equipment:	17 x 12 feet of usable flat deck space, 1,500-lb. Deck winch with 3,000 feet of ¼ in. stainless cable, 10,000-lb. Boom winch with 500 feet of ¼ in. stainless cable, removable 'A' Frame
Special Equipment:	12 KW three-phase generator, Air compressor, flying bridge, swim step with dive ladder
Gross Tons / Net Tons:	Not Available
Official Number:	Not Available
Area of Operation:	Coastal in-shore, bays in Southern California
Seaventures Contact Information:	Vessel Charters – Kenny Nielson Seaventures 33222 Acapulco Dr. Dana Point, CA 92629 Phone: 714.248.4208 714.492.3143 E-mail: N/A EARLY BIRD: N/A

3.2 Navigation and Vessel Positioning

3.2.1 Rationale

Accurate positioning of the survey vessel during all baseline sampling activities is an essential requirement for the pilot cap monitoring program. This positioning capability must include: 1) pre-survey establishment of accurate positions for all sampling locations and survey lanes; 2) a real-time helmsman display of vessel position to aid the vessel's crew in maneuvering to predetermined stations and lanes; and 3) acquisition and automatic digital recording of accurate vessel positions for the duration of each survey. Because survey data will be rendered useless in the absence of accurate position information, only proven navigation equipment and data acquisition/recording procedures will be used throughout the surveys to ensure high accuracy and repeatability in vessel position information.

Vessel positioning accuracy of ±1 to 3 m will be achieved during the pilot surveys via use of the U.S. government-maintained Global Positioning System (GPS) with enhancements to positioning accuracy that can be achieved via differential GPS (DGPS) corrections that are provided in real-time by USCG transmitters located in San Diego and Point Conception. . This criterion for navigational accuracy is consistent with manufacturers specifications.This DGPS capability meets the pilot cap program requirements for vessel positioning accuracy while requiring minimal manpower and equipment investments, in contrast to significantly more effort and equipment that would be required to establish a temporary shore-based navigation system having accuracy and resolution equivalent to DGPS.

3.2.2 Navigation Equipment

For all surveys, SAIC will be responsible for installation, operation, and maintenance of the DGPS navigation system aboard the survey vessel. Identical hardware and navigation software will be used for all surveys to ensure positioning accuracy and data format compatibility. If two survey vessels are being used simultaneously, as during monitoring of placement operations (after the baseline surveys), the navigation systems and procedures used aboard both survey vessels will be identical.

An industry standard software product will be used for survey vessel positioning on all baseline surveys. This product offers a simple user interface for entry of target station locations and survey lanes, as well as excellent real-time display and data recording capabilities. A Global Positioning System (GPS) receiver will provide continuous GPS vessel position data, and a DGPS receiver will be used to acquire real-time DGPS corrections from USCG beacons in San Diego and Point Conception. The GPS and DGPS receivers will be interfaced to a personal computer with a 400 MHz processor for real-time display of vessel positions and data storage.

3.2.3 Data Quality Objectives, Calibration, and Quality Control

Data Quality Objectives

The sole objective for acquisition of navigation data during the baseline surveys is to achieve continuous vessel position data to an accuracy of ±1 to 3 m. All DGPS navigation data will be recorded and displayed in latitude and longitude coordinates, referenced to the North American Datum 1983 (NAD 83) geographic coordinate system.

Calibration and Quality Control

Prior to each survey, calibration of the DGPS system will be verified by acquiring 60 min of DGPS data at a shore-based location with a known geodetic position. These positions will be averaged to quantify the absolute accuracy of the DGPS data acquisition system. Absolute accuracy will be acceptable if the average error is less than 3 m.

3.2.4 Mobilization

Prior to initiation of the first baseline survey, the DGPS navigation equipment, PC-based data acquisition system, and software will be installed aboard the survey vessel, then tested at the pier to validate GPS and DGPS signal reception, as well as overall system functionality.

3.2.5 Data Acquisition and Dissemination

During sediment coring operations and acquisition of sediment profile images, vessel positions will be logged at the exact time the sampling equipment is lowered into the water, and at the time the sampling equipment reaches the seafloor. For each station, both positions will be logged and later used to determine the most accurate position for the sampling event. The acceptance criteria for sediment core and image collection is that the sample must be collected within a 3-meter radius watch circle of the specified sampling coordinates.

Vessel positions will be logged continuously at a sampling interval of 0.5 sec during the side-scan sonar and subbottom profiling surveys. The exact position of the towfish will be determined by adjusting the vessel position according to the “lay-back” (horizontal displacement behind the vessel’s DGPS antenna) of the towfish. These towfish positions will be merged with the geophysical data to yield an accurate position for each acoustic measurement.

Throughout the survey operations, the SAIC Navigator will be responsible for operation of the DGPS navigation system and manually recording all significant events and any problems encountered in the Navigation Log. Upon completion of each survey, the Navigator will provide to the Field Sampling Leader both the Navigation Log and a digital copy of all navigation data recorded during the survey. The Field Sampling leader will review the log for

accuracy and completeness. The Navigator also will provide one additional copy of all vessel navigation data to the data archive maintained by the DAN-LA GIS.

3.3 Sediment Profile Imaging and Plan View Photography

3.3.1 Rationale

The sediment profile camera (SPC) provides a cross-section photograph of surface and near-surface sediment on 35 mm slides. Each photographic image provides a 20 cm high by 14 cm wide "profile" of the surface and near-surface sediments. SPC images provide information describing sediment grain-size, sedimentary fabric, benthic infauna, and physical and biological processes. This technology has been used extensively to map the extent of sediment caps and deposits, conduct sediment quality surveys and sedimentation monitoring, and perform impact assessments associated with confined aquatic disposal (CAD), aquaculture, and oil exploration and production platforms.

For the baseline monitoring activities, SPC sampling will also incorporate plan view underwater photography. This technique generates a plan view (top down) photograph of the seafloor immediately prior to penetration of the SPC prism. This information complements the SPC data by providing a visual inspection of surficial features on the seafloor.

3.3.2 Sampling Equipment

Sediment profile images will be acquired using a Sediment Profile Camera. Figure 3-2 provides a schematic diagram of the camera and the sequence of operation on deployment. The camera consists of a wedge-shaped prism with a Plexiglas face plate; light is provided by an internal strobe. The back of the prism has a mirror mounted at a 45-degree angle to reflect the profile of the sediment-water interface toward the camera which is mounted horizontally on the top of the prism. The prism is filled with distilled water, through which the photographs are obtained. Because the object (sediment) to be photographed is directly against the face plate, turbidity of the ambient seawater is not a limiting factor.

The camera prism is mounted on an assembly that can be moved up and down by allowing tension or slack on the hydrowire. The rate of prism penetration into the bottom sediment is controlled by an adjustable, "passive" hydraulic piston.

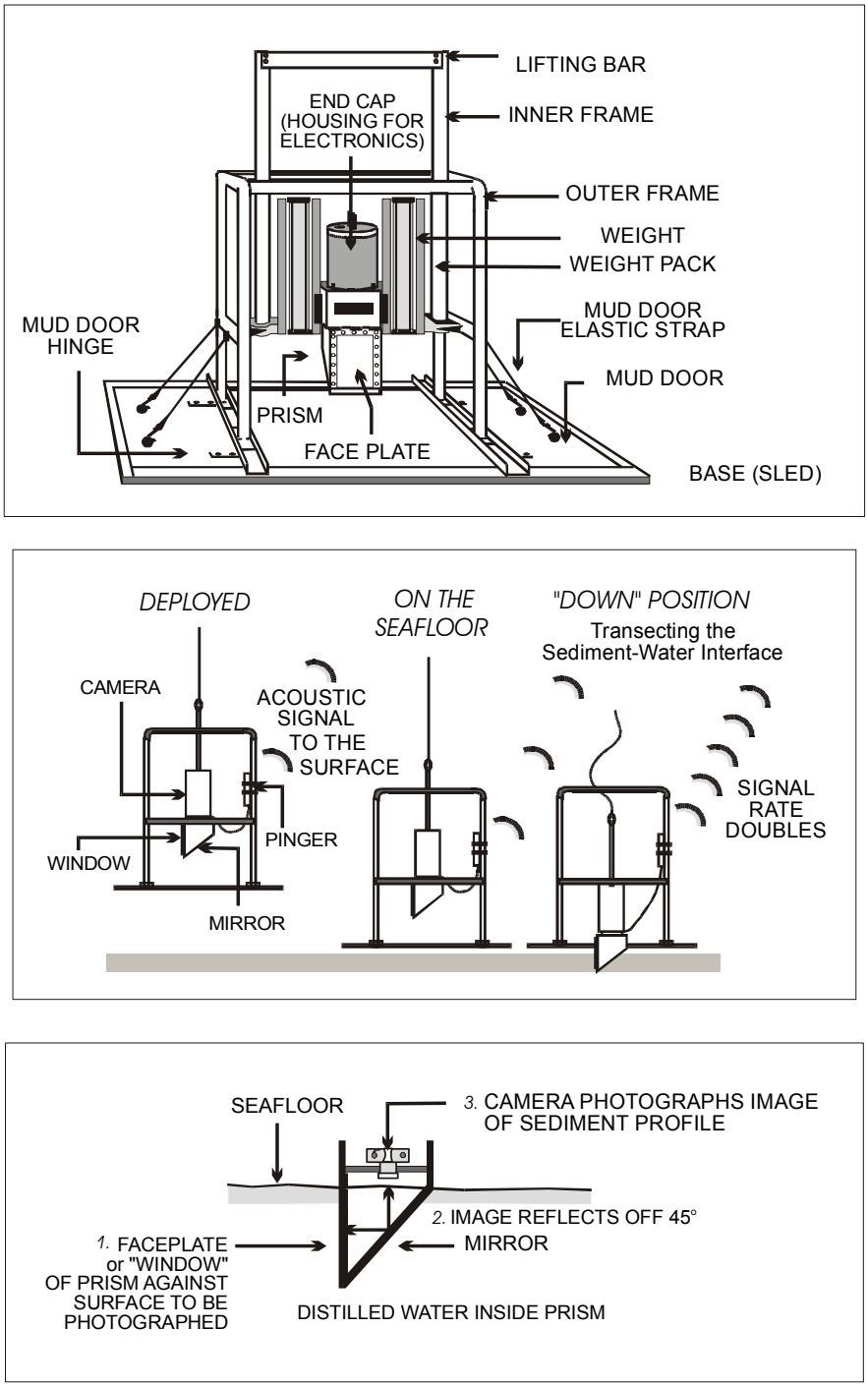

Figure 3-2. Schematic diagram of sediment-profile camera and sequence of operation on deployment.

The equipment and expendable supplies associated with the SPC sampling operations are listed below:

- Sediment Profile Camera
- 25 lb. lead weights (5 sets of 2)
- 7.2 volt rechargeable battery packs
- Pinger and hydrophone
- ASA 100 color slide film (36 exposures per roll)
- "Mud" doors to prevent over penetration into soft sediment
- Glass cleaner and paper towels
- Distilled water
- Winch and hydrowire
- Swivel for hydrowire
- SPC Field Log
- DGPS navigation system and sampling stations
- SPC tool kit with stainless hardware spares

Plan view images of the seafloor will be acquired using a downward-looking underwater 35 mm camera and strobe, which are mounted on the sediment profile camera. Primary components that will be mobilized for the baseline sampling include:

- Underwater 35 mm Camera and Strobe
- Synchronized Camera and Strobe Trigger Assembly
- ASA 100 Color Slide Film (36 exposures per roll)

3.3.3 Data Quality Objectives, Calibration, and Quality Control

Data Quality Objectives

Sediment profile imagery and plan view photography sampling objectives for the baseline program are addressed in the Data Quality Objectives section of this Project Work Plan. As specified in the Monitoring Plan for the Pilot Cap Program (Fredette et al. 2000), sediment profile images will be acquired at each station of the sampling plan. As described below, stations will be reoccupied and additional images and/or photographs will be acquired if good-quality images were not obtained during the first attempt at each station. This determination will be made following the first day of sampling operations and prior to mobilization for “make-up” stations.

Calibration and Quality Control

Prior to survey mobilization, the SPC camera head will be "bench-tested" to ensure that the camera is in focus and firing properly, and that the strobe is operational. The acceptance criteria for a bench test are that the strobe light must fire properly and at the correct time interval following activation of the trigger (typically 13 to 15 seconds), the film must advance, and the readout on the illuminated frame counter must show an advance by one. Spare camera parts, fully-charged battery packs, and an adequate number of film rolls will be stored aboard the vessel to ensure uninterrupted sample acquisition. The plan view camera also will be tested to ensure that the camera is firing properly and the strobe is operational. A fully charged spare plan view camera and strobe will be available as backup.

Three SPC images and three plan view images will be taken at each station. A real-time verification that the electronics within the sediment profile camera are functioning properly is provided by the pinger, which doubles its ping rate when the camera fires successfully (i.e., the pinger is synched with the strobe within the camera - if the strobe does not fire, it indicates that the camera has not been triggered properly or an electronic problems exists. If the strobe does fire, it is an indicator that an image has been acquired and the film within the 35-mm camera has been advanced. Therefore, firing of the strobe and the resulting doubling of the pinger rate are indicators that the camera is functioning properly). At regular intervals during each survey day, the frame counter is checked to make sure that the correct number of replicates has been taken. If images have been missed or the penetration depth is insufficient, then proper adjustments are made (e.g., weight is added to the frame) and additional replicates are taken. Two weight packs, each capable of holding 60 kilograms of lead (in 12-kilogram increments), can be loaded to increase penetration (e.g., for work in sandy or high shear strength, compacted sediments). If penetration is too great, adjustable stops can be lowered to control the distance the prism can descend. In addition "mud" doors can be attached to each side of the frame to increase the bearing strength of the entire unit.

3.3.4 Sampling Plan

For the baseline survey, SPC stations will be located within and surrounding each of the four pilot cells as prescribed by the Monitoring Program for the Palos Verdes Pilot Cap Project (Fredette, et al., 2000). The sampling plan shown in Figure 3-3 applies for each of the four pilot cells. At each cell, fifteen stations (I1 through I15) will be occupied within the cell boundaries, with the majority of stations being situated at the intersection of survey lanes established for the side-scan sonar and subbottom profiling surveys (see Sections 3.5 and 3.6). Additionally, ten SPC stations (O1-O10) will be located immediately outside of each cell, resulting in a total of 100 stations for the four-cell baseline survey. Three replicate SPC images will be collected at each station. Plan view photographs also will be acquired at each SPC station; typically, one plan view photograph will be obtained for each SPC photograph (penetration event). For each image, the camera is raised up about 2 m and then lowered back into the sediment. Because the survey vessel typically experiences some minor lateral movement while sampling, the action of raising the camera with the winch wire results in lateral movement of the camera. In this way, the camera rarely penetrates into sediment that has previously been disturbed by prior penetrations. Disturbances to the sedimentary features caused by prior penetration of the camera would be obvious in the sediment profile and plan view images. In these instances, the station would be re-occupied on a subsequent sampling day.

Tables 3-2a through 3-2d present the target position for each SPC station in each of the four pilot cells (LU, LD, SU and SD). As indicated, station designation will consist of cell, survey, and station number according to the following convention: cell-survey-station. For example, SPC Baseline station I9 in cell LU will be designated LU-B-I9.

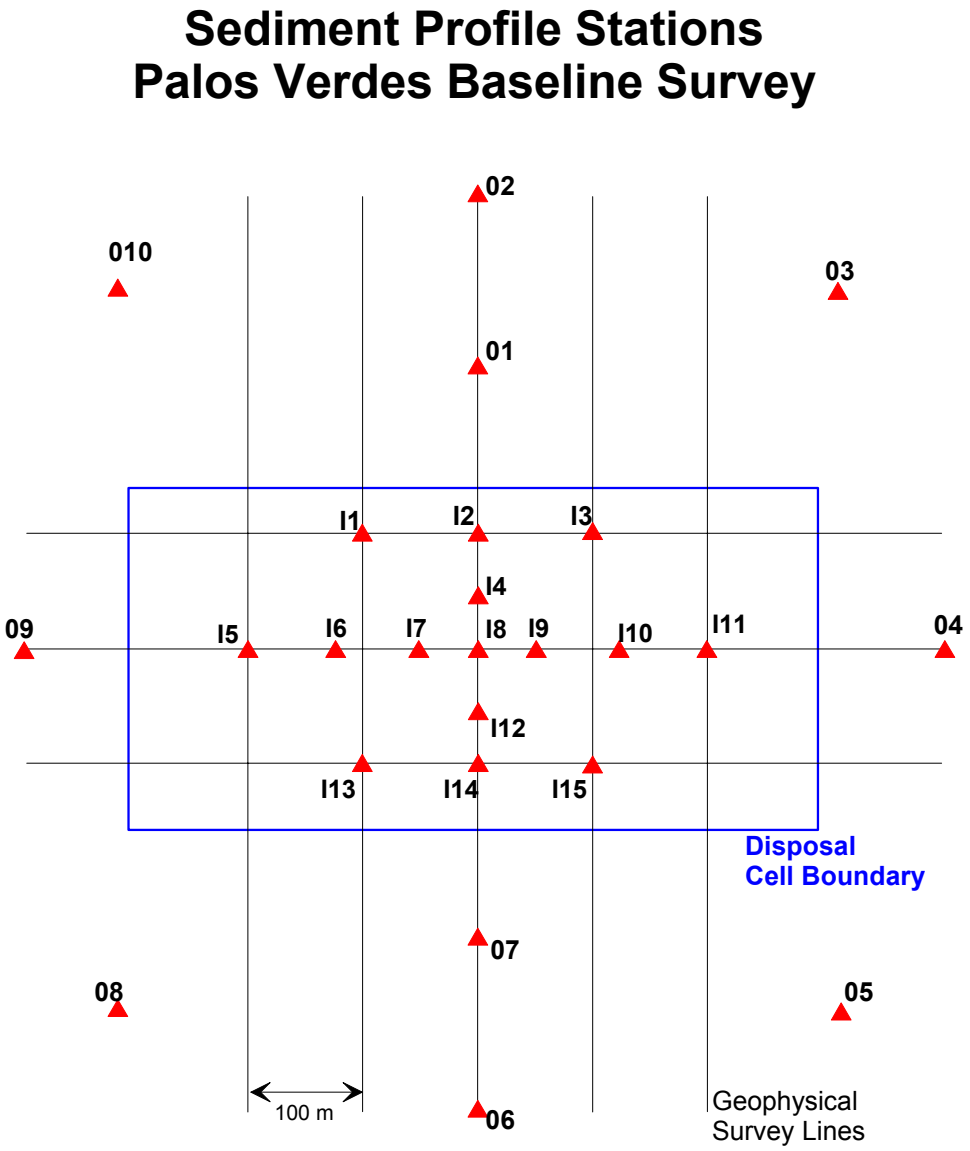

Figure 3-3. Schematic representation of the distribution of sediment profile imaging stations that will be occupied in each of the four experimental capping cells.

Table 3-2A. SVPS Station Locations for Baseline Survey in Cell LU

CELL LU	LATITUDE (N) NAD 83	LONGITUDE (W) NAD 83	STATE PLAN COORDINATES NAD 83	
			X	Y
Baseline Station Number				
LU-B-I1				
LU-B-I2				
LU-B-I3				
LU-B-I4				
LU-B-I5				
LU-B-I6				
LU-B-I7				
LU-B-I8				
LU-B-I9				
LU-B-I10				
LU-B-I11				
LU-B-I12				
LU-B-I13				
LU-B-I14				
LU-B-I15				
LU-B-O1				
LU-B-O2				
LU-B-O3				
LU-B-O4				
LU-B-O5				
LU-B-O6				
LU-B-O7				
LU-B-O8				
LU-B-O9				
LU-B-O10				

Table 3-2B. SVPS Station Locations for Baseline Survey in Cell LD

CELL LD	LATITUDE (N) NAD 83	LONGITUDE (W) NAD 83	STATE PLAN COORDINATES NAD 83	
			X	Y
Baseline Station Number				
LD-B-I1				
LD-B-I2				
LD-B-I3				
LD-B-I4				
LD-B-I5				
LD-B-I6				
LD-B-I7				
LD-B-I8				
LD-B-I9				
LD-B-I10				
LD-B-I11				
LD-B-I12				
LD-B-I13				
LD-B-I14				
LD-B-I15				
LD-B-O1				
LD-B-O2				
LD-B-O3				
LD-B-O4				
LD-B-O5				
LD-B-O6				
LD-B-O7				
LD-B-O8				
LD-B-O9				
LD-B-O10				

Table 3-2C. SVPS Station Locations for Baseline Survey in Cell SU

CELL SU	LATITUDE (N) NAD 83	LONGITUDE (W) NAD 83	STATE PLAN COORDINATES NAD 83	
			X	Y
Baseline Station Number				
SU-B-I1				
SU-B-I2				
SU-B-I3				
SU-B-I4				
SU-B-I5				
SU-B-I6				
SU-B-I7				
SU-B-I8				
SU-B-I9				
SU-B-I10				
SU-B-I11				
SU-B-I12				
SU-B-I13				
SU-B-I14				
SU-B-I15				
SU-B-O1				
SU-B-O2				
SU-B-O3				
SU-B-O4				
SU-B-O5				
SU-B-O6				
SU-B-O7				
SU-B-O8				
SU-B-O9				
SU-B-O10				

Table 3-2D. SVPS Station Locations for Baseline Survey in Cell SD

CELL SD	LATITUDE (N) NAD 83	LONGITUDE (W) NAD 83	STATE PLAN COORDINATES NAD 83	
			X	Y
Baseline Station Number				
SD-B-I1				
SD-B-I2				
SD-B-I3				
SD-B-I4				
SD-B-I5				
SD-B-I6				
SD-B-I7				
SD-B-I8				
SD-B-I9				
SD-B-I10				
SD-B-I11				
SD-B-I12				
SD-B-I13				
SD-B-I14				
SD-B-I15				
SD-B-O1				
SD-B-O2				
SD-B-O3				
SD-B-O4				
SD-B-O5				
SD-B-O6				
SD-B-O7				
SD-B-O8				
SD-B-O9				
SD-B-O10				

3.3.5 Mobilization

Prior to survey mobilization, the SPC camera head will be "bench-tested" to ensure that the camera is focused, firing properly, and that the strobe is operational. Spare camera parts, fully charged battery packs, and slide film will be kept aboard the survey vessel to ensure uninterrupted sampling operations.

At the beginning of each survey day, the time within the data loggers mounted on the SPC and plan view camera will be synchronized with the navigation system clock. Each SPC and plan view station replicate will be identified by the time recorded on the film and the corresponding time and position recorded by the navigation system. Redundant sample logs will be maintained by the field crew. Prior to actual sampling operations, test shots are fired on deck at the beginning of each roll of film to verify that all internal electronics systems are working according to specifications.

The DGPS navigation system will be monitored before the start of the survey to ensure that positional data are being recorded by the computer on the printer, plotter, and data storage medium (diskette). The navigation system also will be checked to ensure that the proper SPC sampling locations are entered into the survey database. The GPS master antenna will be installed as close as possible to the position where the SPC hydrowire enters the water (A-frame) so that the correct sampling position is recorded by the navigation system. The location of the master antenna will be recorded in the navigation log and used in the final position computations.

3.3.6 Data Collection

<u>SPC Sampling Operations</u>

The SPC frame is attached to the hydrowire on the vessel's winch. The camera prism is mounted on an assembly that can be moved up and down by producing tension or slack on the winch wire. As the camera is lowered, tension on the wire keeps the prism in the "up" position (see Figure 3-2). Once the camera frame contacts the bottom, slack on the wire allows the prism to vertically descend into the seafloor. The rate of descent of the optical prism into the sediment is controlled by a passive hydraulic piston. This allows the optical prism to descend at approximately 6 cm per second. The camera trigger is tripped by the prism assembly, activating a 13-second time delay on the shutter release, which gives the prism sufficient time to obtain maximum penetration before a photo is taken.

A pinger is attached to the camera and outputs a constant 12 kHz signal of one ping per second; upon discharge of the camera strobe, the ping rate doubles for 10 seconds. Monitoring the pinger's signal using a hydrophone suspended from the vessel allows confirmation that the camera/strobe unit fired; confirmation that a good-quality image was obtained cannot, however, be obtained until the film is developed.

As the camera is raised off the bottom, a wiper blade automatically cleans any sediment from the prism faceplate. The film is automatically advanced by a motor drive, the strobe capacitor is recharged, and the camera can be lowered for another replicate image.

When the camera is brought to the surface, the frame count is noted/verified by looking at digital counter display, and the camera prism penetration from the previous lowering is estimated from a penetration indicator that measures the distance the prism descended, relative to the camera base. If penetration is minimal, weight packs can be added to the camera frame to give the assembly increased penetration. If penetration is too great, adjustable stops (which control the distance the prism descends) can be lowered, and "mud" doors can be attached to each side of the frame to increase the bearing surface and reduce frame penetration into the seafloor. Because the SPC equipment is not used to collect samples for chemical analysis, there is no need to decontaminate the equipment between sampling stations.

Three replicate images will be taken at each SPC station. After a full roll of film has been exposed from multiple lowerings, the camera will be brought on deck of the vessel, and the film replaced. All completed rolls will be stored in a secure, dark location aboard the vessel. At the end of each survey day, the film will be developed by SAIC personnel using a portable film developer to ensure that adequate image quality was obtained and allow for "quick-look" analysis prior to the next day's survey. The developing will occur in a secure location and the developed film will either be kept in this secure location or else be held in the custody of the Field Leader at all times during the field operations. Any stations where three good quality images are not acquired are considered "make-up" stations and are re-occupied on the next survey in order to acquire the required three images. Because the SPC equipment is not used to collect samples for chemical analysis, there is no need to decontaminate the equipment between sampling stations.

Plan View Photography

The plan view camera system is mounted on the SPC frame. Photographs are taken using a weighted tension trigger that is suspended below the SPC frame. Just before the SPC reaches the bottom, the tension on the suspended trigger is released, and the plan view camera and strobe are fired simultaneously. The film is automatically advanced by a motor drive, and the strobe is immediately recharged for the next photograph.

Three replicate photographs will be acquired at each SPC station. At the end of each survey day, the exposed film will be removed from the plan view camera and developed to ensure that adequate image quality was obtained. If less than three good quality photographs were acquired at a particular station, the station will be reoccupied to acquire additional photographs.

3.3.7 Processing of Sediment Profile Images and Plan View Photographs

Following each day of SPC survey operations, the rolls of photographic film from both the sediment profile camera and the plan view camera will be transferred to the shore-based laboratory for film development and sediment profile image

processing. Information from the SPC Field Log, which documents daily sampling operations and vessel position data from the vessel-based DGPS navigation system, will be used during the analysis of survey results.

A full description of the various scientific analyses that will be conducted on the SPC images is provided in the QAPP; the following list identifies the most pertinent analyses for the baseline monitoring program.

- Optical prism penetration depth
- Sediment grain size determination
- Boundary roughness
- Sedimentary methane
- Apparent Redox Potential Discontinuity (RPD) depth
- Infaunal successional stages
- Organism-Sediment Index (OSI)

3.3.8 Dissemination of Survey Results

On the day following completion of the SPC survey, a brief SPC Survey Report summarizing sampling operations will be prepared and submitted to the LAD Project Manager or technical point of contact for review. Following LAD approval, this SPC Survey Report will be posted on the Palos Verdes Monitoring Project Website (PV-Web) for viewing by all project participants. Additionally, sediment profile images and plan view photographs will be posted on the Website within three days of survey completion; these images will be accompanied by a map indicating locations of all sampling stations, in relation to pilot cell boundaries.

Both the photographic images and the full tabular results from scientific interpretation of the SPC images will be populated on the DAN-LA GIS via CD-ROM updates, roughly two weeks after survey completion.

3.4 Sediment Coring

3.4.1 Rationale

Coring is a simple and effective field sampling technique for collection of sediment samples. A variety of coring devices are available for collection of marine sediments; selection of the optimum device depends upon sampling objectives, including: required depth of sediment penetration, volume of core sample needed, permissible disturbance of sample during coring, capabilities of lifting devices aboard the survey vessel, etc.

The sediment coring requirements of the baseline study are relatively simple: a single, undisturbed core with minimum sediment penetration of 20 cm must be acquired at numerous locations in the study area. To meet this sampling objective, a conventional gravity corer will be used in the field, and sealed core samples will be transported to shore daily for post-survey laboratory analysis. Analyses will include photography and visual description of split cores, as well as both geotechnical and chemical analyses of sediment samples acquired from various positions down-core.

3.4.2 Sampling Equipment

Sediment cores will be acquired using a conventional gravity corer. This device consists of a one meter long aluminum or steel core barrel, having an outside diameter of 4-in, attached to a weight stand (core head). The weight stand is constructed of heavy-gauge steel and is designed to accommodate varying amounts of weight. The individual lead weights are of a 'donut' configuration, weighing approximately 50 lbs. each. The weights slip over a center spindle and can therefore be adjusted for varying sediment types and consolidation characteristics. Generally, one or two test cores are required to fine-tune the weight requirements for a project site. The weight stand is designed to accommodate a maximum of 800 to 900 lbs., Additionally, the weight stand is equipped with a check valve, at the top of the spindle and in line with the core barrel, to allow water to pass freely through the aperture on descent through the water column. Further, there are four “fins” at the top of the weight stand to minimize rotation on descent. Finally, the whole device is manipulated by either a crane or winch and A-Frame via a lifting bail on top of the weight stand.

The core barrel is inserted into a collar using clamps on the lower side of the weight stand. A supply of core barrels will be pre-cut to accommodate 2.5-ft cores, as this will be sufficient to achieve the minimum penetration depth of 20 cm while preventing severe over-penetration yet maintaining control of the sediment core during deployment and recovery.

For each coring station, a 3.5-in inside diameter butyrate core liner will be inserted into the core barrel and retained mechanically by a steel core cutter that is attached at the end of the core barrel to facilitate impact with the seafloor. The core cutter/catcher assembly is attached to the core barrel using rivets or other mechanical fasteners.

The following field equipment and supplies will be mobilized for collection of sediment cores:

- Gravity corer (2 each)
- 4-in OD aluminum core barrels; barrels are shipped in 10- and 20-ft lengths and will be cut down to the appropriate lengths. Several barrel sections will be available on the vessel for repeat sampling or to replace damaged barrels
- Core cutter and core catcher; spares will be kept aboard the vessel
- 3.5-in ID core liners (2.5-ft lengths); 50% spares will be kept aboard the vessel to allow multiple coring attempts at stations where poor penetration is achieved on initial coring attempt
- 3.5-in endcaps for core liner storage during transit to shore processing facility
- Additional lead weights to increase sediment penetration, if necessary
- Coring Field Log
- Sterile gloves for handling core liners and sediment
- Permanent markers for labeling core liners
- Electrical (33 or 99 wt.) tape for securing endcaps
- Complete mechanical tool set for assembly/disassembly of gravity corer
- Equipment for collecting and retaining excess site sediment and associated waters.

3.4.3 Data Quality Objectives, Calibration, and Quality Control

Data Quality Objectives

Sediment core sampling objectives for the baseline program are addressed in the Data Quality Objectives section of this Project Work Plan. As specified in the Monitoring Plan for the Pilot Cap Program (Fredette, et al., 2000), cores will be collected at nine sites within each of the four cells. (The Monitoring Plan does not require sampling outside of the cell or provide justification for this station placement.) A single core will be obtained at seven of the nine locations within each of the four pilot cells. At two of the nine sites per cell (selected randomly), duplicate (co-located) cores will be collected. At these two sites, the first core will be processed for sediment chemistry (i.e., p,p-DDE) and geotechnical parameters, and the second core will be processed for specific geotechnical parameters only. Field duplicate samples for chemical quality assurance analyses will be removed from single core intervals (see Section 3.4.6).

Calibration and Quality Control

Due to the simplicity of the gravity coring device that will be used for sampling, there are no calibration issues associated with this sampling task. Physical marking of core liners according to station number, core number, top of core, etc., and documentation of sampling operations in the Coring Field Log constitute the only activities that will require care in sample handling and field documentation.

3.4.4 Sampling Plan

For the baseline survey, one or more sediment cores will be collected at each of nine coring stations within each of the four pilot cells as prescribed by the Monitoring Program for the Palos Verdes Pilot Cap Project (Fredette, et al., 2000). The sampling plan shown in Figure 3-4 applies for each of the four pilot cells. All stations are located at the intersection of survey lanes established for the side-scan sonar and subbottom profiling surveys (see Sections 3.5 and 3.6). A single core will be collected at each of seven sites within each cell, whereas two cores will be collected at each of two selected sites (the center site and another site selected at random). .The duplicate cores will be used for vane shear measurements and bulk density and Atterberg Limit analyses. A field blank will also be collected.

Tables 3-3a through 3-3d present the target position for each coring station in each of the four pilot cells (LU, LD, SU and SD), respectively. As indicated, core identification number will consist of cell, survey, station number, and duplicate core number to ensure that each core has a unique identification number for each of the baseline, interim and post-cap coring surveys. For example, the first core (D1) obtained at baseline coring station C4 in cell LU will be designated LU-B-C4-D1.

3.4.5 Mobilization

Prior to the survey, all components of the gravity coring system and a supply of core liners will be transferred to the survey vessel. The inventory list will include a sufficient supply of spare equipment, core liners, and endcaps to ensure that all sampling objectives can be met without delays caused by equipment availability.

Before the start of the survey, the DGPS navigation system will be installed aboard the vessel and tested to ensure that accurate DGPS position data are being recorded by the computer on the printer, plotter, and data storage medium (diskette). The navigation system also will be checked to ensure that the proper core sampling locations are entered into the survey database. The GPS master antenna will be installed as close as possible to the position where the hydrowire enters the water (A-frame) so that the correct sampling position is recorded by the navigation system; its position will be recorded in the navigation log.

The shore-based core processing facility also will be mobilized prior to survey initiation to ensure that all equipment and supplies are ready on the day cores are brought to shore. Additionally, all arrangements will have been made for overnight shipment and chain of custody for sediment samples being shipped to the geotechnical and chemical laboratories.

3.4.6 Sample Collection

The sampling objective is to obtain good quality (relatively undisturbed) sediment samples to a depth of 20 cm below the sediment-water interface. Prior to the initial deployment of the gravity corer, the core cutter and catcher will be decontaminated by washing with laboratory-grade, nonphosphate detergent, followed by a tap water rinse, followed by a deionized water rinse, followed by a pesticide-grade methanol rinse, and ending with a pesticide-grade hexane rinse and air drying. Thereafter, during its use in the field, the gravity corer will be rinsed thoroughly with filtered seawater between samples.

Horizontal positioning of the survey vessel to the target station location will use the DGPS navigation system described in Section 3.2. When the survey vessel is positioned on station, the gravity corer, tethered by wire rope from a winch, will be lowered to the seafloor. Corer impact with the seafloor will be apparent from a sudden decrease in tension of the winch wire. Our experience with gravity coring in 200-ft water depths using 3/8-in diameter wire suggests that we will not have difficulties detecting the core's impact with the bottom. The ship's position is logged at the time the sampler impacts the bottom. If the ship is outside the watch circle, the sample will be re-collected.

The actual depth of sediment inside the core liner (sample recovered) may be less than the core barrel's penetration into the bottom sediment, depending on the degree of sediment compaction during penetration, and any potential loss of sample out of the bottom of the core liner (past the core catcher). In soft fine-grained sediments, typical sample

recoveries using gravity corers range from 75 to 85 percent of the penetration depth. If the bottom sediments are composed of coarser-grained materials, there is typically less compaction, but core penetration is usually less due to difficulty in penetration in harder substrate. In such cases where insufficient core penetration is encountered, more weight will be added to the weight stand and another core attempt will be made at that station.

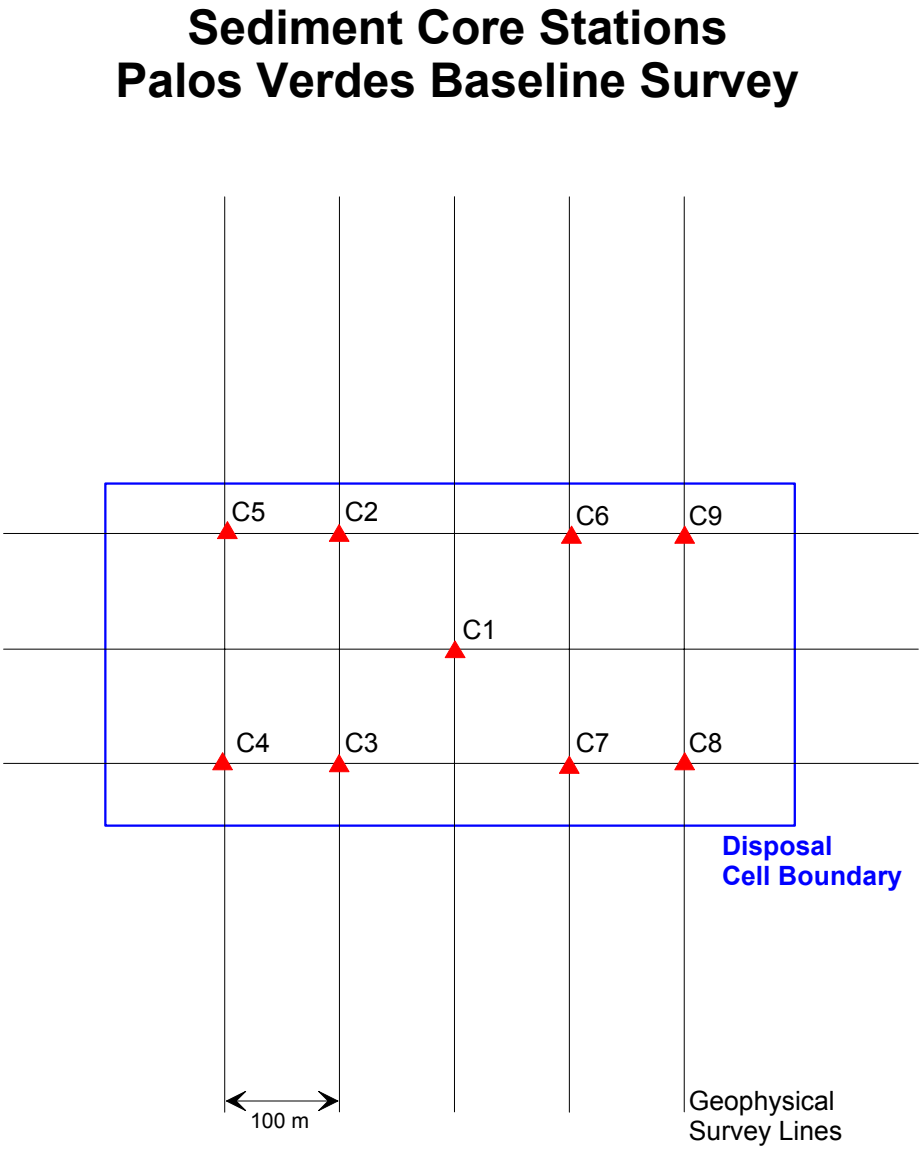

Figure 3-4. Schematic representation of the distribution of core sampling stations that will be occupied in each of the four capping cells.

Table 3-3A. Sediment Core Locations for Baseline Monitoring in Cell LU

CELL LU Station Number	LATITUDE (N) NAD 83	LONGITUDE (W) NAD 83	STATE PLANE COORDINATES (NAD 1983)	
			X	Y
LU-B-C1-Dx	33.7089	-118.34545	1967974.98	523227.94
LU-B-C2-Dx	33.71016	-118.34574	1967947.77	523367.64
LU-B-C3-Dx	33.70863	-118.34694	1967836.37	523198.55
LU-B-C4-Dx	33.70912	-118.34785	1967752.4	523253.51
LU-B-C5-Dx	33.71065	-118.34665	1967863.9	523422.75
LU-B-C6-Dx	33.70918	-118.34395	1968113.82	523258.58
LU-B-C7-Dx	33.70766	-118.34515	1968002.21	523089.99
LU-B-C8-Dx	33.70716	-118.34423	1968086.99	523034.51
LU-B-C9-Dx	33.70868	-118.34304	1968198.12	523203.18

Table 3-3B. Sediment Core Locations for Baseline Monitoring in Cell LD

CELL LD Station Number	LATITUDE (N) NAD 83	LONGITUDE (W) NAD 83	STATE PLANE COORDINATE (NAD 1983)	
			X	Y
LD-B-C1-Dx	33.71494	-118.35575	1967021.81	523901.29
LD-B-C2-Dx	33.71621	-118.35598	1967001.2	524042.19
LD-B-C3-Dx	33.71474	-118.35726	1966882.37	523879.63
LD-B-C4-Dx	33.71527	-118.35813	1966801.93	523939.15
LD-B-C5-Dx	33.71674	-118.35685	1966920.72	524101.54
LD-B-C6-Dx	33.71514	-118.35424	1967162.28	523923.39
LD-B-C7-Dx	33.71367	-118.35552	1967043.2	523760.63
LD-B-C8-Dx	33.71314	-118.35465	1967123.45	523701.25
LD-B-C9-DX	33.71461	-118.35337	1967242.61	523864.15

Table 3-3C. Sediment Core Locations for Baseline Monitoring in Cell SU

CELL SU Station Number	LATITUDE (N) NAD 83	LONGITUDE (W) NAD 83	STATE PLANE COORDINATE (NAD 1983)	
			X	Y
SU-B-C1-Dx	33.70437	-118.34899	1967644.69	522726.63
SU-B-C2-Dx	33.70561	-118.3493	1967616.38	522864.67
SU-B-C3-Dx	33.70414	-118.35045	1967509.24	522702.14
SU-B-C4-Dx	33.70464	-118.35135	1967425.58	522757.56
SU-B-C5-DX	33.70611	-118.35021	1967532.41	522919.62
SU-B-C6-DX	33.70464	-118.34752	1967781.45	522756.6
SU-B-C7-Dx	33.70317	-118.34867	1967673.36	522593.43
SU-B-C8-Dx	33.70266	-118.34775	1967759	522536.71
SU-B-C9-Dx	33.70414	-118.34659	1967867	522700.63

Table 3-3D. Sediment Core Locations for Baseline Monitoring in Cell SD

CELL SD Station Number	LATITUDE (N) NAD 83	LONGITUDE (W) NAD 83	STATE PLANE COORDINATE (NAD 1983)	
			X	Y
SD-B-C1-Dx	33.71056	-118.35955	1966667.81	523416.99
SD-B-C2-Dx	33.71182	-118.35979	1966646.36	523556.76
SD-B-C3-Dx	33.71039	-118.36103	1966530.6	523398.33
SD-B-C4-Dx	33.71092	-118.36191	1966449.7	523457.59
SD-B-C5-Dx	33.71236	-118.36066	1966565.79	523616.33
SD-B-C6-Dx	33.71076	-118.35805	1966807.15	523437.91
SD-B-C7-Dx	33.70933	-118.35929	1966691.86	523280.22
SD-B-C8-Dx	33.7088	-118.35842	1966772.38	523221.24
SD-B-C9-DX	33.71022	-118.35718	1966887.39	523378.55

When the corer is brought aboard following collection of a bottom sample, the corer is held in a horizontal position, the core cutter and catcher are then removed from the lower end of the core barrel, a core cap is placed on the end of the liner and taped in place, then the core liner is removed from the barrel. Next, the core liner is held vertically and a small hole is drilled into the core liner about 1 cm above the sediment-water interface to allow any water that may be trapped above the sediment sample to be removed. (If this interface is not immediately visible, then the core liner is held vertically until all suspended sediment has settled and the interface is apparent.) Lastly, a core cap is taped in place on the top of the corer liner, and the liner is labeled with the station number, core replicate (if multiple cores were acquired at the same station), and core top/bottom. The cores will be stored upright on wet ice (at approximately 4˚C)in a dark container until brought ashore at the end of the sampling day. All cores will be returned to the shore-based laboratory. Excess sediments will be returned to the laboratory for disposal; none of the sediments will be disposed to the ocean.

Core liners are dedicated, one-time use items. Therefore, decontamination of core liners prior to use is not necessary.

A summary of sediment chemistry and related quality assurance samples that will be collected for the baseline survey is presented in Table 3-4.

During at sea operations, all information concerning the collection of cores will be entered in a Coring Field Log. This information will include at a minimum: station number, date, time of collection, DGPS position, water depth at station, visual indicators of the depth to which the core penetrated into the sediment, and any other features that may affect the quality of the coring results.

3.4.7 Core Sectioning and Sample Processing

Shore-Based Processing of Cores

Cores will be transported to shore on the day they are collected. Processing of cores, including splitting, core photography, visual descriptions, and subsampling will occur on the day after collection. The following equipment and supplies will be used for core processing:

- Processing table, router, and supplies (e.g., gloves, foil, coolers, plastic drop cloth)
- Core splitting device, hacksaw, and utility knives
- Camera stand and lighting
- Digital camera, flashcards, and batteries
- Measuring stick
- Materials for laboratory cleanup
- Pesticide grade solvents (hexane and methanol) and laboratory detergent for decontamination

Table 3-4. Summary of Sediment Chemistry and Grain Size Samples

SAMPLE NAME	NUMBER TO BE COLLECTED IN THE FIELD	DESCRIPTION	PURPOSE
Field sample	180 (9 cores from 4 cells, and 5 samples per core)	A single sample of sediment to be collected from each 4 cm interval from 0-20 cm within the cores and analyzed for p,p-DDE, grain size, and density. Vane shear measurements made on intact cores at same sampling intervals.	Evaluation of vertical distribution of p,p-DDE, grain size, and density in surface sediments within the pilot capping cells
Field duplicate	18 (1 duplicate for each batch of 10 samples)	A second (duplicate) sample of sediment to be removed from each 4 cm interval within selected cores and analyzed for p,p-DDE, grain size, and densitry. To be sent to the laboratory as a blind duplicate.	Check on laboratory analytical precision
Field blank	1	Two 1-liter containers of distilled water are opened on the table where the cores are being processed and left open for the same period of time that the core section is exposed to air during the core subsampling procedure. Sent to the laboratory for analysis of p,p-DDE (note: only one of the 1-liter containers is required for analysis - the second represents a back-up sample). No field blanks for grain size or density.	Check on possible contamination of the sediment in the core from the core processing facility/core processing operation.
Core liner rinsate sample	1	Distilled water is poured through a core liner (chosen at random from among those used in the field) and collected in two 1-liter containers, sent to the laboratory for analysis of p,p-DDE (note: only one of the 1-liter containers is required for analysis - the second represents a back-up sample). No rinasate samples for grain size or density.	Check on possible contamination of the collected sediment from the inside of the core liner.
Core tool rinsate sample	9 (1 rinsate per 20 field samples)	The implements used for removing sediment from each 4-cm core interval (i.e., stainless steel spoon/spatula) will be decontaminated between each sampling event (i.e., prior to sampling of each core interval). At regular intervals (e.g., every 20 samples), the spoon will be rinsed with distilled water at the end of the decontamination procedure but before the sediment sample is taken. The rinsate will be collected in two 1-liter containers and sent to the laboratory for analysis of p,p-DDE (note: only one of the 1-liter containers is required for analysis - the second represents a back-up sample). No rinasate samples for grain size or density.	Check on the adequacy of the decontamination procedure to remove residual p,p-DDE from the sampling implements between samples.

Extraction of Sediment Core Samples for Geotechnical and Chemical Analyses

The following equipment and supplies will be used for subsampling sediment cores:

- Chemically inert or decontaminated stainless steel scoops for sediment aliquots and transfers
- EPA 3000 Certified clean jars (with certification) with Teflon lined caps for chemistry samples (consistent with EPA, 1992. *Specifications and Guidance for Contaminant Free Sample Containers.* OSWER Directive #9240 0-05A)
- Polyethylene containers (10 cc) for bulk density samples
- Coolers for sample shipping
- Preservatives (wet ice) for shipping samples
- Resealable plastic bags for grain size and bulk density samples
- Custody seals
- Chains of Custody
- Sample Labels
- Vane shear apparatus

Sample containers, preservation, and holding times are listed in Table 3-5. Duplicate cores for vane shear and Atterberg limit analyses will be processed in the same manner as the other cores.

Table 3-5. Sample Containers, Preservatives, Sample Mass, and Holding Time Requirements for Sediment Core Samples.

Parameter	Container	Preservative	Min. Sample Mass	Holding Time
p,p'-DDE	250-mL wide-mouth glass jar, certified clean, with lids lined with chemcially-inert material	4° C, freeze upon receipt at laboratory	100 g wet weight (includes primary analysis [20 g] and QC analyses and archival material)	14 days if not frozen; up to 1 year if frozen; 40 days for extracts
Grain Size/Density	Resealable plastic bags	4° C	500 g for grain size; approximately 15 g (10 cc) for bulk density	6 months
Vane Shear	None; measured in laboratory	4° C	Not applicable	Analyzed in laboratory
Atterberg Limit	Resealable plastic bags (1 gal size)	4° C	Approximately 600 mL	6 months

Sediment cores will be stored in the dark on wet ice (approximately 4° C) at SCMI until processed. Prior to splitting the core tubes, excess core length will cut off immediately above the sediment/water interface. The excess core liner will be retained for future disposal as hazardous waste. The remaining core (with the sediment sample) will be placed on the splitting table and the external surface of the core liner will be scored using hand-held router. The core liner will be cut using a clean utility knife, and the sediment core split horizontally into two halves using a taut wire (core splitting device). One half of the core will be processed for sediment chemistry samples. Samples will be collected immediately at 4-cm intervals from the top to a depth of 20 cm from one half of the core. The

remaining (undisturbed) half of the core will be photographed and the core log prepared. After the core log is complete, vane shear measurements will be performed in the approximate center of each 4-cm interval (i.e., 2 cm, 6 cm, 10 cm, 14 cm, and 18 cm), and then sediment samples for physical analysis (grain size and bulk densitry) will be collected. The remaining core material will be archived or saved for offsite disposal.

Each 4-cm interval is expected to contain approximately 600 grams wet weight of sediment. Approximately 100 g of sediment will be removed from each horizon using pre-cleaned stainless steel or chemically inert spatulas and placed in pre-cleaned glass jars for analyses of p,p'-DDE. A 100-g sample will provide adequate mass for analyses of p,p-DDE (approximately 20 g wet weight) plus quality assurance samples (e.g., matrix spike/matrix spike duplicates). Chemistry samples will not be composited or homogenized prior to placement in sample jars. For selected core intervals, two subsamples of approximately 50 g each will be removed and placed in separate jars. The second subsample will constitute a field duplicate sample, and these will be collected at an overall frequency of 10% (i.e., total of 18 duplicate samples). The samples for chemical testing will be handled in such a manner as to preclude the contamination of or loss of any of the sampled sediments. The sample containers will be sealed to prevent any moisture loss and/or possible contamination.

Equipment used to section the sediment cores and subsample the sediment intervals will be scrubbed with laboratory-grade detergent, rinsed with potable water, ASTM reagent water or equivalent reagent-grade water, pesticide grade methanol, and pesticide-grade hexane, in that order. All equipment used to dispense ASTM Type II reagent grade water or equivalent reagent water, pesticide-grade methanol, and pesticide-grade hexane will be glass or suitable inert material. Plastic dispensing devices are prohibited.

Equipment rinsate blanks will be prepared for sampling tools used to remove the sediment core intervals. Equipment rinsate blank data assess the efficiency of equipment decontamination procedures in preventing/minimizing cross-contamination between samples. Equipment rinsate blanks will be collected by pouring ASTM Type II reagent water or equivalent reagent water into/through/over sampling equipment that has been decontaminated and then collecting the water into prepared sample bottles (i.e., 1.0 liter brown glass bottles with screw cap lids with liners of inert material). One equipment rinsate blank will be prepared for every 20 sediment interval sample collected. These sample bottles will be randomly selected for the supply of prepared sample bottles. The equipment rinsate blanks will be handled and analyzed in the same manner as the marine sediment samples.

The field blank will be prepared at the SMCI facility as the sediment core intervals are processed . Field blank data indicate the baseline contamination that may be introduced by reagent-grade or potable –quality water used in the field effort. The field blank will be prepared by pouring ASTM Type II or other equivalent reagent water used for equipment decontamination into prepared sample bottles (i.e., 1.0 liter brown glass bottles with screw cap lids lined

with a chemically inert material). These sample bottles will be randomly selected for the supply of prepared sample bottles. The field blanks will be handled and analyzed in the same manner as the marine sediment samples.

The sediment grain size samples (approximately 500 g) will be placed in sealable plastic bags. Duplicate samples for grain size will be removed from the sample container with the primary sample after the material has been homogenized. Bulk density samples will be collected in small plastic tubes (10 cc capacity obtained from Texas A&M University), that are inserted into the core section used for vane shear measurements. The tubes containing sediments will then be removed and placed inside a plastic resealable bag. Duplicate samples will be collected in the same manner, at an overall frequency of 10% After sample containers are filled and sealed, they will processed for shipment to the laboratory.

The two co-located cores collected from each of the four cells will be used for Atterberg limit samples and vane shear measurements. These cores will be divided into two horizons of 0-10 cm and 10-20 cm, unless visible core layering is evident. Samples for Atterberg limit analyses will be removed from the cores and placed in plastic, resealable bags. Vane shear measurements will be made on-site. If the core contains visually distinctive layering, separate vane shear, bulk density, and Atterberg Limit samples will be collected from each layer.

Excess sediments and used core liners will be stored on site, and later disposed as hazardous wastes.

Labels will be placed on sample jars containing sediments for chemical analysis. An example of a sample label is shown in Figure 3-5.

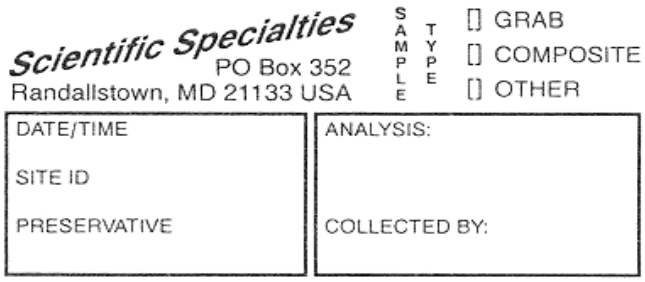
Scientific Specialties
PO Box 352
Randallstown, MD 21133 USA
SAMPLE TYPE
[] GRAB
[] COMPOSITE
[] OTHER
DATE/TIME
SITE ID
PRESERVATIVE
ANALYSIS:
COLLECTED BY:

Figure 3-5. Example label for sediment chemistry samples removed from cores.

All samples will also be listed on a chain-of-custody form, which will accompany the sample shipment. An example of a chain-of-custody form is shown in Figure 3-6. Sample jars will placed in insulated coolers containing wet ice, along with a temperature blank, sealed, and transferred to the custody of an overnight carrier for transport to the appropriate subcontractor laboratory. Temperature blanks will be prepared by filling 40-mL vials with

refrigerated (i.e., to 4°C) portable water and placed in the cooler with the environmental and field QC blank samples immediately before the sample cooler is packaged for shipping to the laboratory. The temperature of the cooler blank will be taken immediately after the sample cooler is opened at the laboratory and the data recorded on the chain-of-custody form. Cooler blank data assess the effectiveness of the ice used to maintain the cooler temperature between 4°C and 8°C.

Chain-of-Custody Record

Woods Hole Group
Environmental Laboratories

375 Paramount Drive
Raynham, MA 02767

TEL: (508) 822-9300
FAX: (508) 822-3288

PAGE ___ OF ___

COMPANY INFORMATION	COMPANY'S PROJECT INFORMATION	SHIPPING INFORMATION	VOLUME/CONTAINER TYPE/ PRESERVATIVE (NOTE 4)
Name:	Regulatory Protocol:	Carrier:	
Address:	For the State of:	Airbill Number:	
	Project Name:	Date Shipped:	
	Project Number:	Quote #:	
Telephone:	P.O. #		
Facsimile:	Sampler Name(s):		
Contact Name:	TAT ___ 10 Day ___ 5 Day ___ 3 Day ___ 48 Hr ___ 24 Hr ___ Other		

WHG LAB #	SAMPLE ID (NOTE 1)	COLLECTION DATE	COLLECTION TIME	COMPOSITE GRAB	MATRIX	ANALYSIS/REMARKS (NOTE 2, 3)	NUMBER OF CONTAINERS

Relinquished by: (signature)	DATE	TIME	Received by: (signature)
Relinquished by: (signature)	DATE	TIME	Received by: (signature)
Relinquished by: (signature)	DATE	TIME	Received for Laboratory by: (signature)

NOTES TO SAMPLER (S): (1) Limit Sample Identification to 6 characters, if possible; (2) Indicate designated Lab Q.C. sample and type (e.g.; MS/MSD/REP) and provide sufficient sample; (3) Field duplicates are separate sample; (4) e.g.; 40ml/glass/H_2SO_4

Notes to Lab:

We cannot accept verbal changes - Please Fax written changes to (508) 822-3288

Figure 3-6. Example of chain of custody form to be used for shipment of sediment chemistry samples to Woods Hole Group environmental laboratory.

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3.4.8 Dissemination of Survey Results

On the day following completion of the coring survey, a brief Coring Survey Report summarizing sampling operations will be prepared and submitted to the LAD Project Manager or her designated technical point of contact. Following LAD approval, this Coring Survey Report will be posted on the Palos Verdes Monitoring Project Website (PV-Web) for viewing by all project participants.

Results from the basic processing of the sediment cores, including core photographs and visual core descriptions, will be available within two days of completion of the baseline coring operations. This preliminary information will be posted on the PV-Web; images will be accompanied by a map indicating locations of all coring stations, in relation to pilot cell boundaries. These data will later be populated on the DAN-LA GIS via CD-ROM updates.

Chemical and geotechnical results from laboratory analysis will be provided via the DAN-LA GIS according to a schedule discussed in the QAPP.

3.5 Side-Scan Sonar Surveying

3.5.1 Rationale

One of the most commonly used systems for generating two-dimensional maps of seafloor features is side-scan sonar. This system consists of a vessel-based data acquisition system connected electronically to a "towfish" which contains acoustic transmitting and receiving circuitry. In normal operation, the towfish is towed behind the survey vessel while traversing predetermined survey lanes. Acoustic transducers on the towfish project acoustic signals outward laterally from both sides to obtain information on seafloor characteristics at 90-degree angles from the vessel track. The acoustic beam propagates through the seawater and ensonifies the seafloor. A portion of the incident acoustic energy is reflected backward, with part of the return signal reaching the acoustic receivers of the side-scan towfish. Although the acoustic return signals are weak, amplifiers in the side-scan electronics boost the amplitude of the return signals so that high resolution data on seafloor characteristics can be obtained at considerable distances on both sides of the vessel track. Physical objects as small as 0.5 m in size, and small-scale sedimentary features (e.g., rock outcrops, sand ripples, trawl scour marks, etc.) can be clearly delineated from the sidescan records.

Early side-scan sonar technology was based upon analog recorders that produced only graphic "strip-chart" records of side-scan data along survey lanes. In recent years, digital data acquisition systems have been developed to greatly improve the resolution of side-scan data, as well as allow direct merging of vessel position and digital data storage for post-survey processing and mosaicing. The improved resolution of digital data acquisition systems is required to meet the DQO of distinguishing between the capping material and the ambient EA sediments.

This surveying technique will be used to assess seafloor characteristics in the vicinity of the four pilot cells. The baseline survey results will indicate any heterogeneity in seafloor characteristics within the pilot area, as well as facilitate later comparison with survey results acquired from the identical seafloor area following placement of cap material, in order to assess the spatial coverage and potential spreading of cap material. This spatial information (100% bottom coverage) will compliment data and information to be acquired at a limited number of station locations from sediment cores, sediment profile images, and plan view photographs of the seafloor. The side-scan data also will be compared with subbottom profile results obtained acoustically along the same side-scan survey lanes, as described in Section 3.6.

3.5.2 Sampling Equipment and Methods

For the surveys associated with the Pilot Cap Monitoring Program, a state-of-the-art side-sonar system will be used for acquisition of two-dimensional seafloor data in the vicinity of the four pilot cells. The system will consist of an digital side-scan towfish interfaced to a top-side sonar data acquisition system. The system is dual-frequency capable of simultaneously emitting and receiving sound waves at both 100 and 500 kHz frequencies. The side-scan sonar data acquisition system will be configured to collect seafloor imagery data 100 m on either side of the towfish, resulting in a total swath coverage of 200 m along each survey lane. With the 100-m lane spacing established for each cell, side-scan data coverage within each cell will be approximately 200%. The sampling rate is 150 milliseconds, equivalent to approximately six measurements per second. All sonar returns are digitized to 12-bit high-resolution data within the towfish, merged with vessel heading information from the built-in compass, and transmitted to the top-side data acquisition unit via a high-speed digital uplink.

Aboard the survey vessel, the sonar acquisition system is used for archiving and display of the digital side-scan data. The system integrates the raw sonar image data with towfish position information provided by the onboard, DGPS-based vessel navigation system. The merged data are stored on Magneto-Optical disks for playback and post-processing.

In addition to data storage, the system displays the high-resolution sonar imagery in real-time on a computer monitor. Vessel speed over the ground and slant range corrections are applied in real-time to the data so that images are displayed with the correct aspect ratio. In this manner, the geodetic position of targets and other seafloor features can be determined in near real time

Hardcopy side-scan records are generated on an EPC 1086 high-resolution thermal printer. The hardcopy record is annotated with event marks at equally spaced intervals listing the date, time, towfish position, speed over the ground, and associated filename for correlation with the digitally stored sonar data.

3.5.3 Data Quality Objectives, Calibration, and Quality Control

Data Quality Objectives

Side-scan sonar survey objectives for the baseline program are addressed in the Data Quality Objectives section of this Project Work Plan. As specified in the Monitoring Plan for the Pilot Cap Program (Fredette, et al., 2000), side-scan lanes will be spaced at 100-m intervals. The side-scan system will be operating with 100-m range (on each side of the vessel track) to achieve 100% bottom coverage in the pilot cells. This coverage will provide an excellent data set from which to identify any spatial variations in seafloor characteristics (e.g., bottom roughness), and possibly sediment characteristics, that may exist within the pilot study area. Furthermore, the side-scan results will also provide a spatial context to the "point measurements" of sediment characteristics derived from the sediment cores and the sediment profile images.

Calibration and Quality Control

As described in Section 3.5.5, electronic tests of the side-scan system and towfish will be conducted prior to deployment for survey operations to ensure that all system components are fully operational. For purposes of quality control during survey operations, side-scan sonar data will be acquired along intersecting survey lanes, which will allow post-survey comparison of data from two independent measurements at 15 locations in each pilot cell surveyed. These data will be used to assess the repeatability of the seafloor characteristics information (as inferred from the side-scan data) and any dependence upon survey operations such as vessel speed and heading, sea state and water depth.

3.5.4 Survey Plan

For the baseline survey of the Pilot Cap Monitoring Program, side-scan sonar data will be acquired over an area that spans the four cells (LD, LU, SD and SU) targeted for the pilot program (Figure 3-7). Data will be acquired along both parallel and intersecting survey lanes spaced 100 meters apart, as prescribed by the Monitoring Program for the Palos Verdes Pilot Cap Project (Fredette, et al., 2000).

Within each cell, five survey lanes will be oriented perpendicular to the long (600-m boundary) of the cell, whereas three lanes will be oriented perpendicular to the short (300-m boundary) of the cell. The middle lane in each direction will pass through the geometric center of the cell.

Because the four cells are nearly adjacent, each survey lane will traverse two cells, such that only 16 lanes will be surveyed to achieve the required coverage of the four cells, specified by Fredette et al., (2000). In order to acquire side-scan data beyond the boundaries of the cells, survey lanes will extend 500 m beyond cell boundaries in the

inshore direction as well as in both alongshore directions. Offshore of cells SD and SU, side-scan survey lanes will extend 750 m to acquire seafloor data in the downslope direction.

Overall, the survey lanes encompass an area that measures 2150 meters in the onshore direction, and 2800 meters in the alongshore direction.

3.5.5 Mobilization

Prior to the survey operations, SAIC technicians will install all necessary navigational and positioning equipment on the survey vessel. The side-scan sonar data acquisition system will be installed and data communication interfaces will be tested for proper operation. A hydraulic winch equipped with a 300-m length of double-armored coaxial signal/tow cable and an electrical slip-ring will be installed on the deck of the vessel. The signal/tow cable will be led through a shieve on the articulated A-Frame. Offset distances between the tow point (shieve) and the GPS positioning antenna will be determined to facilitate accurate calculation of towfish position during survey operations.

On deck "rub-tests" will be conducted while the side-scan towfish is operating on deck. The purpose of this test is to check that the acoustic transducers on both sides of the towfish are working properly and that the amplitude of both data channels (port and starboard) are matched. Any problems encountered will be remedied prior to survey operations.

3.5.6 Data Collection

The side-scan sonar data acquisition system will be configured to collect seafloor imagery data 100 m to either side of the towfish, resulting in a total swath coverage of 200 m along each survey lane. With the 100-m lane spacing established for each cell, side-scan data coverage within each cell will be approximately 200%. The sampling rate will be 150 msec, equivalent to approximately six measurements per second.

During survey operations along each lane, the survey vessel will maintain a constant course and speed of approximately 4 knots to achieve clear seafloor images. Towfish position will be determined continually, and to an accuracy of approximately 5 to 10 m, using the DGPS navigation system, based on the vessel position, speed, heading, and length of cable behind the vessel.

Side-Scan Sonar and Subbottom Profile Lanes
Palos Verdes Baseline Survey

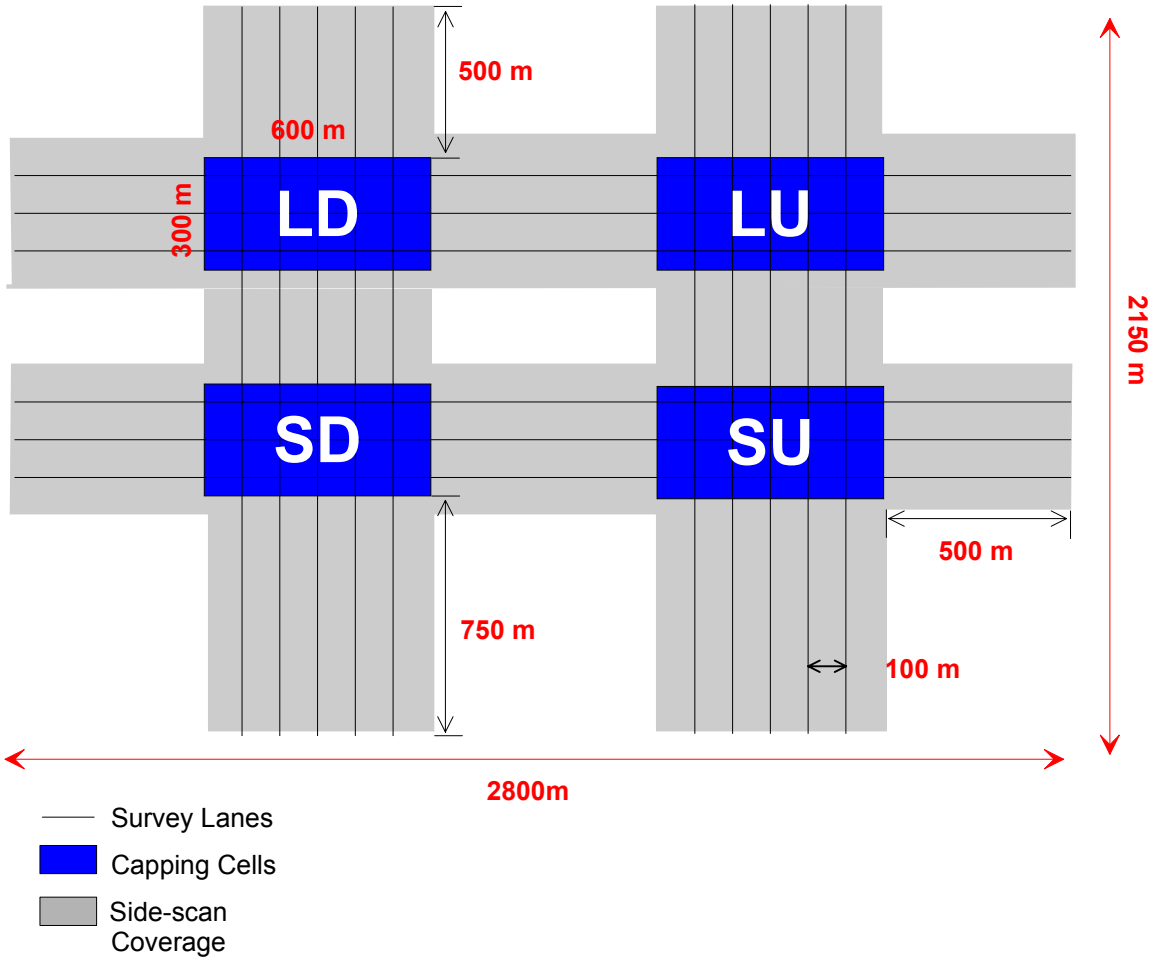

Figure 3-7. Schematic representation of survey lanes and nominal sidescan sonar coverage over four capping cells for the pilot cap study.

Four channels of data (port and starboard channels from both the 100 kHz and 500 kHz frequencies) will be both archived on disk and displayed in real time aboard the survey vessel. During survey operations, the towfish will be maintained at an altitude above the seafloor equivalent to 8 to 20% of the range scale selected (e.g., 8 to 20 m above the seafloor for the 100 m range scale) to achieve optimum surveying resolution.

3.5.7 Data Processing

Following the survey, side-scan data will be processed with map software. Data from each survey lane will be analyzed for surficial sediment texture and identification/location of objects or features on the seafloor. Screen grabs of the individual targets will be generated and stored in the GIS relational database so the location and the image can be accessible for future analyses.

The side-scan data from each survey lane will be mapped and composited using the position data that are merged with the side-scan data. This process results in a geo-referenced, two-dimensional, gray-scale image called a "mosaic" that is compatible with other spatial mapping applications.

3.5.8 Dissemination of Survey Results

On the day following completion of the side-scan survey, a brief Side-Scan Survey Report summarizing surveying operations will be prepared and submitted to the LAD Project Manager or her designated technical point of contact for review. Following LAD approval, this Side-Scan Survey Report will be posted on the Palos Verdes Monitoring Project Website (PV-Web) for viewing by all project participants.

Preliminary data products including a side-scan coverage map and a high-resolution screen grabs for selected features or objects will be posted on the PV-Web within two days of survey completion.

Within two weeks, all processed side-scan results will be populated on the DAN-LA GIS via CD-ROM updates. These results will include a side-scan mosaic of the pilot study area, a tabular listing of targets observed on the seafloor and their location, as well as example images of targets and seafloor substrates presented at full resolution.

3.6 Subbottom Profile Surveying

3.6.1 Rationale

Subbottom seismic profiling is an acoustic, remote sensing technique for determining relative changes in sediment characteristics beneath the sediment-water interface. Acoustic profiling systems, which have transmitters and receivers in a submersible towfish, are used to acquire high-resolution digital data on the acoustic impedance of

seafloor sediments beneath the survey vessel as it travels along predetermined survey lanes. Acoustic impedance is a function of the density of a sedimentary layer and the speed of sound within that layer. The depth of acoustic penetration into the sediments and the ability to resolve sedimentary layering (stratigraphy) from the returned acoustic signals are both dependent on the frequency and pulse-width of the transmitted acoustic signal, and the characteristics of the sediments being profiled.

For the pilot cap program, high-resolution subbottom profiling will be used to assess the vertical and spatial variability of sediment characteristics in the vicinity of the four pilot cells. At a specific measurement location, the subbottom profile results (vertical profile data) will reveal any sedimentary layering that may exist in the upper few meters beneath the sediment-water interface, as a result of the effluent-affected (EA) sediments overlying "native" sediments which characterized the region prior to commencement of effluent discharge. Data acquired along individual survey lanes will illustrate the horizontal extent of any sedimentary layers (acoustic reflectors); results from numerous parallel survey lanes will illustrate the two-dimension (areal) extent of prominent layers.

Results from the subbottom profiling will compliment the side-scan sonar survey results that reveal spatial variations in surface sediment characteristics. For example, if the side-scan results reveal a horizontal gradient in sediment characteristics or bottom roughness at a specific location, the subbottom profile results can be used to determine whether this surface transition is also associated with horizontal gradients in subsurface sediment properties (layers). Furthermore, if the side-scan data indicate hard-bottom outcrops or other bottom features, the subbottom data can be used to validate the side-scan interpretations.

The subbottom profile results also will be complimented by the sediment cores to be acquired at nine locations in each of the four cells. The sediment characteristics determined from geotechnical analysis of the cores will be useful for visual correlations of remotely sensed data from both the subbottom profiling and the side-scan sonar. For example, if distinct sedimentary layers are identified in a sediment core, then assessment of layers in the subbottom results could be visually correlated. Although these independent measurements are intended to be complimentary, acceptance of the subbottom profile data quality is not based on specific criteria for agreement with other measurement data (e.g., maximum acceptable difference).

The subbottom profile results from the baseline survey will later be used for comparison with subbottom profile results acquired along the identical survey lanes following placement of cap material, in order to assess the spatial coverage and potential spreading of cap material.

3.6.2 Sampling Equipment and Methods

For the baseline program, high-resolution subbottom profile data will be acquired using an digital subbottom profiler. The acoustic transducers of the system are mounted in a towfish and lowered using the winch and crane aboard the survey vessel. The electronic signal cable from the towfish is mated to a mechanical tow cable with brass clips.

The amplified return signal of the transducers are sent through an A/D converter to an on-board data acquisition system for data storage to 8 mm magnetic tape, real-time color data display, and hard-copy printouts of profile data.

3.6.3 Data Quality Objectives, Calibration, and Quality Control

Data Quality Objectives

Subbottom profile survey objectives for the baseline program are addressed in the Data Quality Objectives section of this Project Work Plan. As specified in the Monitoring Plan for the Pilot Cap Program (Fredette, et al., 2000), subbottom profile data will be acquired along the identical survey lanes established for the side-scan sonar survey, with eight lanes traversing each of the four cells chosen for the pilot program. This horizontal coverage will provide an excellent data set from which to identify vertical layering in subsurface sediment properties, as well as areal extent of the most prominent layers. The results will also provide a spatial context to the "point measurements" of sediment characteristics derived from the sediment cores and the sediment profile images.

Calibration and Quality Control

As described in Section 3.6.5, electronic tests of the subbottom profile system and towfish will be conducted prior to deployment for survey operations to ensure that all system components are fully operational. Although there is no quantitative method of calibration for the subbottom profiling system, the "ground-truth" data on subsurface sediment characteristics to be derived from the sediment cores will offer the best means for calibration of the remotely-sensed subbottom profile data (see discussion below).

For purposes of quality control during survey operations, subbottom profile data will be acquired along intersecting survey lanes, which will allow post-survey comparison of data from two independent subbottom measurements at 15 locations in each pilot cell surveyed. These data will be used to assess the repeatability of the seafloor characteristics information (as inferred from the subbottom profile data) and any dependence upon survey operations such as vessel speed and heading, sea state, water depth, etc.

As indicated in Section 3.6.1 (Rationale), sediment cores will be acquired at nine locations in each cell, each core being positioned at the intersection of subbottom profile lanes. The geotechnical results from core samples will be

used for "ground-truthing" of the subbottom profile results, via correlation between actual sediment grain size (and bulk density) and prominent sedimentary layers as deduced from the remotely sensed subbottom profile data.

3.6.4 Survey Plan

For the baseline survey, subbottom profile data will be acquired simultaneously along the same survey lanes (see Figure 3-7) as identified for the side-scan sonar survey (Section 3.5.4). Unlike side-scan sonar technology which acquires data in broad swaths on both sides of the vessel track, the subbottom profiler acquires data only beneath the vessel as it travels along the survey lane. Therefore, the subbottom data represent continuous vertical profiles of the upper sedimentary layers along vessel tracks. The horizontal (spatial) resolution provided by this technique is a direct function of the number of survey lanes traversed within the study area. For the baseline survey, lanes will be spaced 100 m apart.

3.6.5 Mobilization

Prior to the survey operations, the subbottom profile system will be installed and data communication interfaces will be tested for proper operation. The subbottom signal cable will be mated to a mechanical tow cable mounted the vessel's winch. Offset distances between the tow point (shieve) and the GPS positioning antenna will be determined to facilitate accurate calculation of towfish position during survey operations.

Electronic tests of the subbottom profile system and towfish will be conducted prior to survey operations to ensure that all system components are fully operational. These tests will include full-system "wet tests" with the towfish in the water while the survey vessel is at the pier, to test acoustic transmit energy and receiving circuitry.

3.6.6 Data Collection

The XStar system generates a frequency-modulated pulse that sweeps over an acoustic range. The 216S towfish is capable of generating three separate sweep ranges; 2 to 10 kHz, 2 to 12 kHz, and 2 to 15 kHz. In practice, the vertical resolution of subbottom profile results is highly dependent upon the physical characteristics of the sediments being ensonified. On the Palos Verdes Shelf, we expect vertical resolution of sedimentary layers on the order of ±20 cm or greater, depending upon the characteristics of the sediments.

The pulse rate will be set to 8 pulses per second for optimum performance of the output devices. At 8 pulses per second, traveling at an average vessel speed of 4 to 5 knots, a subbottom measurement will be acquired every 34 to 43 cm along the vessel track. Each subbottom return signal will be recorded digitally and stored with a geodetic positional fix.

The XStar profiler generates a relatively narrow (13°) acoustic beam which translates to a 12-m wide swath on the seafloor along each survey lane for an average water depth of 55 m, as encountered in the pilot study area. Swath width will vary proportionally with water depth and the depth at which the fish is towed. For the baseline survey, the towing depth will be approximately 10 m. With a lane spacing of 100 meters, approximately 12% bottom coverage will be obtained over the survey area.

3.6.7 Data Processing

Following the survey, subbottom profile data stored on 8mm tape will be reviewed and analyzed to identify any subbottom horizons or features that may be used as benchmarks to evaluate cap thickness from subsequent surveys. The subbottom data will be displayed on the PC monitor as both a continuous profile, duplicating the shipboard display, as well as individual pulses. The processed digitized data are stored in data files containing the geodetic position and the vertical distance (depth) from the first return (sediment-water interface) to the subsurface layer for each sonar ping. A relational database of survey lanes and screen images of subbottom profiles will be compiled for incorporation into the DAN-LA GIS database.

3.6.8 Dissemination of Survey Results

On the day following completion of the subbottom profiling survey, a brief Subbottom Survey Report summarizing surveying operations will be prepared and submitted to the LAD Project manager for review. Following LAD approval, this Subbottom Survey Report will be posted on the Palos Verdes Monitoring Project Website (PV-Web) for viewing by all project participants.

Preliminary data products including a survey trackline map and examples of subbottom profile images from selected lanes will be posted on the PV-Web within two days of survey completion. Within two weeks, all processed subbottom results will be populated on the DAN-LA GIS via CD-ROM updates. These results will include graphical subbottom profiles for all lanes of the pilot study area.

4.0 FIELD DOCUMENTATION, CHAIN OF CUSTODY, AND DATA MANAGEMENT

4.1 Field Logs

As described in Section 3, a hard-copy field log will be maintained for each of the main survey activities of the baseline monitoring project. These logs will be used to document all sampling and data recording events, as well as other significant activities or problems encountered during survey operations. Maintenance and custody of these logs will be the responsibility of the field leader for the specific sampling activity, as identified in Section 2.

Upon completion of the baseline survey activities, the following logs will be provided to the SAIC Project Manager:

- Navigation Log
- Sediment Profile Field Log
- Sediment Coring Log
- Side-Scan Sonar and Subbottom Profile Log

If a significant deviation from the Field Sampling Plan is necessitated, the field leader aboard the survey vessel will be responsible for noting such deviations in the field log, and notifying the SAIC Project Manager as soon as possible (e.g., via a telephone call to shore during the survey activities). It will be the responsibility of the SAIC Project Manager to contact the LAD Project Manager to discuss the deviations.

4.2 Samples and Data Records

4.2.1 Photographic Film from Sediment Profiles and Plan View Photography

During survey operations, exposed rolls of 35-mm film from both the sediment profile camera and the plan view camera will be carefully marked according to: project name, date, time, serial number of the camera, and station numbers surveyed. Roll number and all pertinent information will be entered on the appropriate chain of custody (COC) form. At the end of each day of survey operations, film rolls will be transferred to the person responsible for shore-based data processing.

4.2.2 Sediment Cores

As described in Section 3.4, core liners containing sediment samples will be clearly marked immediately following core retrieval. A label is attached to all cores at the time of collection. The pre-printed label identifies the project title, cruise number, sample type, station number, and sample number. Specific sample information is written in indelible ink for survey number, station identification, date and time collected, sample replicate number, top/bottom indicators, collector's name or initials, sample depth (if appropriate). Sample labels are attached to the core using clear tape to prevent the label from washing off or dissolving. All pertinent information for each core will be entered

on the appropriate COC form. At the end of each day of survey operations, cores will be transferred to the person responsible for shore-based core processing.

4.2.3 Digital Data Records from Side-Scan Sonar and Subbottom Profiling

Data from side-scan sonar and subbottom profiling operations will be stored on magnetic computer medium. Each data disk and/or zip-drive will be marked according to project name, instrument type, date, start and stop time of data acquisition, and survey lanes traversed. Additionally, all pertinent information for each digital data record will be entered on the appropriate COC form. At the end of each day of survey operations, data records will be transferred to the person(s) responsible for side-scan sonar and subbottom profile data processing.

4.3 Chain of Custody

A measurement-specific COC form will be generated for each type of data to be acquired during the baseline survey activities. It will be the responsibility of the specific Field Leader to complete the COC form for each day of sampling operations. These COC forms will accompany the samples and/or data records that are transferred to shore at the end of the day's field operations. A duplicate copy of the completed COC form will be submitted to the SAIC Project Manager for entry to the project archive.

4.4 Corrections to Documentation

If errors or omissions in the field logs, sample documentation, or COC records are identified by project personnel involved with the baseline program, these occurrences will be communicated to both the SAIC Project Manager and the QA/QC Manager for the baseline project. The need for any significant corrections will first be documented in writing, then corrections will be made in red ink on the original logs, records, or COC forms; additionally, corrections will be dated and signed by the person affecting the change.

4.5 Data Management and Security

For the baseline project, the SAIC Project Manager will be responsible for security of all field records and project data/information acquired during survey operations. Originals of Logs and data records will be maintained in a secure storage facility at SAIC's Newport, Rhode Island, office. Additionally, back-up copies of all digital data will be stored on magnetic medium in an appropriate storage area. Processed data will be maintained by the DAN-LA GIS and frequent (i.e., daily) backups of the DAN-LA data archive will be part of the routine procedure for maintenance of the DAN-LA system.

5.0 CONTROL OF INVESTIGATION-DERIVED WASTES

5.1 Sediment Profile Imaging and Plan View Photography

Sediment profile images and plan view photographs will be acquired using conventional photographic equipment and commercially available 35-mm film. All used film will be transported to shore at the end of each day's sampling operations for post-survey development. Consequently, no chemicals or other film developing agents will be brought aboard the survey vessel. The only wastes that will be generated during survey operations include: manufacturer's packaging containers for rolls of 35-mm film; glass cleaner and paper towels for periodic cleaning of camera lenses, and distilled water for use in the prism of the sediment profile camera. With the exception of relatively small volumes of distilled water that will be discarded into the sea, all other waste products will be transported to an appropriate shore-based waste facility.

5.2 Sediment Coring

Sediment cores will be collected using reusable steel core barrels with butyrate core liners that are inserted into the core barrel. Sediment samples are retained within the core liners during the coring process. Following retrieval of the corer, the core liner is removed from the core barrel while on deck, sealed, and labeled. During handling of core liners, the following expendables will be used aboard the vessel: sterile gloves, permanent markers, and plastic tape. No wastes from coring operations will be discarded at sea; used expendables will be transported to an appropriate shore-based waste facility.

During retrieval and on-deck handling of the corer, a small volume of bottom sediments will be lost during washdown of the corer. Prior to the survey vessel's departure from a coring station, all waste sediment will be washed over the side of the vessel to ensure that no waste sediment is transported and disposed at a different offshore location.

Upon return to shore at the end of each day's sampling operations, all core liners containing samples will be transported to the shore-based core processing facility. Any core barrels that were bent during coring operations also will be removed from the vessel and transported to an appropriate recycling facility. All sediment that remains after core processing and subsampling will be held in contaminated waste containers until transport to an appropriate waste processing facility.

5.3 Side-Scan Sonar Surveying

Survey activities for acquisition of side-scan sonar data will utilize electronic equipment to acquire remotely sensed data on seafloor characteristics. Consequently, no physical samples will be acquired and no cleaning materials nor

sample containers will be used during the survey activities. Data will be stored on magnetic computer storage medium and transferred to shore-based processing facilities upon completion of daily survey operations.

5.4 Subbottom Profile Surveying

Acquisition of remotely sensed subbottom profile data will not generate wastes, for the same rationale as described above for side-scan sonar survey operations.

6.0 SCHEDULE OF BASELINE PROJECT ACTIVITIES

The primary objectives of the baseline monitoring program are to acquire data and information to: 1) aid the final design of the operational, engineering, and scientific monitoring elements of the Pilot Cap Program, and 2) facilitate comparisons with results from subsequent interim and post-cap monitoring surveys that will be conducted in July and August of 2000. To meet both of these objectives, it is essential that results of the baseline monitoring activities be available to the Palos Verdes project team soon after the field measurements are completed. Below, we provide details on the scheduling of the various baseline sampling activities.

6.1 Schedule of Baseline Field Sampling

The baseline field operations have been separated into two phases: Phase 1 will occur at least one month prior to commencement of the capping operations of the pilot program, whereas Phase 2 sampling will occur within one week of initiation of capping in each of the four cells, in order to assess the physical and biological conditions of the seafloor within the target cells "immediately" before capping. Accordingly, the plan for conducting both phases of the baseline sampling program is given below.

Phase 1 Sampling Activities

The first baseline sampling activity will consist of sediment coring operations in the four pilot cells. This effort entails collection of 40 gravity cores, with likelihood of repeated core attempts where sediment penetration was initially less than the requirement of at least 20 cm. This sampling will require 3 to 4 days of survey operations, assuming a minimum of 8 hours of coring per day at the work site. Cores will be sectioned on the day following collection, and sediment samples will be sent to analytical laboratories for rapid processing so that results are available within 3 weeks, depending upon the type of chemical or geotechnical analysis being performed. Note that geotechnical results may be available in 1 to 2 weeks, whereas the chemical results will require a minimum of 3 to 4 weeks.

Next, the underway side-scan sonar and subbottom profiling survey will be conducted in the area encompassing the four pilot cells. As both profiling systems can be operated simultaneously, survey lanes will be traversed only once, except in the event that lanes need to be resurveyed due to equipment problems or marginal data quality. This survey work will require 2 days of at-sea operations assuming the four-cell survey plan does not vary from that shown in Figure 3-7.

A conservative estimate of the number of survey days required for the Phase 1 baseline sampling program would be 6 days, excluding weather delays or other factors which may impact the survey schedule. In April, rough sea conditions should be relatively infrequent, but a few days of weather contingency should be incorporated into the project schedule in order that field sampling and data acquisition are conducted during optimum sea conditions.

The Phase 1 sampling operations are scheduled to commence in mid-May so that all results from laboratory analysis of core samples will be available by early June, thus allowing nearly one month for final decisions about the operational design of the Pilot Cap Program.

Phase 2 Sampling Activities

Sediment vertical profile sampling (SVPS) and plan view photography will be conducted in the four pilot cells and adjacent areas during Phase 2 of the baseline sampling operations. A total of 25 stations will be occupied for each cell, requiring less than one day of field operations per cell. However, it may be necessary to return to the cell on the following day to reoccupy stations where insufficient good-quality SVPS imagery or plan view photographs were acquired on the initial day of sampling, either due to equipment malfunction or insufficient penetration of the SVPS into the bottom sediments. Therefore, two calendar days are planned for SVPS operations within each cell.

The sequence of baseline SVPS sampling for each cell shall correspond with capping events identified in the Monitoring Plan for the Pilot Cap Project (Fredette, 2000) and indicated below:

SVPS Monitoring Event	Location	Schedule
Phase 2-A	Cell LU	1 week prior to initiation of Capping Event #1
Phase 2-B	Cell LD	1 week prior to initiation of Capping Event #2
Phase 2-C	Cell SU	1 week prior to initiation of Capping Event #4
Phase 2-D	Cell SD	1 week prior to initiation of Capping Event #5

Note that from a scientific standpoint, it will be permissible to conduct SVPS sampling up to one week before initiation of capping.

Because there may be one or more weeks between the beginning of individual Capping Events (especially between Events 4 and 6), the final schedule of baseline SVPS surveys (Phases 2-A through 2-D) cannot be specified at this time. Where possible, SVPS surveys (phases) will be conducted back-to-back to eliminate repetitive mobilization efforts and associated costs. This may occur, at least for SVPS surveys of cells LU and LD, since Capping Events 1 and 2 may occur within a few days of each other. Similarly, SVPS profiling of cell SU (Phase 2-C) could occur immediately following Phase 2-B if the LAD Project Manager deems this schedule satisfactory in light of scientific and operational requirements. Note that this back-to-back sampling scheme would result in significant cost savings because “make-up” stations within one cell (say LU) could be occupied on the same day as initiation of SVPS sampling in a second cell (i.e., LD), and so on.

In the worst-case scenario where none of the four baseline SVPS phases (2-A through 2-D) could be conducted back-to-back, the survey vessel may be required at the pilot study area for fractions of eight calendar days (four days for initial sampling in each cell, and the potential for resampling on four other days associated with “make-up

stations"), excluding any delays associated with rough seas. This could be reduced by up to three days if "make-ups" were conducted on "initial" sampling days at other cells.

6.2 Schedule of Baseline Data Analyses

Processing of field data and laboratory analysis of sediment samples will begin within 1 to 2 days following completion of each baseline survey element. Accordingly, the schedule for informal distribution of baseline data and results to the Palos Verdes project team is given below:

Analysis of Sediment Samples from Cores

- Basic core logging (photographs, physical descriptions, etc.) will be completed 1 week after the Phase 1 coring survey; some results will be available within 2 days of core collection
- Geotechnical results will be available 1 to 2 weeks after core subsampling
- Chemical results will be available 3 weeks after core subsampling (see the QAPP for further clarification of which analyses will yield results in 3 weeks, while other analyses will take additional time)

Analysis of Data from Side-Scan Sonar and Subbottom Profiling

- Preliminary graphic data products will be available 2 days after completion of the Phase 1 survey
- Final data products will be available 1 week after completion of the survey

Analysis of Sediment Profile Images and Plan View Photographs

- Photographs (both sediment profile and plan view images) will be available for viewing 2 days after completion of each SVPS survey (Phases 2A through 2D)
- Full scientific results from analysis of the sediment profile images will be available 2 weeks after each SVPS survey

All baseline data will be entered into the DAN-LA GIS within one week after informal distribution to the project team, and later presented in the Final Report for the Baseline Monitoring Program.

6.3 Summary of Baseline Schedule

In summary, the survey and data analysis activities of the Baseline Program will be conducted according to the following schedule:

Phase 1 Schedule	Activity
Mid May:	Phase 1 baseline monitoring conducted
Two days after surveys:	Preliminary core photographs and descriptions, side-scan sonar, and subbottom profiling results distributed to project team
Late May:	Final results provided via data update to GIS, including: core photos and descriptions side-scan sonar results subbottom profiling results geotechnical results from core samples
Early June:	Results from initial chemical analyses of core samples are distributed
Mid June:	Final results from subsequent analyses of core samples are distributed

Phase 2 Schedule*	Activity
Last week of June	Phase 2 SVPS monitoring conducted
Two days after surveying	Preliminary results distributed to project team
Two weeks after surveying	Final results provided via data update to GIS

* Schedule assumes commencement of capping in early July

7.0 REFERENCES

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Palermo, M. 2000. Field Pilot Study of *In-Situ* Capping of Palos Verdes Shelf Contaminated Sediments - Operations and Monitoring Plan. Working Draft 23 dated February 2000.

APPENDIX A
Palermo 2000

Field Pilot Study of In-Situ Capping of Palos Verdes Shelf Contaminated Sediments- Operations and Monitoring Plan

Background

Region 9 of the U.S. Environmental Protection Agency (EPA) is currently evaluating alternatives for sediment restoration of DDT and PCB contaminated sediments on the Palos Verdes (PV) shelf off the coast of Los Angeles, California. One option under consideration is in-situ capping, which is defined as the placement of a covering or cap of clean material over the in-situ deposit of contaminated sediment.

The U.S. Army Corps of Engineers (USACE) has performed an evaluation of insitu capping options for Region 9. The evaluation included prioritizing areas of the PV shelf to be capped, determining appropriate cap designs, developing an equipment selection and operations plan for placement of the cap, developing a monitoring plan to ensure successful cap placement and long term cap effectiveness, and developing preliminary cost estimates. The complete capping options study is published as USACE Waterways Experiment Station report TR-EL-99-2 (http://www.wes.army.mil/el/elpubs/pdf/trel99-2.pdf).

EPA region 9 has recently entered into an interagency agreement with the USACE Los Angeles District (LAD) to provide technical support for ongoing needs at the PV Shelf Site to include tasks related to Pre-Design Data Collection & Studies. One aspect of the pre-design studies is a field pilot study of cap placement on the shelf. This document serves as the operations and monitoring plan for the field pilot study.

Description of In-Situ Capping Options

Two capping approaches were considered in TR EL-99-2 for selected areas of the shelf: 1) placement of a Thin Cap (design thickness of 15 cm) which would isolate the contaminated material from shallow burrowing benthic organisms, providing a reduction in both the surficial sediment concentration and contaminant flux, and 2) placement of an Isolation Cap (design thickness of 45 cm) which would be of sufficient thickness to effectively isolate the majority of benthic organisms from the contaminated sediments, prevent bioaccumulation of contaminants and effectively prevent contaminant flux for the long term.

The shelf area presently under consideration for capping lies between the 40- and 70-m depth contours (in TR EL-99-2, this area was defined as two separate capping prisms: prism A centered over the “hot spot,” and prism B located northwest of the “hot spot"). If capping is selected as a remedy for the PV Shelf, the operations would be done in an incremental fashion until the total selected area was capped. Since the area that could be capped is large (on the order

of several square kilometers), capping placement cells 300 by 600 m have been defined for purposes of managing the placement of material and monitoring[1].

Pilot Study Objectives and Approach

The overall objective of the field pilot study is to demonstrate that a cap can be placed on the shelf as intended by the design and to obtain field data on the short-term processes and behavior of the cap as placed.

Specific objectives to be addressed as a part of the pilot include:

1. Demonstrate that an appropriate cap thickness can be placed with an acceptable level of variability in cap thickness.
2. Demonstrate that excessive resuspension of existing sediments and excessive mixing of cap and contaminated sediments can be avoided.
3. Demonstrate that excessive losses of cap materials can be avoided.
4. Determine, to the degree possible, the effect of variable cap material type, bottom slope, water depth, and placement method (e.g., conventional vs spreading) on cap thickness and sediment displacement and resuspension.
5. Demonstrate the effectiveness of the cap with respect to short-term isolation of contaminants during the initial advective flow resulting from sediment consolidation.
6. Demonstrate the ability to monitor operations and success.
7. Evaluate and modify, where needed, all operational and monitoring approaches.
8. Improve the knowledge base contributing to decisions on implementation of a full scale cap.

The construction of the field pilot study cap is anticipated to occur over a time period of several weeks, and the associated monitoring effort is anticipate to address short term processes. The pilot study would therefore meet several objectives related to capping operations and processes occurring during and shortly after cap material placement. A full-scale monitoring program to be conducted during any placement of a full-scale cap and in the years to follow would additionally include activities aimed at long-term processes which could not be easily observed during the time period available for a pilot study (e.g. erosion during storm events or migration of contaminants due to diffusive processes). Depending on the time scales in which the pilot cap is left in place prior to any full scale cap placement, there may be opportunity to obtain data from the pilot area related to such long-term processes, but such activities are not included in the present pilot scope.

The pilot study approach consists of controlled operations for placement of capping material within selected areas on the PV shelf and associated monitoring prior to, during, and

1 It should be noted that a grid of 56 capping placement cell locations was defined in TR EL-99-2 for purposes of volume and cost estimates for various capping options, however, these cell locations are not considered "cast in concrete" for purposes of either the pilot or any full scale capping operation. A new grid has been defined for purposes of the pilot with cells extending over a larger area at the south east end of the site, as compared to the locations in TR EL-99-2.

following the placements. Operational aspects for the pilot include the selection of appropriate placement areas for the pilot, capping materials, and placement techniques. Monitoring aspects for the pilot include cap thickness as placed, mixing of cap and contaminated sediments, resuspension of contaminated sediments during cap placement, short term cap benthic recolonization, and short term physical and chemical characteristics of the cap and underlying sediments immediately after capping and following initial sediment consolidation.

Selection of Pilot Capping Placement Areas

Specific considerations for selection of the pilot placement locations include:

1. To the extent possible, placement locations for the pilot should be representative of the overall range of conditions within the total anticipated capping prism for a full scale remediation.
2. Different pilot placement locations will be necessary to demonstrate the effect of water depth, bottom slope, cap material type, and placement method on cap thickness and sediment resuspension.
3. Physical bottom material type in the pilot placement areas should be clearly distinguishable from capping material. This requirement would be met by any location with surficial fine-grained EA sediment, since the capping material is anticipated to be composed of fine sandy sediment.
4. The thickness of the EA sediment in the pilot placement areas should be sufficient to potentially measure the degree of mixing of cap and contaminated sediment and the effects of advection due to consolidation. The mixing requirement would be met with any location with surficial fine-grained EA sediment thickness in excess of 10 cm. The thicker the EA deposit, the easier the measurement of advection effects.
5. The level of surficial sediment contamination (upper few cm) for the pilot placement areas should provide representative data on resuspension and water column contaminant release. Areas with lower ranges of surficial contamination (i.e. a few mg/kg) have low potential for water column release. Areas with higher ranges of surficial contamination (i.e. 10 to 20 mg/kg) would provide conservative (worse-case) data on resuspension and water column release.
6. There are concerns related to placement of capping materials directly over or immediately adjacent to the LACSD outfall pipes. Until the nature of cap accumulation is demonstrated, cap placements should NOT be located directly over or immediately adjacent to LACSD outfall pipes.
7. Locations should be selected to minimize the potential for recontamination of the pilot cap both during and following cap placement. The prevailing bottom current is from southeast to northwest, so locations to the southeast are preferable from this standpoint.
8. The southeastern boundary of capping Prism A as defined in TR EL-99-2 is currently based on the EA sediment footprint as defined by the 1994 USGS box core data. LACSD data indicate that EA sediment extends well to the southeast of this boundary. Data collected for the pilot may further define the most appropriate boundary which should be considered for capping, and selection of the pilot capping

locations at the southeast end of prism A would provide the opportunity to collect data as a part of baseline monitoring.

9. The size of the pilot placement area(s) should be sufficiently large to avoid interference between intentionally separate placements using different options and to allow for demonstrating the effect of adjacent placements in building the desired cap thickness. Modeling results indicate the size of a footprint of measurable cap thickness accumulation resulting from a single conventional placement is about the size of a single 300 by 600 meter capping cell. Therefore adjacent and/or overlapping placements within a single capping cell would be sufficiently large to observe the buildup effect.

Based on the above considerations, four 300 by 600 meter capping placement cells are recommended for the pilot. One pair of cells would be located adjacent to the landward limit of the capping area in a comparatively shallow site with comparatively flat bottom slope (40 m to 45m depth contour with an average slope across the cell of about 1.5 degrees). A second cell pair would be located adjacent to the seaward limit in a comparatively deeper site with steeper bottom slope (60 to 70 m depth contour with average slope across the cell of about 2 degrees). The two cell pairs would be separated by a full cell length in the along-shore direction to avoid the potential for interferences during monitoring.

The four cell locations are labeled LU (Landward Upstream), LD (Landward Downstream), SU (Seaward Upstream), and SD (Seaward Downstream) in Figure x. The cell grid in Figure x may be adjusted following the collection of baseline data as described below. Pilot placements would occur within the limits of these four cells, but the area monitored would extend to adjacent cells as described below.

Note: two locales are presently currently under consideration for the pilot cells - SE end and NW middle of Prism A.

The locale recommended for the placement cells is at the southeastern end of capping prism A, in the area roughly bounded by the 40 and 70 m depth contours and between LACSD transects 9 and 10. This area is to the southeast of the terminus of the outfalls, on the "upstream" end of the capping area with respect to prevailing bottom currents. There is little USGS boxcore data for this area, however, available LACSD data indicates the EA sediment thickness in this area easily exceeds 10 cm (refer to Figure 60 in Lee et al 1994) and the surficial DDE concentration is about 2 mg/kg (refer to Figure 5 in Lee et al 1994). Note: this locale has the advantage of "upstream" wrt bottom currents, but the disadvantage of thin EA sediment thickness and low DDE concentration wrt the overall area.

A possible alternate locale for pilot placement is to the northwest of the terminus of the outfalls (Note that no specific area for this secondary locale has been discussed in detail, but the conditions are roughty consistent from the outfalls to the NW boundary of Prism A). This secondary locale could be considered as a contingency if revised placement methods are needed once the pilot placement operations are underway. Note: Also, this locale could be selected as

the primary if there are serious LACSD concerns regarding placements upstream of the outfalls. (Note: Also, there is still some unresolved issues with locating the pilot here and the consideration of using an area with surficial concentrations in the low range. This locale has the disadvantage of being "downstream" wrt bottom currents, with the higher potential for surface recontamination. But the sediment thickness is better for consolidation effects and the surficial DDE is at 10 to 20, yielding better resolution potential for cores and worse-case resuspension data).

(Note: An initial exercise for the GIS will be to determine how much of the area within each pilot cell and within the overall area of the pilot has a bottom slope > 2 degrees).

Selection of Cap Material Sources

LAD surveyed the region for potential cap material sources as a part of the capping options study and is currently updating available information on borrow sources. Dredged sediments from navigation channels (primarily the Queen's Gate deepening project) and sand borrow areas were identified as the two primary borrow sources, and the cap designs and placement approaches were developed based on those potential sources. Available data for these sources indicate that the materials are variable and are mixtures of fine sands, silts and clays. LAD is currently arranging for additional exploration of both the Queen's Gate and Borrow Areas.

The cap material used for the pilot study must be representative of the materials which would be available for a full scale capping remedy. Other drivers in selection of pilot capping materials are cost and schedule. Use of dredged material from on-going navigation projects will be far less expensive than excavation from borrow sites, since the operational cost attributable to the pilot would be limited to the difference in transportation and disposal cost to the PV shelf as compared to the selected disposal sites. But use of dredged material from the on-going project is dependent on close coordination of navigation dredging schedules and contracts. Use of dredged material from an approved navigation project can also be advantageous for the overall schedule, since the dredging impacts in the channel areas and ocean disposal of the sediments will have already been evaluated, thus making the NEPA process and other regulatory considerations for the pilot project more straight-forward.

The Queen's Gate project is the only on-going navigation project identified to date with sufficient volumes of clean material to conduct the pilot project described in this plan. The material has an in-situ mean grain size of approximately 0.1 mm. Recent sampling has indicated that there may be localized areas with coarser mean grain size. Also, dredging operations for Queen's Gate and any subsequent placement of the materials in rehandling sites such as the West Anchorage site, results in some losses of fines during overflow and placement, with a subsequent "coarsening" of the material. Modeling to date indicates that the Queen's Gate material can be used for cap construction if the conventional method of placement is used. LAD has indicated that the finer material mixtures from Queen's Gate may be representative of much of the material available from the borrow areas. Therefore, in the context of the pilot, use of Queen's Gate is appropriate for demonstration of conventional placement techniques with a finer material type available in the Los Angeles region. LAD is currently considering additional borings in selected

areas within and adjacent to the present navigation project to locate coarser grained materials. If such areas are found, they would be appropriate for demonstration of spreading placement techniques with a coarser material type.

Sand borrow areas outside the harbor breakwaters (designated as AII and AIII) have in-situ mean grain sizes in excess of 0.2 mm based on available data. However, these materials are also highly variable, and available data do not allow for fine resolution of grain size distributions within the larger borrow areas. There are also environmentally sensitive areas located within the larger borrow areas corresponding to submerged aquatic vegetation (SAV) and rock "pinnacles" with high fisheries values. LAD is planning to obtain borings in selected portions of borrow area AIII (water depths less than 80 ft and outside known sensitive areas) to define a source of coarser material for the pilot.

Modeling conducted to date indicates that use of mixtures of fine sand and silt/clay cap material (such as material from Queen's Gate) results in a larger proportional dispersion off-site, and potentially greater spread downslope as compared to a coarser sand (such as from the sand borrow areas). The finer materials will be placed using conventional release from the hopper dredge. The coarser materials will be placed using a spreading method of placement.

Placement Equipment and Contract Arrangements

Use of hopper dredges was identified as a preferable placement equipment type in TR EL-99-2, and use of a hopper is anticipated for the pilot. A hopper dredge is the equipment of choice for the pilot capping on the PV shelf for the following reasons:

a. Hopper dredges are currently the most readily available equipment for the pilot work.
b. Hopper dredges provide better control of placement in the open ocean environment and allow for more flexibility in placement options to include pumpout capabilities.
c. Hopper dredges remove material from channels by hydraulic means, resulting in a breakdown of any hardpacked material and addition of water as material is stored in the hopper for transport. Material from hopper dredges is therefore more easily dispersed in the water column, and would therefore settle to the seafloor with less energy and less potential for resuspension of the contaminated sediment.

Current plans call for use of the NATCO Manhattan-class dredge *Sugar Island* for the pilot placements. The *Sugar Island* utilizes a split-hull hopper opening mechanism that can be used to control the rate of release. This dredge is also equipped with a hopper pumpout capability over the bow and water jets to aid in pumpout operations. Pumpout can also be accomplished through the adjustable skimmers within the hopper. NATCO has indicated that, with minor modifications, pumpout can be accomplished through one of the two dragarms, allowing for a submerged point of discharge. Any of these methods of placement could potentially be utilized during the pilot, if needed.

Pilot Cap Thickness and Volume

Two objectives of the pilot are drivers in determining the volumes of material necessary for placement for the pilot: 1) the need to determine differences in cap material behavior for differing placement options, and 2) the need to determine if a full design cap thickness can be constructed as intended. Time and cost limitations for the pilot make it impractical to undertake construction of the full design thickness for each possible combination of cap material type, water depth, bottom slope, and placement technique. Therefore the pilot should include some combination of small placement volumes and larger placed volumes. Data on various placement methods and variable material types can be obtained from a few hopper placements with small placement volumes. The most likely placement method and material type to be employed full scale should be evaluated for construction of a full cap design thickness over a sufficient area to determine the process of cap thickness buildup for adjacent placements. Since the bottom slope only slightly increases with water depth for areas between the 40 and 70 meter depth contours, a comparison of shallow and deeper placement areas for the pilot would provide the needed information for both depth and slope.

Based on these considerations, a total of four types of pilot placements are anticipated:

Fine material/ conventional placement/ shallow cell
Coarse material/ spreading placement/ shallow cell
Fine material/ conventional placement/ deep cell
Coarse material/ spreading placement/ shallow cell

Small Volume Pilot Placements

Placement of a relatively small volume should be sufficient to observe the differences between conventional vs. spreading placement methods, finer vs. coarser material types (cap material sources) and shallow vs. deeper cells. Based on the modeling conducted to date, the spreading method of placement is appropriate for the coarser material type. Placement of coarser material using conventional methods is not considered desirable, at least for the initial layer of cap material, because of the higher potential for sediment displacement and resuspension.

Removal of large volumes from the sand borrow area may require extensive and time-consuming studies. Large volumes of coarse material have not be identified within the scope of the current Queen's Gate project. For these reasons, placement of coarser material for a full cap thickness over a large area is not anticipated for the pilot, and should be evaluated with small volume placements. The small volume placements should be at least a few hopper loads (say four to five hopper loads) to confirm the rate of buildup of cap thickness and spreading and dispersion behavior.

The anticipated hopper load for a Manhatten class dredge is approximately 1200 cubic meters (hopper or "bin" volume)[2]. Coarse cap material should be placed using spreading methods only, but placed in both shallow and deep cells, so multiple small volume placements would be required. Therefore, on the order of 20,000 cubic meters (in hopper volume) is required from a coarse grained site.

[2] Personnal communication with Bill Pagendarm, NATCO.

Full Design Cap Placements

Designs of 15 cm for a thin cap and 45 cm for an isolation cap were recommended in TR EL-99-2. Sufficient material should therefore be placed during the pilot to determine if these cap thicknesses can be constructed over a larger area with acceptable rates of buildup and acceptable variability in cap thickness, considering the overlapping effect of adjacent placements. The major consideration here is to observe the rate of sediment accumulation as a function of distance from clusters of individual hopper dredge placements. It may not be necessary to construct a full 45 cm cap thickness to obtain the needed field data on full design cap placement. If a 15 cm cap can be constructed over a larger area, then the same methods of placement can be used to construct a 45 cm cap. However, the pilot scope should plan for construction of the 45 cm thickness.

Data on placement behavior for the full design cap thickness are needed for both shallow and deep pilot cap placement areas. The source of fine grained cap material will be Queen's Gate and this material source would be used to build the design cap thickness in both shallow and deep locations. Data for cap buildup can be obtained from a minimum thickness of 15 cm, but a 45 cm thickness would be desirable over at least a portion of the area. A 15 cm coverage over one 300 by 600 m cap cell equates to 27000 cubic meters in-cap volume. For Queen's Gate sediment, 27000 cubic meters in-cap is equivalent to approximately 58000 cubic meters in-hopper or approximately 42000 cubic meters in-source volume. For a 45 cm coverage over one cell, approximately 174,000 cubic meters in-hopper would be needed. To accumulate these thicknesses uniformly over a total cell, a larger volume must be placed, with some of that material going onto adjacent cells and some being lost during placement. So, the required total volume of Queen's Gate material placed on the shelf for two cells capped at 45 cm would be in the range of 300,000 to 500,000 cubic meters in-hopper volume[3].

The present cap designs and recommended operational approaches call for placement of the needed volumes uniformly over each of the capping cells, to include those adjacent to the seaward capping limit at the 70 m depth contour. However, there are concerns regarding the potential for flow of cap material over the shelf break during placement. The need for placement of materials uniformly over a deeper cap cell may depend on the observed behavior of cap placements at the shallower depths. The limits of seaward placement locations may be established at depths landward of the 70 m depth contour, and this may limit the cap thickness which can be constructed down to 70 m.

[3] A detailed discussion of the volumes required to construct the design cap thicknesses is found in Appendix E of TR-EL-99-2. The ratios of in-channel, in-source, in-hopper, and in-cap volumes used here are given in Table E6 of TR EL-99-2. Note that NATCO currently estimates an average in-situ density for Queen's Gate material of 1.936, and an average in-hopper density of 1.4, and these represent volume relationships similar to those in Table E6.

Refined Model Predictions

The USACE MDFATE model was used to predict the rate of cap material buildup for specific sediment characteristics, various water depths over the shelf and various placement approaches. The USACE STFATE model was used to predict cap material dispersion during placement and velocities of bottom impact for further evaluation of spreading behavior using the SURGE model. These predictions were based on a broad range of assumed properties for the cap material. Once specific cap material sources are selected, refined predictions using the specific site conditions and cap material properties should be made. Results of the refined predictions will determine any needed adjustments in the operational approach and monitoring station placement for the initial placements for the pilot. The models will also be used during the course of the pilot placements to refine operational methods for full cap placements constructed as a part of the pilot.

Sequence of Placement Operations

A sequence of the pilot placements must consider the need to observe the basic behavior of single hopper dredge placements for finer vs. coarser cap material, seaward vs. shoreward cell locations, and spreading vs. conventional placement methods. In this way, if the behavior of a given placement exceeds acceptable limits on spread or dispersion or resuspension, adjustments can be made to the operation prior to placement of larger volumes over a larger area during the pilot.

The proposed Placement/ Monitoring sequence is as follows:

> Event #0 - Prior to any actual pilot placement on the site, releases of the Queen's Gate material with conventional placement methods at the disposal sites now in use should be observed to determine the nature and rate of release from the hopper. Placements of coarser material with the spreading method of placement should also be observed at the disposal sites now in use or at the borrow source to determine the rate of release from the hopper and any tendency of the material to bridge. These can be considered “practice releases” for purposes of the pilot and must be conducted outside the potential capping prism.
>
> Event #1 Single Conventional Discharge LU - The first pilot placement would be a single hopper load of the finer material from Queen's Gate discharged at the center cell LU (see Figure 1). This load would be placed using the conventional placement method. Approximately one week of downtime following this single placement should be planned to assess the adequacy of the monitoring equipment and techniques, shift instrumentation for the next placement, and analyze the monitoring results for this single placement.
>
> Event #2 Small Volume with Spreading Discharge LD - If a suitable coarse material source is available, this event would be a single hopper load followed by a small volume placement discharged ~~at~~ along the centerline of cell LD (see Figure 1). A single load would be placed using the spreading method of placement. The direction of travel of the

hopper should proceed downstream to upstream along the landward boundary of cell LD beginning at the northwest corner of the cell to allow for any overshoot of the placement away from the outfalls. Once the data from a single hopper placement have been assessed, placement of up to 4 additional hopper/barge loads will occur with the intent of creating a thicker cap using this method. Once it has been determined that data collection is complete for Event #2, (i.e. data such as SPC images are captured), Event #3 could proceed from a scheduling standpoint prior to complete initial analysis of data from Event #2.

Event #3 Full Cap Thickness LU - Event 3 is the essentially uninterrupted placement of a full cap thickness over landward upstream cell LU. Event #3 can proceed if the spreading and dispersion observed for the Event #1 single placement is acceptable, and the initial placements for Event #3 would not interfere with Events #4 and #5 in the seaward cells SU and SD located downslope from cell LU. The Event #3 operation would be conducted using conventional placement techniques and finer material from Queen's Gate. Additional hopper placements would be made at the same release point as used for Event #1 until a cap thickness of ~ 15 cm is constructed. Then placement locations would be shifted to the next placement point and the process repeated to build the thickness over a larger area. Once a cap thickness of ~15cm is constructed over the total area of cell LU, operations would be repeated until a cap thickness of ~45 cm is constructed. (Note that the present monitoring scope does not include multiple placements in LU, and this is an item which should be discussed). Spacing between placements of 200 feet is recommended in TR EL-99-2, and this spacing will be refined based on additional modeling. Once placements are completed along the entire landward lane, the placements would be shifted to the next lane. Spacing between lanes would initially be set at 200 feet. Both the lane and placement spacings may be adjusted, during the cap placement, depending upon observed rates of buildup. Event #3 also would include the placement of additional hopper loads of coarser material using the spreading method in cell LD until the total of 4 to 5 hopperloads are placed.

Event #4 Single Conventional Discharge SU - This placement is similar to Event #1 except in a deeper seaward cell. A single hopper load of the finer material from Queen's Gate would be discharged at the center of cell SU which is at the ~60 to 65 m depth. This load would be placed using the conventional placement method. Essentially no dredge downtime would be needed to analyze the monitoring results for this single placement if previous data from Event #1 indicates no interference from on-going cap placement during Event #3. Once it has been determined that data collection is accomplished for this event, and instrumentation is shifted, the next event could begin.

Event #5 Small Volume with Spreading Placement SD - Event #5 would be similar to Event #2 except in a deeper seaward cell. If a suitable coarse material source is available, this event would be a single hopper load load followed by a small volume placement discharged along the centerline of cell SD. This load would be placed using the spreading method of placement. The direction of travel of the hopper should proceed downstream to upstream along the landward boundary of cell SD beginning at the northwest corner of the cell to allow for any overshoot of the placement away from the

outfalls. Once the data from a single hopper placement have been assessed, placement of up to 4 additional hopper/barge loads will occur with the intent of creating a thicker cap using this method. Once it has been determined that data collection is accomplished for this event, and instrumentation is shifted, the next event could begin.

Event #6 Full Cap Thickness SU - Event 6 is the essentially uninterrupted placement of a full cap thickness over the seaward upstream cell SU. Event 6 can proceed if the spreading and dispersion observed for the Event #4 single placement is acceptable. This operation would be conducted using conventional placement techniques and finer material from Queen's Gate. Initial placements start at landward boundary of cell SU. Spacing between placements would initially be set at 200 feet. Once placements are completed along the entire landward lane, the placements would be shifted to the next lane. Spacing between lanes would initially be set at 200 feet. Both the lane and placement spacings may be adjusted, during the cap placement, depending upon observed rates of buildup. Depending on observed behavior, placements on lanes near the 70m depth contour (near the seaward boundary of cell SU) may be limited to avoid excessive buildup of capping material in areas with steeper slopes. Event #6 also would also include the placement of additional hopper loads of coarser material using the spreading method in cell SD until the total of 4 to 5 hopperloads are placed.

GIS-Based Project Management Tools

Once the placement operations begin, data will be available from side-scan surveys, sediment profile surveys, etc. in hours. Decisions to continue placement with an initial operational approach or to change the approach must be made in a matter of a day or two throughout the period of the pilot. This will require a reliable and flexible data management tool. GIS-based approaches are proving to be invaluable in such project environment. Such a system is now in use in management of the HARS ocean remediation site off New York Harbor. Similar approaches will be developed and used for the PV Shelf pilot project and could be later used for a full scale cap placement.

Monitoring Requirements

Key Questions to be Addressed

Monitoring of the Pilot project will enable the EPA to address five key short and intermediate term questions relative to capping on the Palos Verdes Shelf. These questions are:

- Does placement occur as modeled?
- Can we construct a uniform cap?
- Can we limit disturbance to in-place sediments?

- Does the cap remain clean?
- Does the cap remain stable?

Each of these questions (with slight variation in wording) and the generic monitoring approach was addressed in Appendix H of TR EL-99-2, but we will briefly review the environmental concerns that relate to these issues here. The detailed scope of work to accomplish this monitoring is attached as Appendix A to this document.

Does placement occur as modeled? This question and its associated monitoring will incorporate several concerns that have been raised about the placement of sediments from vessels at the ocean surface onto the seafloor below. These concerns include:

- how far the sediments spread,
- how thick the material is once it comes to rest on the bottom,
- the effect of depth, slope, and material type,
- and the potential for the creation of turbidity flows or mudwaves.

For example, modeling predicts that one hopper load of sediment placed by split-hull methods will produce a deposit approximately 500 meters in diameter with a maximum thickness of 3 cm at the center and thinning to 0.1 cm at the edge.

Several monitoring tools will be used to measure the actual distribution and thickness of the deposit during several phases of the Pilot project and under several different scenarios (Table x). Combined these will allow an assessment of how actual field conditions reflect those predicted by the model.

Can we construct a uniform cap? This question involves the ability to place multiple loads of sediment over an area without creating many areas that are too thick and others that are too thin. The ability to control placement will be assessed both during the series of barge placements and once they are complete. Many of the same tools used for the above effort will be utilized in these interim surveys with the addition of sub-bottom profiling and possibly bathymetric surveys.

Can we limit disturbance to in-place sediments? Sediments released from the placement vessel will fall through the water column, impact the bottom, and then spread laterally. This process has the potential to disturb the in-place sediments both at the direct point of impact, and to a lesser degree in the area where lateral spread occurs. The Operations Plan is intended to minimize potential disturbance by only disposing directly on the EA sediment with the initial hopper load. Following this first hopper load, the next several will be directed to the same location so that disturbance of the EA sediment will be insulated by the sediments already in place from the first load. From that point on, all subsequent disposal will always occur over cap sediments that have already reached their position on the seafloor through lateral spreading.

The amount of disturbance to the EA sediments will be assessed both at the point of impact and in the area of lateral spreading. The sediment profile camera and coring will be the principal

methods used to assess this level of disturbance. In particular, the absence or thickness of the sediment's oxidized layer, which will be measured prior to disposal, will provide a very good marker for this assessment.

A second concern regarding mixing is the effect on water quality. Again, because of the operational approach, resuspension of EA sediment should be greatly reduced after the initial placement, but the amount of contaminant in the plume will be monitored to assess this expectation. This effort will involve tracking the plume and measuring suspended solids and contaminant concentration relative to background.

Does the cap remain clean? In the short and intermediate term this question will be addressed as part of the assessment of mixing of the EA and cap sediments. Both direct coring with chemical analyses and the sediment profile photographs will be useful for evaluating whether the cap was placed with minimal mixing. Some presence of contaminants in the cap can be expected, because of the natural resuspension and transport of EA sediments that will occur during the cap construction process, along with resuspension caused by the operations themselves. However, the monitoring will allow measurement of what levels can be expected immediately after capping. These data will then be useful for determining any changes in the sediment or contaminant profiles in future cores.

Does the cap remain stable? The stability of the cap both during and immediately after construction will be determined by the combination of surveys that are being conducted to assess the distribution of the cap over the EA deposit. The bottom mounted arrays will document the changes in bottom lateral surge speeds that occur during the placement process. Side-scan, sediment profile photography, and coring will all be used to map the actual extent of the deposit. Side-scan in particular, will be useful for assessing the down slope spread of material in assessing the potential for turbidity flow.

Table x. Monitoring tools and applications.

Monitoring Tool	**Applications**
Sediment Profile Camera	Sediment layer thickness, lateral extent, layer mixing, grain size, biological condition
Coring	Sediment layer thickness, layer mixing, grain size, chemical profile, cap stability
Side-scan sonar	Sediment distribution, bottom disturbance features, bottom

	topography
Sub-bottom chirp profiler	Cap thickness
Bathymetry	Cap thickness
Acoustic Doppler Current Profiler (ADCP)	Current speed, surge speed, plume location
Optical Back Scatter	Plume location and relative concentration
Water samples	Suspended solids, contaminant concentrations

Monitoring Program Components

The monitoring program, as detailed in the appendix, consists of several integrated components. The lists below provide a summary of these components, the tools, and the data that will be collected.

Baseline Data Collection

Vane shear for in-situ sediments
Relative density/ water content of in-situ sediments
Grain size
Chemistry from cores
Sediment profile camera photographs

Hopper Dredge Operation Data

Transit route
Positioning during placement
Time to release material

Hopper Load Monitoring

Hopper load curves for all loads
Samples of hopper inflow and overflow for GSD, TSS, and TOC
(Samples for each load for small placements; 5% of loads for full cap)

Data Collection During Placement

OBS/ADCP bottom array
Ship deployed OBS/ADCP
Water column samples
Sediment profile camera photographs (for cap buildup and extend of accumulation)

Sediment cores
Side-scan sonar survey

Post Cap Monitoring

Subbottom profiling
Sediment profile camera photographs
Bathymetry (pending technical evaluation)
Sediment cores

Longer Term Questions

The monitoring scope that has been developed for the Pilot project does not far field or long term, though this scope will be prepared when requested by the EPA project managers. TR EL-99-2 provides the outline for that effort, but briefly, it would include coring, sediment profile camera surveys, sub-bottom profiles.

Several other items related to monitoring are not explicitly addressed in this plan. This includes determination of the abundance of deep burrowers, reductions in water column contaminant concentrations, verification of the diffusion model, and reductions in tissue levels in resident benthic or fishery species.

Presence of deep burrowers on the Palos Verdes Shelf and their effects on sediment mixing has been addressed by a number of investigators (list them). Video camera surveys have clearly shown evidence of burrower presence (ref), yet there are other investigations that suggest that even if these burrowers are present, they are having little influence on the long-term burial of the EA deposit (ref). In either event, direct assessment of deep burrower abundance may not be necessary, since the monitoring approach as described in TR EL-99-2 is intended to directly address the mixing that they would cause.

Verification of the diffusion model will be reliant on data from longer term cores collected from the pilot cells or from the full cap. The broad scale changes in water quality and fishery contamination can only be addressed once the full scale project has been completed. Investigations by xxxxx (199x) and xxxxx (199x) suggest that both water quality and contaminant tissue levels of some fishery species exhibit a decreasing gradient away from the Palos Verdes Shelf. Thus, if a decision is made to proceed with the full cap, designing a monitoring program to assess changes in these parameters appears to hold promise as reasonable means to include as measurements of success.

Reports and Interpretation

Data reports from the monitoring contractor should be provided as data is collected.
A post-cap comprehensive report will be prepared (joint effort USACE/ Contractor).
An addendum following the 6 mos/ 1 year monitoring will be prepared (joint effort USACE/ Contractor).

References

USACE Los Angeles District. "Project Management Plan (PMP) For U.S. Environmental Protection Agency, Region IX on Palos Verdes Shelf Superfund Site, Los Angeles County, California," Prepared by U.S. Army Corps of Engineers Los Angeles District.

Palermo, Michael, Paul Schroeder, Yilda Rivera, Carlos Ruiz, Doug Clarke, Joe Gailani, James Clausner, Mary Hynes, Thomas Fredette, Barbara Tardy, Linda Peyman-Dove, and Anthony Risko. 1999. "Options for In Situ Capping of Palos Verdes Shelf Contaminated Sediments," Technical Report EL-99-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. http://www.wes.army.mil/el/elpubs/pdf/trel-99-2.pdf

APPENDIX B
Fredette 2000

Palos Verdes Shelf Pilot Project Monitoring Scope of Work

Background

The contractor is to become familiar with the monitoring sections of Palermo et al. (1999). In particular, the contractor should become familiar with the objectives of the work and the purpose (null hypotheses) of the monitoring (Chapter 5 and Appendix F). The objectives of this monitoring work are to assist in constructing, evaluating and demonstrating the ability to cap in-place, effluent affected (EA) sediments on the Palos Verdes Shelf during the pilot project. The contractor is also to become familiar with the Operations and Monitoring Plan prepared for this effort. The contractor is to review additional information collected for this Pilot Project (e.g., sediment physical and chemical data) and recommend modifications to the monitoring plan if necessary. This will include identification of needed changes to the null hypotheses. This is an experimental effort and the contractor is to build flexibility into the monitoring schedule and approaches in order to incorporate necessary adjustments in placement schedule or approaches.

Task 1. Collection of Additional Background Data and SOW Revision
Task 2. Buoy Placement
Task 3. Hopper Dredge Operation Data
Task 4. In-hopper Sediment Data
Task 5. Flex Surveys
Task 6. Monitoring of Cell LU (Events #1 and#3a)
Task 7. Monitoring of Cell LD (Events #2 and 3b)
Task 8. Monitoring of Cell SU (Events #4 and #6a)
Task 9. Monitoring of Cell SD (Events #5 and #6b)
Task 10. Evaluation of Bathymetry Surveying
Task 11. Disposal Plume Transport Survey
Task 12. Cap Erosion Analysis Samples
Task 13. Reporting

Task 1. Collection of Additional Background Data and SOW Revision

Background: The distribution of the effluent affected (EA) deposit has been studied by both the USGS and the LACSD. Conceptual cap prism design is described in Palermo et al. (1999). The Field Pilot Study Operations and Monitoring Plan (Palermo et al. 2000) recommends that the pilot project be carried out on four cells to the north-west of the outfalls. Prior to conducting the pilot project there is a need to more fully characterize these pilot cells to provide a well-defined baseline to which post-capping samples can be compared. These investigations will be carried out in the weeks and days prior to cap placement.

Objectives:

1. Provide baseline sediment chemistry and physical characteristics in the target pilot cells.

2. Re-evaluate this scope of work in response to the new information collected, review of relevant documents provided by the Corps Project Manager, and the approved Project Work Plan (developed under a separate scope). Based on those reviews the contractor will recommend changes to this SOW.

Approach:

A. The contractor will collect 9 gravity cores or vibracores (minimum 20 cm length) from each of the four pilot cells for analysis of sediment chemistry and physical data. Note that these locations will be at points where the sub-bottom profile lanes will cross (see figure 1). Repeating these stations in the post-cap monitoring will assist in the interpretation of the sub-bottom data. Cores will be sectioned into 4 cm increments (0-4, 4-8, 8-12, 12-16, 16-20 cm). The increments will be analyzed for p,p' DDE, bulk density, and grain size.

B. The contractor will collect in-situ vane shear strength [illegible]n/Mike need one of you to draft language for this).

C. The raw data from the top 2 increments of the cores in Task A, above, will be submitted in a report to the Corps Project Manager 4 weeks after field collection. A full data report will be submitted to the Corps Project Manager 8 weeks after field collection. The data will be added to the project GIS at the time of the full report submission.

D. The contractor will perform a base-line, high resolution sub-bottom profiler and high resolution, dual frequency digital side scan survey at each of the four pilot cells. The sub-bottom profiler should be adjusted to maximize resolution in the top meter of the sediment column. Later surveys will be compared to these surveys as part of the tools used to assess cap thickness and distribution.

E. The contractor will evaluate the new data collected in the previous approaches, review relevant documents provided by the Corps Project Manager, and the approved Project Work Plan (developed under a separate scope). Based on those reviews the contractor will recommend changes to this SOW by reallocating survey effort within the overall level of effort already planned (including the flex surveys identified in Task 5). These changes may include modifications to the approaches, station numbers, sampling methods, and so on. The contractor may also recommend modifications to the monitoring effort beyond the existing level of effort, but these will require thorough explanation as to why they can not be achieved through reallocation of effort.

Task 2. Buoy Placement and Intercalibration of Vessel Navigation Systems

Objective: Surface marker buoys will be used to 1) facilitate intercalibration of DGPS navigation units installed among the hopper dredge and survey vessels to be used for the

monitoring activities, and 2) mark areas to be avoided, such as the outfalls adjacent to the pilot cap area or to delimit the boundaries of the pilot capping area. Buoys will not be used as visual aids to mark the pilot cells as they would pose obstructions to both cap placement and surveying operations.

Approach: The contractor will be responsible for fabricating, placing, maintaining, and removing temporary taut-wire buoys. The contractor will propose a buoy design along with their submission of the estimate on this work order. The contractor will be ready to deploy and move buoys as needed during the construction of the pilot cells. Up to 4 buoys may be needed at any one time, and two spares must be maintained ashore to facilitate emergency replacement in the field. Precise electronic positioning (via DGPS) will be used for placement of all buoys. Buoys will conform to U.S. Coast Guard specifications. The Contractor will be responsible for coordination with the appropriate U.S. Coast Guard offices and for placement of Notice to Mariners. The contractor will provide graphical, electronic maps, and buoy coordinate listings within 4 hours of buoy deployment to the Corps Project Manager and dredging contractor throughout the placement operations.

The contractor also will propose and implement a field plan for acquisition of DGPS intercalibration data, with periodic (i.e., weekly) participation of all vessels operating in the project area. A brief report on the intercalibration results will be submitted biweekly.

Task 3. Hopper Dredge Operation Data

Objective: The contractor will collect hopper dredge positioning data during transit to and during the cap placement operations. The contractor also will collect information on the time and rate of material discharge to monitor where sediment placement occurs.

Approach: The contractor will coordinate with the dredging contractor to install and maintain an automated electronic tracking system on the placement vessel during the pilot project operations. This system will acquire and store DGPS vessel positions at regular intervals (i.e., 10-min intervals) during loading and transit to the PV Shelf placement locations. Upon approach to the placement location(s), the system will automatically increase the rate of position recording (i.e., to 6-sec intervals). Additionally, hopper dredge draft and/or tonnage data will be acquired from the dredging contractor during all placements events (updated every 10 seconds or less during placement events). This time series information will be merged with the dredge position data to yield an accurate record of placement location/volume/rate for each load.

Associated data services will include: 1) daily data updates presenting the start time/position and end time/position for each placement event, optionally on a Web Site, 2) weekly reports presenting tabular data and graphic plots of dredge sediment release positions for each event, 3) weekly updates of placement data on DAN-LA to provide the project team with access to placement results for MDFATE modeling. Additionally, the DAN-LA database will maintain a record of loading position for each load of cap material.

Task 4. In-hopper Sediment Data

Objective: Data on the physical characteristics of the sediment in the placement vessels will be needed as part of the evaluation of how well actual field results compare to the expected spread and thickness of sediments at the capping cells. Additionally, data on the chemical characteristics of sediments that may be dredged from borrow areas (e.g., A2 and A3) will need to be acquired for later comparison of chemical concentrations within the cap and underlying EA sediment, if borrow area sediments are used for capping.

Approach: The contractor will obtain assistance from the dredging contractor for collection of sediment samples from the hopper for the following events during the pilot cap monitoring program: 1) the first three loads of cap material transported to each cell of the capping area, 2) 30% of the loads during continuous capping operations, and 3) the first three loads of any cap material originating from borrow areas. For each load, three samples will be collected (one each from bow, center and stern of hopper) and composited to achieve a single composite sediment sample from each load.

The contractor will be responsible for providing sample containers, instructions to the dredging contractor for sample collection, sample custody, and laboratory analysis of geotechnical properties (grain size, bulk density, specific gravity, water content, and atterberg limits) of each composite sediment sample. Additionally, chemical analysis of p,p' DDE will be conducted for composite sediment samples from the first three loads acquired from the borrow areas. Raw sediment grain-size data from the first three loads for each cell will be provided to the Corps Project Manager within 24 hours of sample collection.

All the results will be presented in a report upon completion of the pilot cap monitoring program. The data also will be entered into the database of DAN-LA within one week as the results become available.

Task 5. Flex Surveys

Approach: In addition to the survey efforts requested in Tasks 6-9, the contractor will plan on 60 additional SPC/PVC stations, 20 additional sediment cores (all for visual core descriptions, 8 for p,p' DDE sampled at five intervals as described in the Post Cap sections below), and 25 additional water samples (all for TSS, 5 for p,p' DDE). These extra samples will be used to augment, as needed, the surveys already planned in Tasks 6-9 or to conduct separate supplementary surveys during the course of the placement operations. This will permit maximum survey flexibility and allow immediate investigation of areas of uncertainty. Collection of these additional samples will be at the request of the Corps Project Manager and may be based on recommendations of the contractor.

Task 6. Monitoring of Cell LU (Landward – upstream) (Events #1 and #3a)

Background: This portion of the project will involve the **conventional placement** of hopper loads of sediment from the Queen's Gate entrance channel. Initially, the placement vessel will be directed to the center point of the capping cell that has been denoted as the landward and

upstream cell (LU). Following the first placement, approximately 7 days will be provided for collection and analysis of the monitoring data before any additional placement occurs (figure 2). Once the data have been assessed, additional placement will occur with the intent of creating a 15 cm cap over the entire cell.

Objectives

Objective 1: Assess the thickness and lateral distribution of capping sediments during placement operations.

Objective 2: Assess plume TSS and p,p' DDE concentrations and extent for two hours following hopper placement.

Objective 3: Assess extent of surge during placement operations.

Objective 4: Assess mixing of cap sediments with the in-situ sediments.

Objective 5: Evaluate monitoring approaches.

Approach

A. Baseline Survey. The contractor will conduct a 25 station pre-placement sediment profile camera/plan view camera (SPC/PVC) survey at the cell named LU(#1) (Figure 1). Three replicate photographs will be obtained from each station (75 photographs total) for full analysis of infaunal successional status and sediment physical conditions. The contractor will also conduct a high resolution, dual frequency, digital side-scan survey of the cell which covers the cell and extends beyond the cell boundaries by the following distances, 500 m up slope, laterally, and 750 m down slope (Figure 3).

B. Single Hopper Placement Survey **(Event #1).**

i.) Prior to the first placement event the contractor will deploy six (6) bottom-moored arrays (see figure 4) consisting of a recording current meter [Nortek Aquadopp current meters (see www.NortekUSA.com for more information) or equivalent] and a self-recording OBS gage. Two of these arrays will also be outfitted with an upward-looking ADCP. Three of these arrays will be deployed in a transect up slope of the planned placement point at distances of 50, 100, and 200 meters. The second set will be placed in an identical configuration down slope of the placement point. The arrays at 100 m will have the upward looking ADCP. The instruments will be set to record once per second. The contractor will retrieve the instruments after the placement event, download, and analyze the data to assess the surge from sediment placement. The raw data from the hour around the cap placement event will be graphed and provided to the Corps Project Manager within 48 hours of array retrieval.

ii.) The contractor will use acoustic Doppler current profiler (ADCP) and optical back scatter (OBS) equipment to map the location and extent of the plume created by the placement of cap material for two hours. The contractor will take up to 30 water samples for total suspended solids (TSS) analysis and 6 samples for p,p' DDE. The p,p' DDE samples will be taken in the centroid of the plume within 2 meters of the bottom (where concentrations can be expected to be greatest) at 5, 20, 40, 60, 90, and 120 minutes after placement. Prior to the placement event the contractor will take 3 background samples from within 2 meters of the bottom. Samples will be analyzed for p,p' DDE.

iii.) After the placement event the contractor will conduct a 37 station sediment profile camera/plan view camera survey at the cell (Figure 1). One photograph will be obtained from each station, though triplicates will be obtained at 4 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

iv.) The contractor will take gravity cores at 5 stations (figure 1). The contractor will randomly select these 5 stations from among the 37 SPC/PVC stations in the previous task. Four of the five will be selected from inner stations expected

to have cap accumulation and one selected from the outer stations expected to be free of cap. These cores will be used as an independent check on the SPC measurements. Cores will be extracted, vertically split, photographed, and visually described within 24 hours of collection to assess the thickness of cap material and the degree of mixing between the cap and EA sediment.

v.) The contractor will conduct a high resolution, dual frequency digital side-scan survey over the cell to assess distribution of cap sediment. Preliminary results on cap distribution will be provided to the Corps Project Manager within 24 hours of survey completion.

C. Interim Placement Surveys (Creation of 15cm Cap) **(Event #3a).**

i.) Prior to the next series of four placement events the contractor will deploy six (6) bottom-moored arrays (see figure 4) consisting of a recording current meter [Nortek Aquadopp current meters (see www.NortekUSA.com for more information) or equivalent] and a self-recording OBS gage. Two of these arrays will also be outfitted with an upward-looking ADCP. Three of these arrays will be deployed in a transect up slope of the planned placement point at distances of 50, 100, and 200 meters. The second set will be placed in an identical configuration down slope of the placement point. The arrays at 100 m will have the upward looking ADCP. The instruments will be set to record once per second. The contractor will retrieve the instruments once the four placement events have occurred, download, and analyze the data to assess the surge from sediment placement. The raw data from the hour around the cap placement events will be graphed and provided to the Corps Project Manager within 48 hours of array retrieval.

ii.) The contractor will map the location, concentration, and extent of the plume created by the placement of cap material of the second and third placement for two hours. The contractor will repeat the approach used for the Single Hopper Placement Survey.

iii.) The contractor will conduct two 14 station sediment profile camera/plan view camera surveys, one after the predicted number of loads to create a 10 cm cap have been placed at the first disposal point, and the second two thirds of the way through cap placement (figure 1). One photograph will be obtained from each station, though triplicates will be obtained at 2 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

iv.) The contractor will take gravity cores at 5 stations (figure 1), one after the predicted number of loads to create a 10 cm cap have been placed at the first disposal point, and the second two thirds of the way through cap placement. Cores will be extracted, vertically split, photographed, and visually described as for the Single Hopper Placement Survey.

D. Post Cap Monitoring

i.) After the placement event the contractor will conduct a 37 station sediment profile camera/plan view camera survey at the cell (Figure 1). One photograph will be obtained from each station, though triplicates will be obtained at 4 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

ii.) The contractor will conduct a sub-bottom, chirp acoustic profile of the capping cell to assess cap thickness. The survey should consist of 3 longitudinal transects and 7 cross sections (figure 1).

iii.) The contractor will collect 9 gravity cores or vibracores from the capping cell. These cores will penetrate at least 20 cm into the EA sediment. The cores will be split, photographed, visually described, and sampled. Particular attention should be given to the condition of the transition between the EA and cap sediments. Sediment grain size, bulk density, specific gravity, water content, atterberg limits (if sufficient fines), and chemistry samples will be taken from four of these cores (randomly selected from the nine). Samples will be taken at the sediment/water interface (top of core), 3 cm and 7 cm above the interface/mixed layer and 4 cm and 8 cm below the interface/mixed layer. The "7 cm" and "8 cm" samples will be archived. The "0, 3 and 4 cm" samples will be analyzed for the physical parameters listed above and p,p' DDE.

iv.) The contractor will conduct a high resolution, dual frequency digital side-scan survey over the cell to assess distribution of cap sediment. Preliminary results on cap distribution will be provided to the Corps Project Manager within 24 hours of survey completion.

Task 7. Monitoring of Cell LD (Landward, downstream) (Events #2 and #3b)

Background: This portion of the project will involve the **spreading placement** of a single hopper load of sediment from the coarse sediment borrow site. The placement vessel will be directed to the center lane of the capping cell that has been denoted as the landward and downstream cell (LD). Following placement of the first hopper load in this cell, approximately 7 days will be provided for collection and analysis of the monitoring data, though if the data from the first LU event provides good confirmation of predictions, placement Event #3a will begin during this 7 days (figure 2). Once the data have been assessed, additional placement of several hopper loads will occur **(Event #3b),** with the intent of creating a thicker cap, using this method.

Objectives: As in described for Task 6.

Approach

A. Baseline Survey. The contractor will conduct a 25 station pre-placement sediment profile camera/plan view camera survey at the cell named LD(#2) (Figure 1). Three replicate photographs will be obtained from each station (75 photographs total) for full analysis of infaunal successional status and sediment physical conditions. The contractor will also conduct a high resolution, dual frequency digital side-scan survey of the cell, 500 m up slope, laterally, and 750 m down slope (figure 3).

B. Single Hopper Placement Survey **(Event #2).**

i.) Prior to the first placement event the contractor will deploy six (6) bottom-moored arrays (see figure 4) consisting of a recording current meter [Nortek Aquadopp current meters (see www.NortekUSA.com for more information) or equivalent] and a self-recording OBS gage. Two of these arrays will also be outfitted with an upward-looking ADCP. Three of these arrays will be deployed in a transect up slope of the planned placement point at distances of 50, 100, and 200 meters. The second set will be placed in an identical configuration down slope of the placement point. The arrays at 100 m will have the upward looking ADCP. The instruments will be set to record once per second. The contractor will retrieve the instruments after the placement event, download, and analyze the data to assess the surge from sediment placement. The raw data from the hour around the cap placement event will be graphed and provided to the Corps Project Manager within 48 hours of array retrieval. If the spreading occurs as planned, there will be no bottom surge associated with the particle settling. Also the path the dredge takes will be quite long. Therefore the need for the bottom mounted current meters and OBS gages will be primarily to document the negative, i.e., to show that in fact individual particle settling did occur.

ii.) The contractor will use acoustic doppler current profiler (ADCP) and optical back scatter (OBS) equipment to map the location and extent of the plume created by the placement of cap material for two hours. For this scenario, the ADCP will be used to estimate the fall velocity of the individual particles and estimate the point at which they impact the bottom. A 0.2 mm particle should reach the bottom in about 30 minutes. The contractor will take up to 30 water samples for total suspended solids (TSS) analysis and 6 samples for p,p' DDE. The p,p' DDE samples will be taken in the centroid of the plume within 2 meters of the bottom (where concentrations can be expected to be greatest) at 5, 20, 40, 60, 90, and 120 minutes after placement. Prior to the placement event the contractor will take 3 background samples from within 2 meters of the bottom. Samples will be analyzed for p,p' DDE.

iii.) After the placement event the contractor will conduct a 37 station sediment profile camera/plan view camera survey at the cell (Figure 1). One photograph will be obtained from each station, though triplicates will be obtained at 4 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

iv.) The contractor will take gravity cores at 5 stations (figure 1). Four will be selected randomly from among the SPC stations in the cell and one randomly selected from among the SPC stations outside the cell. Cores will be processed and analyzed for visual descriptions as in previous tasks.

v.) The contractor will conduct a high resolution, dual frequency digital side-scan survey over the cell to assess distribution of cap sediment. Preliminary results on cap distribution will be provided to the Corps Project Manager within 24 hours of survey completion.

C. Interim Placement Surveys. **(Event #3b)**

i.) Prior to the next four placement events, the contractor will deploy six (6) bottom-moored arrays (see figure 4) consisting of a recording current meter [Nortek Aquadopp current meters (see www.NortekUSA.com for more information) or equivalent] and a self-recording OBS gage. Two of these arrays will also be outfitted with an upward-looking ADCP. Three of these arrays will be deployed in a transect up slope of the planned placement point at distances of 50, 100, and 200 meters. The second set will be placed in an identical configuration down slope of the placement point. The arrays at 100 m will have the upward looking ADCP. The instruments will be set to record once per second. The contractor will retrieve the instruments once the four placement events have occurred, download, and analyze the data to assess the surge from sediment placement. The raw data from the hour around the cap placement events will be graphed and provided to the Corps Project Manager within 48 hours of array retrieval.

ii.) The contractor will map the location, concentration, and extent of the plume created by the placement of cap material of the second and third placement for two hours. The contractor will repeat the approach used for the Single Hopper Placement Survey.

iii.) The contractor will conduct two 14 station sediment profile camera/plan view camera surveys, one after the predicted number of loads to create a 10 cm cap have been placed at the first disposal point, and the second two thirds of the way through cap placement. One photograph will be obtained from each station, though triplicates will be obtained at 2 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

iv.) The contractor will take gravity cores at 5 stations (figure 1), after all of the loads have been placed along the placement lane. Cores will be processed and analyzed for visual descriptions as in previous tasks.

D. Post Cap Monitoring

i.) After the placement event the contractor will conduct a 37 station sediment profile camera/plan view camera survey at the cell named LD(#2) (Figure 1). One photograph will be obtained from each station, though triplicates will be obtained at 4 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

ii.) The contractor will conduct a sub-bottom, chirp acoustic profile of the capping cell to assess cap thickness. The survey should consist of 3 longitudinal transects and 7 cross sections.

iii.) The contractor will collect 9 gravity cores or vibracores from the capping cell. These cores will penetrate at least 20 cm into the EA sediment. The cores will be split, photographed, visually described, and sampled. Particular attention should be given to the condition of the transition between the EA and cap sediments. Sediment grain size, bulk density, specific gravity, water content, atterberg limits (if sufficient fines),and chemistry samples will be taken from four of these cores (randomly selected from the nine). Samples will be taken at the sediment/water interface (top of core), 3 cm and 7 cm above the interface/mixed layer and 3 cm and 8 cm below the interface/mixed layer (because this cell will not be receiving a full 15 cm cap the location of these sample locations will be coordinated with the Corps Project Manager during the survey). The “7 cm” and “8 cm” samples will be archived. The “0, 3 and 4 cm” samples will be analyzed for the physical parameters listed above and p,p’ DDE.

iv.) The contractor will conduct a high resolution, dual frequency digital side-scan survey over the cell to assess distribution of cap sediment. Preliminary results on cap distribution will be provided to the Corps Project Manager within 24 hours of survey completion.

Task 8. Monitoring of Cell SU (Seaward, Upstream) (Events #4 and #6a)

Background: This portion of the project will involve the **conventional placement** of hopper loads of sediment from the Queen’s Gate channel. Initially, the placement vessel will be directed to the center point of the capping cell that has been denoted as the seaward and upstream cell (SU). Following placement of the first hopper load in this cell, approximately 6 days will be provided for collection and analysis of the monitoring data, during which time

other placement may occur concurrently (figure 2). Once the data have been assessed, additional placement will occur with the intent of creating a 15 cm cap over the entire cell.

Approach: The contractor will repeat all surveys conducted for cell LU during the placement of cap at this cell.

Task 9. Monitoring of Cell SD (Seaward, Downstream) (Events #5 and #6b)

Background: This portion of the project will involve the **spreading placement** of hopper loads of sediment from the coarse sediment borrow site. Initially, the placement vessel will be directed to the center lane of the capping cell that has been denoted as the seaward and downstream cell (SD). Following placement of the first hopper load in this cell, approximately 3 days will be provided for collection and analysis of the monitoring data, with continued placement anticipated to be occurring at cell LU (figure 2). Once the data have been assessed, additional placement of several hopper loads will occur, with the intent of creating a thicker cap, using this method.

Approach

A. Baseline Survey. The contractor will conduct a 25 station pre-placement sediment profile camera/plan view camera survey at the cell named SD(#4) (Figure 1). Three replicate photographs will be obtained from each station (75 photographs total) for full analysis of infaunal successional status and sediment physical conditions. The contractor will also conduct a high resolution, dual frequency digital side-scan survey of the cell, 500 m up slope, laterally, and 750 m down slope.

B. Single Hopper Placement Survey **(Event #5).**

i.) Prior to the first placement event, the contractor will deploy six (6) bottom-moored arrays (see figure 4) consisting of a recording current meter [Nortek Aquadopp current meters (see www.NortekUSA.com for more information) or equivalent] and a self-recording OBS gage. Two of these arrays will also be outfitted with an upward-looking ADCP. Three of these arrays will be deployed in a transect up slope of the planned placement point at distances of 50, 100, and 200 meters. The second set will be placed in an identical configuration down slope of the placement point. The arrays at 100 m will have the upward looking ADCP. The instruments will be set to record once per second. The contractor will retrieve the instruments after the placement event, download, and analyze the data to assess the surge from sediment placement. The raw data from the hour around the cap placement event will be graphed and provided to the Corps Project Manager within 48 hours of array retrieval. If the spreading occurs as planned, there will be no bottom surge associated with the particle settling. Also the path the dredge takes will be quite long. Therefore the need for the bottom mounted current meters and OBS gages will be primarily to document the negative, i.e., to show that in fact individual particle settling did occur.

ii.) The contractor will use acoustic doppler current profiler (ADCP) and optical back scatter (OBS) equipment to map the location and extent of the plume created by the placement of cap material for two hours. For this scenario, the ADCP will be used to estimate the fall velocity of the individual particles and estimate the point at which they impact the bottom. A 0.2 mm particle should reach the bottom in about 30 minutes. The contractor will take up to 30 water samples for total suspended solids (TSS) analysis and 6 samples for p,p' DDE. The p,p' DDE samples will be taken in the centroid of the plume within 2 meters of the bottom (where concentrations can be expected to be greatest) at 5, 20, 40, 60, 90, and 120 minutes after placement. Prior to the placement event the contractor will take 3 background samples from within 2 meters of the bottom. Samples will be analyzed for p,p' DDE.

iii.) After the placement event the contractor will conduct a 37 station sediment profile camera/plan view camera survey at the cell (Figure 1). One photograph will be obtained from each station, though triplicates will be obtained at 4 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

iv.) The contractor will take gravity cores at 5 stations (figure 1). Four will be selected randomly from among the SPC stations in the cell and one randomly selected from among the SPC stations outside the cell. Cores will be processed and analyzed for visual descriptions as in previous tasks.

v.) The contractor will conduct a high resolution, dual frequency digital side-scan survey over the cell to assess distribution of cap sediment. Preliminary results on cap distribution will be provided to the Corps Project Manager within 24 hours of survey completion.

C. Interim Placement Surveys. **(Event #6b)**

i.) Prior to the next four placement events, the contractor will deploy six (6) bottom-moored arrays (see figure 4) consisting of a recording current meter [Nortek Aquadopp current meters (see www.NortekUSA.com for more information) or equivalent] and a self-recording OBS gage. Two of these arrays will also be outfitted with an upward-looking ADCP. Three of these arrays will be deployed in a transect up slope of the planned placement point at distances of 50, 100, and 200 meters. The second set will be placed in an identical configuration down slope of the placement point. The arrays at 100 m will have the upward looking ADCP. The instruments will be set to record once per second. The contractor will retrieve the instruments once the four placement events have occurred, download, and analyze the data to assess the surge from sediment placement. The raw data from the hour around the cap placement

events will be graphed and provided to the Corps Project Manager within 48 hours of array retrieval.

ii.) The contractor will map the location, concentration, and extent of the plume created by the placement of cap material of the second and third placement for two hours. The contractor will repeat the approach used for the Single Hopper Placement Survey.

iii.) The contractor will conduct two 14 station sediment profile camera/plan view camera surveys, one after the predicted number of loads to create a 10 cm cap have been placed at the first disposal point, and the second two thirds of the way through cap placement. One photograph will be obtained from each station, though triplicates will be obtained at 2 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

iv.) The contractor will take gravity cores at 5 stations (figure 1), after all of the loads have been placed along the placement lane. Cores will be processed and analyzed for visual descriptions as in previous tasks.

D. Post Cap Monitoring

i.) After the placement event the contractor will conduct a 37 station sediment profile camera/plan view camera survey at the cell named SD(#4) (Figure 1). One photograph will be obtained from each station, though triplicates will be obtained at 4 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

ii.) The contractor will conduct a sub-bottom, chirp acoustic profile of the capping cell to assess cap thickness. The survey should consist of 3 longitudinal transects and 7 cross sections.

iii.) The contractor will collect 9 gravity cores or vibracores from the capping cell. These cores will penetrate at least 20 cm into the EA sediment. The cores will be split, photographed, visually described, and sampled. Particular attention should be given to the condition of the transition between the EA and cap sediments. Sediment grain size, bulk density, specific gravity, water content, atterberg limits (if sufficient fines),and chemistry samples will be taken from four of these cores (randomly selected from the nine). Samples will be taken at the sediment/water interface (top of core), 3 cm and 7 cm above the interface/mixed layer and 3 cm and 8 cm below the interface/mixed layer (because this cell will not be receiving a full 15 cm cap the location of these sample locations will be coordinated with the Corps Project Manager during the survey). The “7 cm” and “8 cm” samples will be archived. The “0, 3 and 4

cm" samples will be analyzed for the physical parameters listed above and p,p' DDE.

iv.) The contractor will conduct a high resolution, dual frequency digital side-scan survey over the cell to assess distribution of cap sediment. Preliminary results on cap distribution will be provided to the Corps Project Manager within 24 hours of survey completion.

Task 10. Evaluation of Bathymetry Surveying

Background: Because of the planned 15 to 45 cm cap thickness for the Pilot Cap placement, it is believed that the use of precision bathymetry to evaluate cap thickness will be of little value. However, before this decision is made there is merit to evaluating the feasibility of various methods and their associated costs.

Objective: Determine whether there are bathymetric survey methods that may be feasible for use in assessing cap thickness (both 15 and 45 cm caps) at the Palos Verdes shelf.

Approach

A. The contractor will assess the value of different bathymetric survey methods for detecting both a 15 cm and 45 cm cap at the Palos Verdes shelf. The contractor should evaluate the errors, precision, and accuracy of methods such as multi-beam equipment and systems based on towed transducers, coupled with *in situ* navigation beacons. The contractor should evaluate modifications to survey procedures that may improve accuracy.

B. The contractor will prepare a report evaluating the feasibility of using bathymetry as a survey tool for the Palos Verdes capping project. The report should describe the systems evaluated, their limitations, and advantages. The report will include recommendations for the use of bathymetric systems and will detail any approaches that may make their use feasible.

C. The contractor will prepare a proposed scope of work to evaluate any recommended system(s) during the Pilot Project. This scope should include an estimate of the cost that such a test would require.

Task 11. Disposal Plume Transport Survey

Background: Potential transport of suspended solids towards regional kelp forests is a concern. An assessment as to whether plumes would reach these locations and their extent and level of turbidity if they reach the kelp forests is needed.

Objectives: The contractor will contact local experts to determine the known location of the kelp forests nearest to the pilot demonstration area. The contractor will determine and map the extent and concentration of plume suspended sediments in the upper water column during expected on-shore transport events.

Approach:

1. The contractor will contact local experts to determine the location and extent of kelp forests near to the pilot study area. The contractor will acquire or develop a GIS data layer to contain this information.

2. The contractor will use an acoustic Doppler current profiler (ADCP) and optical back scatter (OBS) equipment to map the location and extent of the upper water column plume (upper 30 m) created by the placement of cap material for two hours. This will be accomplished 3 separate times during the period of the pilot study when placement of finer cap sediments are being placed in the Land ward cells. This will also occur when oceanographic conditions are expected to move the surface waters towards shore. The contractor will select these times in coordination with the Corps Project Manager. The contractor will take up to 30 water samples for total suspended solids (TSS) analysis in each plume to assist in mapping plume concentration.

Task 12. Cap Erosion Analysis Samples

Background: The potential for the cap to be susceptible to erosion is one of the concerns that has been raised with the planned capping. One means of evaluating this possibility, will be to take samples of the in-place cap and test them in an erosion flume. The contractor will be responsible for collection of the samples for delivery to the analytical labs as specified. The actual testing of these samples is not a responsibility of the contractor under this scope of work.

Objective: Collect sediments for evaluation of the relative erosion potential of the in-place cap sediments.

Approach

A. After the completion of all other post-capping pilot surveys identified in this scope the contractor will collect sediment samples from near the center of cells LU and SU. At each of the two cells, the contractor will collect 120 liters of sediment using a Smith- McIntyre Grab and 3 cores (5 to 9 cm diameter by minimum 60 cm long, maximum 100 cm long). The 120 liter samples will be stored in sealed 12-liter buckets. Each bucket will be labeled to indicate location of samples.

B. The buckets and two cores from each of the two sites will be palletized and shipped to:

Dr. Rich Jepsen
Department of Energy
Sandia National Laboratory
4100 National Parks Highway
Carlsbad, NM 88220
(505) 234-0072

rajepse@sandia.gov

A brief letter will be submitted at completion of task to document samples collected including Latitude, Longitude, Area, Date, Time, and Water Depth at sample locations. The cores should remain upright and be padded to reduce vibrations. The samples should not be frozen and should be kept between 4 and 20 degrees centigrade. The cores should be split into 20 cm sections prior to shipping, and recapped and sealed.

One core from each site and a second copy of the letter documenting the sample locations, etc., should be sent to:

Dr. Marian Rollings
USAERDC
3909 Halls Ferry Rd.
Vicksburg, MS 39180-6199
ATTN: CEERD-GP
(601) 634-2952
rollingm@wes.army.mil

Task 13. Reporting

A. The contractor will provide daily updates via phone, e-mail, or fax to the Corps Project Manager during the operational portion of the Pilot capping. Weekly project meetings will be held with the Corps Project Manager to discuss progress and issues.

B. Within 3 weeks of the completion of monitoring the contractor will provide a cruise report to the Corps Project Manager. This report should provide a log of monitoring operations and a compilation of the data that are immediately available (qualified, as appropriate, regarding their preliminary or final validated status).

C. The contractor will prepare a detailed report (divided into chapters as appropriate) evaluating the results of the surveys. Methods used and data produced will be presented and analyzed. The report will address the objectives of the work and the purpose (null hypotheses). This report will include identification of needed changes to the null hypotheses, evaluation of the monitoring and operational approaches used, and recommendations. The contractor will produce both a final and draft report. The report will include an Executive Summary, Table of Contents, List of Figures, List of Tables, Introduction, Methods, Results, Discussion, Recommendations, References, Index, and Appendices. Ten copies of the draft report will be delivered to the Corps Project Manager 10 weeks following completion of all field work. The report will be delivered both in paper format and on electronic disk in MSWord 97 SR-2 format. Six (6) weeks following receipt of comments from the Corps Project Manager, the contractor will submit a ten copies of the final report. In addition to the paper and MS Word versions, the final report will also be submitted in PDF format on CD-ROM.

D. All data will be entered into the project GIS/Database and submitted to the Corps Project Manager on CD-ROM at the time of draft report submission.

Palermo, M., P. Schroeder, Y. Rivera, C. Ruiz, D. Clarke, J. Gailani, J. Clausner, M. Hynes, T. Fredette, B. Tardy, L. Peyman-Dove, and A. Risko. 1999. Options for In Situ Capping of Palos Verdes Shelf Contaminated Sediments.

Palermo, et al. 2000. Field pilot study of in situ capping of Palos Verdes Shelf contaminated sediments – Operations and Monitoring Plan.

Lee, H. J. (1994). "The distribution and character of contaminated effluent-affected sediment, Palos Verdes Margin, Southern California," Expert Report.

Figure 1.

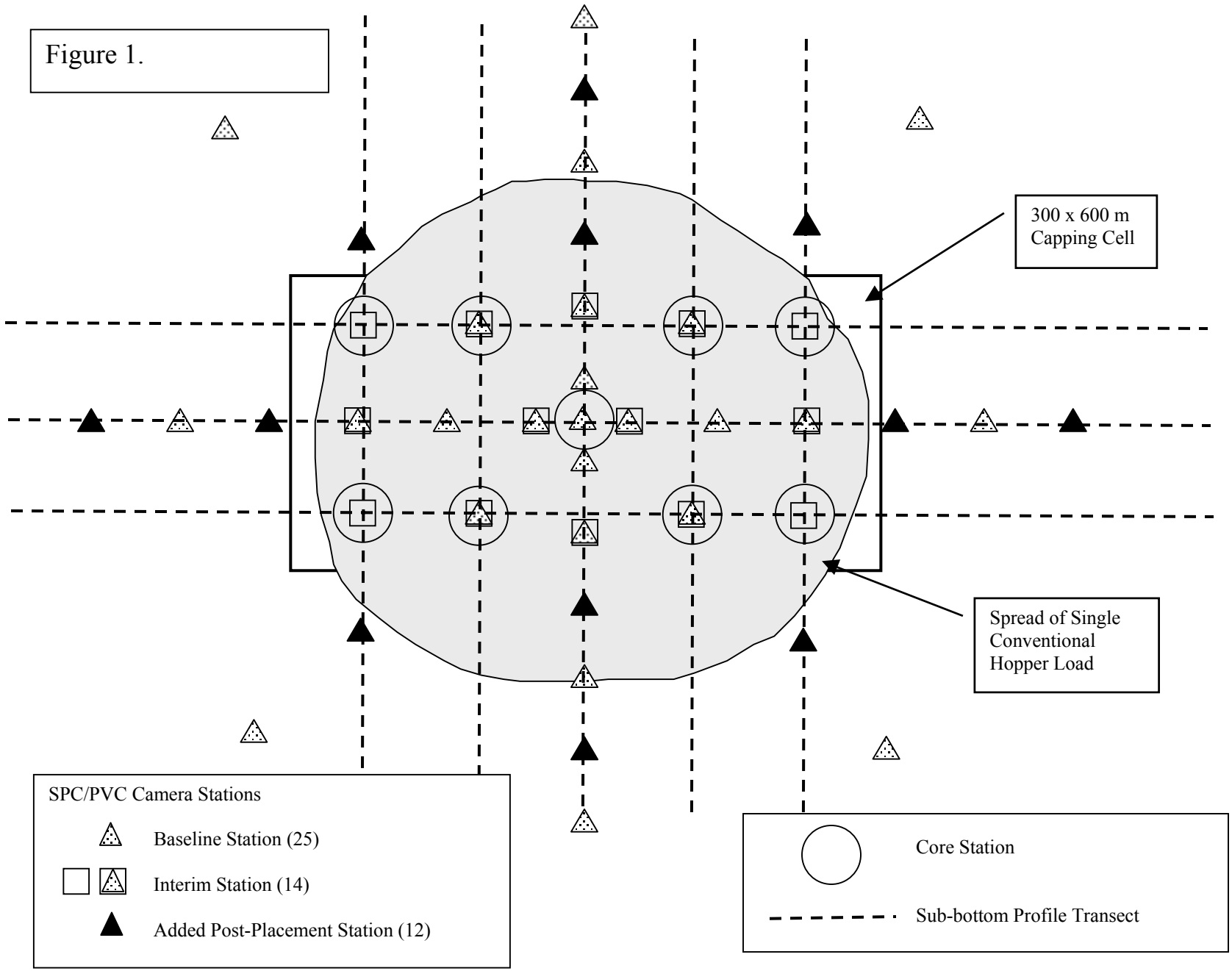
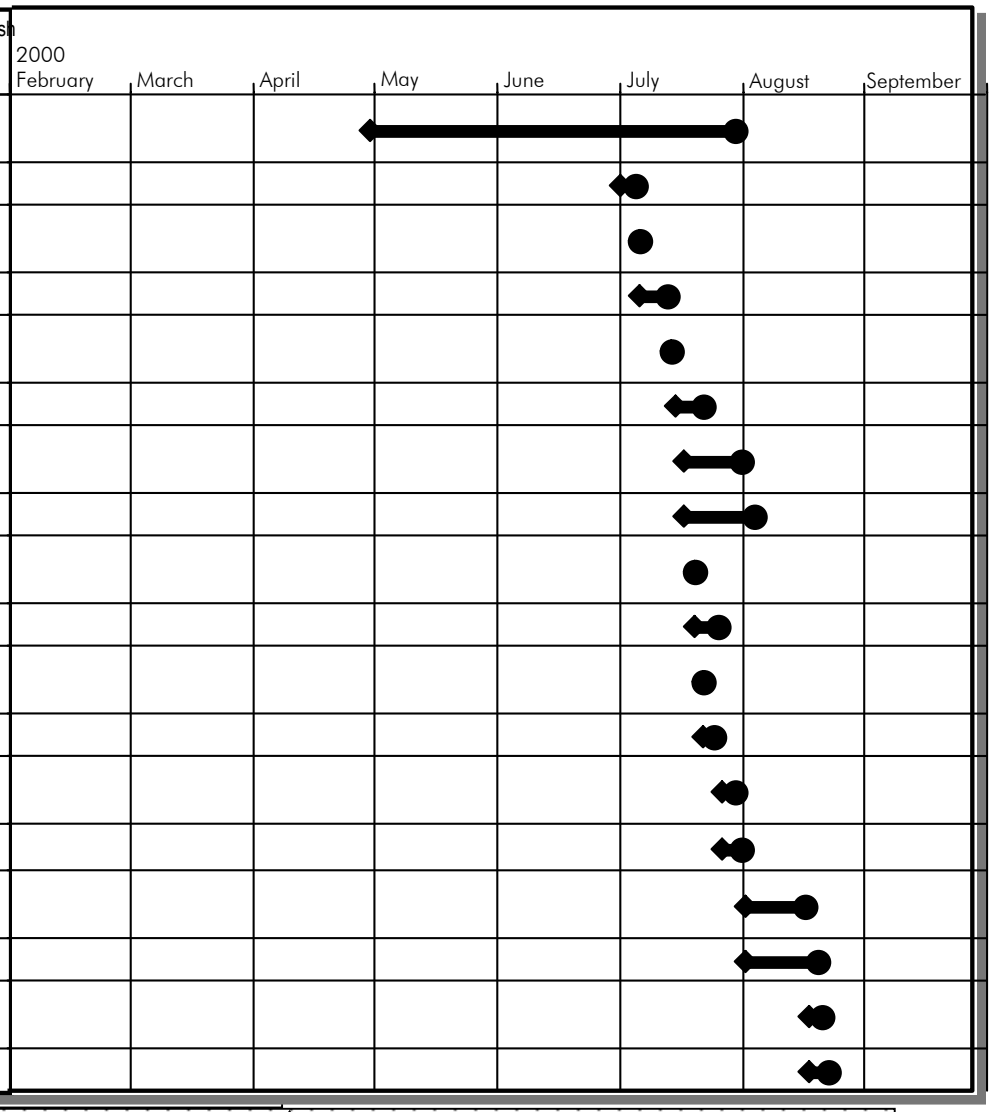
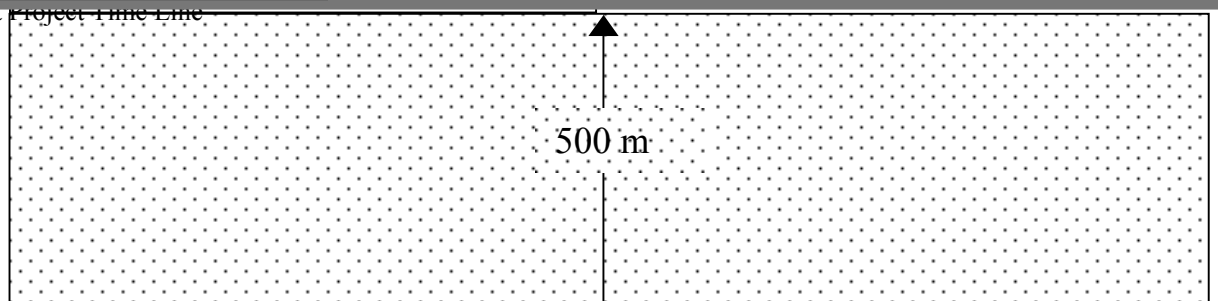

300 x 600 m
Capping Cell
Spread of Single
Conventional
Hopper Load
SPC/PVC Camera Stations
Baseline Station (25)
Interim Station (14)
Added Post-Placement Station (12)
Core Station
Sub-bottom Profile Transect

Figure 2.

Task	Planned Start	Duration in Days	Planned Finish
Baselin Monitoring	4/30/0	91	7/30/0
Event #0	7/1/0	4	7/5/0
Event #1 LU Convent./Fin	7/6/0	0	7/6/0
Monitoring #1	7/6/0	7	7/13/0
Event #2 LD Spreading/Coars	7/14/0	0	7/14/0
Monitoring #2	7/15/0	7	7/22/0
Event #3a LU Fine to 15cm	7/17/0	15	8/1/0
Monitoring #3a	7/17/0	18	8/4/0
Event #4 SU Convent./Fin	7/20/0	0	7/20/0
Monitoring #4	7/20/0	6	7/26/0
Event #5 SD Spreading/Coars	7/22/0	0	7/22/0
Monitoring #5	7/22/0	3	7/25/0
Event #3b LD Coarse +cm	7/27/0	3	7/30/0
Monitoring #3b	7/27/0	5	8/1/0
Event #6a Fine to 15cm	8/2/0	15	8/17/0
Monitoring #6a	8/2/0	18	8/20/0
Event #6b Coarse +cm	8/18/0	3	8/21/0
Monitoring #6b	8/18/0	5	8/23/0



Conceptual Pilot Project Time Line



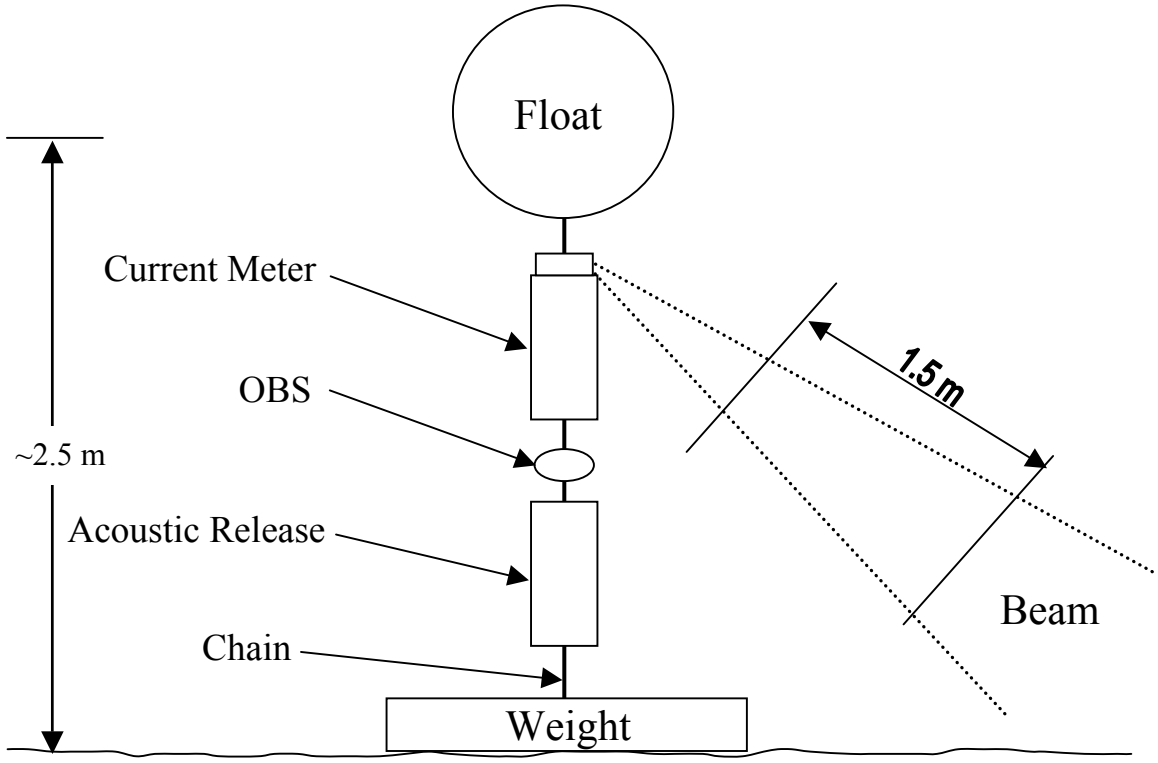


Figure 4. Schematic of Bottom Array.

Project Work Plan
for the
Palos Verdes Pilot Capping Project:
Baseline Monitoring Activities

QUALITY ASSURANCE PROJECT PLAN

Prepared for:

U.S. Army Corps of Engineers
Los Angeles District
Environmental Construction Branch

U.S. Environmental Protection Agency
Region IX
Superfund Division (SFD-7-1)

February 2001

Prepared by:

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Newport, RI 02840
SAIC Report Number 486D

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1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) describes the Quality Assurance (QA) Program to be implemented and the quality control (QC) procedures to be followed for the U.S. Army Corps of Engineers' (USACE) baseline monitoring program. This plan presents the QA/QC procedures for the following:

- QA objectives for measurement data
- Sampling procedures
- Sample custody
- Calibration procedures and frequency
- Analytical procedures
- Data reduction, validation, and reporting
- Internal quality control checks and frequency
- Performance and systems audits and frequency
- Preventive maintenance
- Specific routine procedures for measurement parameters involved
- Corrective action
- QA reports to management

Other specific topics, such as project organization and responsibilities, typically addressed in QAPPs following standard U.S. EPA format, are presented in other sections of this Project Work Plan and are not repeated here to minimize redundancies.

The requirements contained in this QAPP are to ensure that data are of known and acceptable quality and sufficiently complete, comparable, representative, accurate, and precise to fulfill their intended use and related data quality objectives.

1.1 Overview and Objectives of the Baseline Monitoring Program

An overview of the objectives of the pilot capping project is presented in the Overview section of this Project Work Plan. General objectives of baseline monitoring are to acquire data and information to:

- Aid with final design of operational, engineering, and scientific monitoring elements of the pilot capping program;
- Facilitate comparisons with interim and post-cap monitoring results.

Specific Data Quality Objectives are described in the Data Quality Objectives section of this Project Work Plan.

1.2 Types of Sampling

Baseline monitoring will consist of four integrated sampling tasks: sediment coring; sediment profile imaging; side-scan sonar; and subbottom profiling. The objectives of these sampling tasks are to characterize pre-capping conditions (sediment chemistry and geotechnical characteristics) at specific cells within the effluent-affected (EA)

footprint considered for capping. Each of the sampling tasks requires a specific approach to data collection and analysis. These approaches are described in detail in the Field Sampling Plan.

Quality assurance reviews of data generated from the field surveys and laboratory analyses (e.g., relative to Data Quality Objectives, as well as error and format checks) will be performed. Reviewed data will be input to a DAN-LA (Disposal Analysis Network - Los Angeles) geographic information system (GIS) being developed for the project.

2.0 QUALTITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

U.S. EPA specifies five major characteristics of data quality that must be addressed in environmental sampling and analytical projects. These QA objectives are accuracy, precision, completeness, representativeness, and comparability. Accuracy, precision and completeness objectives can be expressed quantitatively, while representativeness and comparability are qualitative parameters. Table 2-1 provides a summary of the accuracy, precision, and completeness objectives for the various measurement data to be obtained in the baseline monitoring program. These objectives, as well as those for representativeness and comparability, are discussed in greater detail in the following sections.

Accuracy is the degree of agreement of a measurement (or measurement average) with an accepted reference or true value. It is a measure of system bias. It is usually expressed as the difference of "measured" from "true" values, or as a percentage of the difference. For this project, accuracy can be evaluated quantitatively only for sediment chemistry analyses. Reference standards are not available for sediment profile, side-scan, and subbottom imagery data.

Precision is a measure of agreement among individual measurements of the same property under similar conditions. It is expressed in terms of percent difference or the standard deviation of replicate values. As a measure of sampling precision, some replicate field samples will be collected and analyzed and replicate field measurements performed. These samples will yield information regarding the precision of the field sampling effort and the degree of spatial heterogeneity. Analytical precision (i.e., for sediment chemical analyses) will be determined by replicate analyses of selected field and laboratory QC samples.

Completeness is the measure of the total number of usable data points (i.e., total data points minus unusable [i.e., rejected] data points) divided by the total number of data points collected. Usable data points are those that meet the project quality objectives for accuracy, precision, comparability, and representativeness. Completeness is applicable to all data collection processes, including the sediment profile imaging and plan view photography, sediment coring, side-scan sonar surveying, and subbottom profile surveying. Completeness is always expressed as a percentage.

Representativeness is defined as the degree to which the data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter relating to the proper design of a sampling program, and is ensured by collecting sufficient samples of a population medium, properly distributed with respect to location and time. Representativeness is ensured in the laboratory by proper sample storage, analyses, and extraction within the project-required holding time, and acceptable instrument calibration and operation. The methods and protocols used to select samples that are representative of a particular test cell are described in the FSP.

Table 2-1. Summary of Measurement Quality Objectives for Data to be Collected in the Baseline Monitoring Program

MEASUREMENT	ACCURACY OBJECTIVE	PRECISION OBJECTIVE	COMPLETENESS OBJECTIVE
Sediment p,p'-DDE	See laboratory SOP (Appendix A) for recovery criteria for spike method blanks and MS/MSD; within acceptance range for Regional Reference Material (RRM) (see Table 2-3)	RPD < 30 for field duplicates (see Table 2-3); see laboratory SOP for MS/MSD precision criteria (Appendix A)	100%
Sediment bulk density	NA[1]	RPD < 30	100%
Sediment grain size	NA[1]	RPD < 30	100%
Sediment Atterberg Limits	NA[1]	NA[2]	100%
Sediment vane shear	NA[1]	NA	100%
Sediment profile imaging and planview photography	Sediment profile imaging grain size results and coring grain size results should agree at 90% or more of the stations where both are obtained	NA	100%
Side-scan sonar	Side-scan sonar characterization of sediment types should agree visually with coring and sediment profile imaging results	"Duplicate" results (obtained at survey lane intersection points) should agree with respect to type and location of seafloor features	100%
Sub-bottom profiling	Sub-bottom profiling results indicating the presence of sediment layers should agree with coring and/or sediment-profile imaging results within ±20 cm	"Duplicate" results (obtained at survey lane intersection points) should agree within ±20 cm	100%

[1] NA = not applicable because accuracy-based standards are not available for these measurement types

[2] NA = not applicable because insufficient sediment volume available from cores for duplicates analyses.

Comparability is the degree to which data from one study can be compared with data from other studies, reference materials, or reference values. Comparability can be maximized by analyses of common reference materials and calibration standards, using standardized protocols or approaches, and/or intercalibration exercises.

The quality assurance objectives for the different data collection activities are discussed below.

2.1 Sediment Coring

Subsamples of sediment taken from each core will be analyzed chemically for p,p'-DDE, bulk density, grain size, and Atterberg Limits. In addition, vane shear measurements will be made directly on each core. For the chemical analysis of sediment subsamples obtained from each core, the following types of samples will be generated in the field: field sample, field duplicate, field blank, core liner rinsate sample, and core tool rinsate sample. Table 2-2 provides a summary description of each of these field-generated samples. Table 2-3 provides a summary of all of the QC samples that will be analyzed in the laboratory (including field-generated samples) for the sediment p,p'-DDE analysis, including frequency of analysis and target accuracy and precision limits. Table 2-4 provides a summary of the QC samples that will be analyzed in the laboratory (including field-generated samples) for sediment grain size and bulk density analyses. Duplicate analyses for Atterberg Limits will not be performed due to the limited sediment volume to be acquired from the cores for this measurement parameter.

Accuracy of sediment chemical analyses (i.e., p,p'-DDE) will be assessed by analyzing Regional Reference Material (RRM) PV7C, consisting of Palos Verdes Shelf sediment that has been characterized for the Bight '98 regional monitoring program. The RRM PV7C will be analyzed along with each sample batch. Matrix spikes and matrix spike duplicate samples also will be prepared and analyzed with each sample batch. The recoveries of spiked compounds in the MS/MSD will provide a further check on the accuracy achieved by the laboratory. Analytical accuracy is also addressed by acceptable calibration, surrogate recoveries, and method blank results. Laboratory-specific acceptance criteria for these results are provided in the laboratory SOPs (Appendix A).

The precision of the sediment p,p'-DDE analyses will be evaluated from results of analyses of RRM PV7C, as well as the laboratory-generated matrix spike/matrix spike duplicate (MS/MSD) that will be analyzed with each sample batch. Precision of grain size and bulk density data will be evaluated using results from analyses of both field and laboratory duplicate samples.

The completeness objective for the sediment DDE and geotechnical analyses, which will be calculated on those samples collected and analyzed (as opposed to those collected and archived), is 100%. Data from samples will be considered complete if the samples have been properly collected, preserved, stored, prepared, and analyzed within holding times, and all of the associated quality control criteria have been met.

The representativeness of the sediment chemistry, grain size, and density results will be determined by documenting the collection location and conditions to describe fully each sample's origin and handling history. Representativeness of the sediment chemistry data also will be verified by evaluating method and clean-up blank interference, field and equipment interference, and matrix spike/matrix spike duplicate results (see Section 7.5 describing data validation procedures). Comparability will be evaluated from results of the SRM and RRM analyses, as well as comparisons

with historical site data. The target precision and completeness goals for grain size and bulk density analyses are RPD ≤25% and 90%, respectively.

Table 2-2. Summary of chemistry samples (p,p'-DDE analysis) to be collected in the field in association with sediment coring.

SAMPLE NAME	NUMBER TO BE COLLECTED IN THE FIELD	DESCRIPTION	PURPOSE
Field sample	180 (9 cores per cell at 4 cells; five 4-cm sampling intervals per core)	A single sediment sample collected from each 4-cm interval within the cores and analyzed for p,p-DDE	Evaluation of vertical distribution of p,p-DDE in surface sediments within the pilot capping cells
Field duplicate	18 (10% of field samples; up to 5 samples from each of 4 cores; one core per cell)	A second (duplicate) sediment sample collected from each 4-cm interval within selected cores (those from the center station within each of the 4 cells) and analyzed for p,p-DDE. To be sent to the laboratory as a blind duplicate.	Check on both efficacy of sediment homogenization procedure and laboratory analytical precision
Field blank	1	Two 1-liter containers of distilled water are opened on the table where the cores are being processed and left open for the same period of time that the core section is exposed to air during the core subsampling procedure. Sent to the laboratory for analysis of p,p-DDE (note: only one of the 1-liter containers is required for analysis - the second represents a back-up sample)	Check on possible contamination of the sediment in the core from the core processing facility/core processing operation.
Core liner rinsate sample	1	Distilled water is poured over the internal surface of a core liner (chosen at random from among those used in the field) and collected in two 1-liter containers, sent to the laboratory for analysis of p,p-DDE (note: only one of the 1-liter containers is required for analysis - the second represents a back-up sample)	Check on possible contamination of the collected sediment from the inside of the core liner.
Core tool rinsate sample	9 (1 rinsate per every 20 field samples)	The implements used for removing sediment from each 4-cm core interval (i.e., stainless steel spoon/spatula) will be decontaminated between each sampling event (i.e., prior to sampling of each core interval). At regular intervals (e.g., every 20 samples), the spoon/spatula will be rinsed with distilled water at the end of the decontamination procedure but before the sediment sample is taken. The rinsate will be collected in two 1-liter containers and sent to the laboratory for analysis of p,p-DDE (note: only one of the 1-liter containers is required for analysis - the second represents a back-up sample).	Check on the adequacy of the decontamination procedure to remove residual p,p-DDE from the sampling implements between samples.

Table 2-3. Summary of QC Samples and Performance Criteria for Laboratory Analysis of p,p'-DDE in Sediment Core Samples. NA = not applicable; RPD = relative percent difference; MDL = method detection limit; MS/MSD = matrix spike/matrix spike duplicate; RRM = regional reference material.

QC Sample	**Number (Frequency)**	**Accuracy Criteria**	**Precision Criteria**	**Blank Contribution**
Initial Calibration Verification (ICV)	9 (1 per batch of 20 field samples)	Laboratory-specific, see laboratory's SOP (Appendix A)	Laboratory-specific, see laboratory's SOP (Appendix A)	NA
Continuing Calibration Verification (CCV)	9 (1 per batch of 20 field samples)	Laboratory-specific, see laboratory's SOP (Appendix A)	Laboratory-specific, see laboratory's SOP (Appendix A)	NA
Field duplicate	18 (10% of field samples)	NA	RPD ≤30	NA
Field blank	1	NA	NA	< 3x MDL
Core liner rinsate sample	1	NA	NA	< 3x MDL
Core tool rinsate sample	9 (1 rinsate for every 20 field samples)	NA	NA	< 3x MDL
Method Blank	9 (1 per batch of 20 field samples)	NA	NA	< 3x MDL
Spike Method Blank	9 (1 per batch of 20 field samples)	Laboratory-specific, see laboratory's SOP (Appendix A)	Laboratory-specific, see laboratory's SOP (Appendix A)	NA
MS/MSD	9 (1 per batch of 20 field samples)	Laboratory-specific, see laboratory's SOP (Appendix A)	Laboratory-specific, see laboratory's SOP (Appendix A)	NA
RRM PV7C	9 (1 per batch of 20 field samples)	Within acceptance range of 6,556 to 15,297 ug/kg p,p'-DDE	Within laboratory control chart limits	NA

Table 2-4. Summary of QC Samples and Performance Criteria for Laboratory Analysis of Grain Size and Bulk Density in Sediment Core Samples. NA = not applicable; RPD = relative percent difference.

QC SAMPLE	NUMBER (FREQUENCY)	ACCURACY CRITERIA	PRECISION CRITERIA	BLANK CONTRIBUTION
Field duplicate	18 (10% of field samples)	NA	RPD ≤30	NA
Laboratory duplicate	18 (10% of field samples)	NA	RPD ≤30	NA

2.2 Sediment Profile Imaging

Sediment profile imaging (SPI) is a semi-quantitative sampling technique, and no specific reference materials or standards exist that can be used to evaluate directly the accuracy of SPI data. Comparability for the sediment-profile imaging component will be addressed by adherence to SAIC Standard Operating Procedures for this monitoring technique. Use of standard procedures for image acquisition, analysis and reporting will ensure comparability among multiple surveys to be performed throughout the course of the PV Pilot Capping monitoring program. Representativeness for SPI will be ensured through the use of a survey design which includes obtaining three images at each station, with stations distributed throughout each pilot capping cell. This should provide an evaluation of both small-scale (i.e., within station) and larger-scale (i.e., among station) variability and thus accurately represent sediment physical and biological baseline conditions within each cell.

For the three replicate images obtained at each station, an average value will be calculated for each of the measured parameters (e.g., redox potential discontinuity depth, penetration depth, Organism-Sediment Index) and used for mapping and interpretative purposes. For parameters which are not expressed on a continuous number scale (e.g., successional stage designation; grain size major mode), all of the replicate values will be displayed in maps and used for interpretative purposes. It is not possible to specify acceptance criteria for precision or agreement among the values measured for the three replicate images; these values will reflect the small-scale (i.e., on the order of meters) spatial heterogeneity or homogeneity which is naturally present at a given station. However, if the results for the replicate images at a given station are widely different (e.g., difference in grain size major mode of more than 3 size classes, difference in redox potential discontinuity depth of greater than 3 cm, difference in penetration depth of greater than 10 cm), it would be considered cause to re-sample the station to confirm that the difference is truly due to actual spatial heterogeneity in sediment conditions. The completeness objective for sediment profile imaging is 100%. The SPI field procedures and associated QA/QC are designed to ensure that the 100% completeness goal is met. These procedures are described in detail in the Field Sampling Plan. Briefly, back-up camera systems and a complete inventory of spare parts will be available to avoid loss of data due to mechanical or electronic equipment malfunction. The film will be developed and reviewed immediately following the completion of each day's field work. Images can be missed due to over- or under-penetration of the SPI camera prism at a given station. The SPI camera penetration can be adjusted by adding weights, lowering the "stops" or adding "snow shoes" to allow successful image acquisition. Same-day developing and review of the images will allow stations to be re-occupied

on the following field day and the missed images obtained. Representativeness of the SPI data will be evaluated by comparisons with data from coring, side-scan, and subbottom profiling.

2.3 Sub-bottom Profiling

No specific reference materials or standards exist that can be used to evaluate directly the accuracy of subbottom profiling data. Precision will be evaluated by comparing data for the "duplicate" subbottom profile records that will be obtained at the intersections of perpendicular transects. This duplication provides a means to check on the precision (repeatability) and degree of resolution of the survey method. The resolution of the subbottom technique in the study area (water depths ranging from 40 to 70 m) is expected to be on the order of ±20 cm. The degree of agreement between "replicate" measurements cannot be expected to be any better than this minimum resolution (i.e., the acceptance criteria for precision is that the replicates should agree within ±20 cm). Sediment coring and SPI data will be obtained at the subbottom points of intersection. If there are any discrete depositional layers on or near the sediment surface with thickness less than about 20 cm, both coring and SVPS imaging should detect them. This provides a means to independently ground-truth the subbottom results. Distinct sediment horizons or depositional layers greater than 20 cm also may be detected through core sampling, depending on the depth of core penetration. The results of the baseline subbottom survey will be compared against both the SPI and coring results. One of the Data Quality Objectives (DQOs) for subbottom profiling relates to completeness. To meet the objective of characterizing sediment conditions (including the degree of spatial variability) within and around each placement cell, it is important that a complete subbottom records obtained along each of the 8 survey transects. The procedures for ensuring that the 100% completeness goal is met are described in detail in the Field Sampling Plan.

Comparability for subbottom profiling will be addressed by adherence to SAIC Standard Operating Procedures for this monitoring technique, to ensure comparability among multiple surveys to be performed throughout the course of the PV Pilot Capping monitoring program. Representativeness will be ensured through the use of a survey design which includes obtaining continuous records along survey lanes throughout each pilot capping cell.

2.4 Side-scan Sonar

No specific reference materials or standards exist that can be used to evaluate directly the accuracy of side-scan sonar data. Precision will be evaluated by comparing the "duplicate" side-scan sonar records that will be obtained over relatively broad areas. This duplication provides a means to check on the precision (repeatability) and degree of resolution of the survey method. Duplicate records should agree closely in terms of both the type(s) of surface features present and the location of these features. Data on surface sediment type (i.e., grain size) at the side-scan sonar lane points of intersection will be obtained from both the sediment coring and SPI surveys. These data can be used as an independent check or ground truth of the side-scan sonar interpretation. The sediment type determinations for the baseline side-scan sonar survey will be compared against both the SPI and coring results.

One of the DQOs for the side-scan sonar sampling effort relates to completeness. To meet the objective of characterizing sediment conditions (including the degree of spatial variability) within and around each placement cell, it is important that a complete side-scan sonar record is obtained along each of the 8 survey transects. Procedures for meeting the 100% completeness goal are described in the Field Sampling Plan.

Comparability for side-scan sonar will be addressed by adherence to SAIC Standard Operating Procedures for this monitoring technique, to ensure comparability among multiple surveys to be performed throughout the course of the PV Pilot Capping monitoring program. Representativeness will be ensured through the use of a survey design which includes obtaining continuous records along survey lanes throughout each pilot capping cell.

3.0 SAMPLING PROCEDURES

This section provides a summary of specific objectives and design information for the sampling program. Details regarding the sampling program are presented in the Field Sampling Plan. Requirements for sampling frequencies, intervals (i.e., depth, sediment layers), sample collection methods, sample containers, preservation methods, holding times, and method references, where applicable, are summarized in Tables 3-1 and 3-2.

Table 3-1. Sediment Coring Locations, Frequency, and Sampling Intervals by Parameter

PARAMETER	MATRIX	FREQUENCY	SAMPLING STATIONS	SAMPLING INTERVAL
p,p'-DDE	sediment	Once for Baseline Monitoring	One core at each of 9 stations in each of four cells. In the core from the center station in each cell, a field duplicate will be obtained from selected intervals	5 4-cm intervals per core up to 5 4-cm intervals per center station core
Grain Size	sediment	Once for Baseline Monitoring	One core at each of 9 stations in each of four cells. In the core from the center station in each cell, a field duplicate will be obtained from selected intervals	5 4-cm intervals per core up to 5 4-cm intervals per center station core
Bulk Density	sediment	Once for Baseline Monitoring	One core at each of 9 stations in each of four cells. In the core from the center station in each cell, a field duplicate will be obtained from selected intervals	5 4-cm intervals per core up to 5 4-cm intervals per center station core
Bulk Density	sediment	Once for baseline monitoring	One duplicate core at each of 2 stations in each of four cells	up to 5 intervals per core
Atterberg Limits	sediment	Once for baseline monitoring	One duplicate core at each of 2 stations in each of four cells	up to 5 intervals per core
Vane Shear	sediment	Once for baseline monitoring	One core at each of 9 stations in each of four cells	5 4-cm intervals per core
Vane Shear	sediment	Once for baseline monitoring	One duplicate core at each of 2 stations in each of four cells	up to 5 intervals per core

Sediment sampling for the Pilot Capping Monitoring Program will occur during several stages. However, this document addresses only the baseline monitoring effort. A baseline monitoring survey will be conducted prior to cap placement in four designated pilot cells. Each pilot cell covers an area of 300 by 600 meters. A total of nine

cores with a minimum penetration depth of 20 cm will be collected from each cell prior to cap placement. Each core will be divided along discrete 4-cm horizons (intervals). Each core will produce five 4-cm core subsections for chemical (p,p'-DDE) and physical (grain size and bulk density) analyses. In addition, a vane shear measurement will be made on each of the five 4-cm core intervals. At two stations within each cell (the center station and one other station selected at random), a second (duplicate) core will be obtained. At minimum of two and a maximum of five samples will be obtained from each duplicate core (depending on the number of visible sedimentological horizons present in the core) for analysis of Atterberg Limits and bulk density. Furthermore, a minimum of two and a maximum of five vane shear measurements will be made on each duplicate core, to coincide with the horizons where the Atterberg Limits and bulk density samples are obtained.

Table 3-2. Sediment Core Sample Containers, Preservation, Sample Volumes, and Holding Times by Parameter

PARAMETER	CONTAINER	PRESERVATIVE	MIN. SAMPLE MASS	HOLDING TIME
p,p'-DDE	250-mL wide-mouth glass jar, certified clean, with lids lined with chemcially-inert material	4° C, freeze upon receipt at laboratory	100 g wet weight (includes primary analysis [10 g] and QC analyses and archival material)	14 days if not frozen; up to 1 year if frozen; 40 days for extracts
Grain Size/Density	Resealable plastic bags	4° C	500 g for grain size; approximately 15 g (10 cc) for bulk density	6 months
Vane Shear	None; measured in laboratory	4° C	Not applicable	Analyzed in laboratory
Atterberg Limits	Resealable plastic bags (1 gal size)	4° C	Approximately 600 mL	6 months

As indicated in Table 3-2, 100 g of sediment will be sent the laboratory for analysis of p,p'-DDE. The sediment will be held at 4° C following collection and during shipping and frozen upon receipt at the laboratory. For analysis, the sediment will be thawed and a 10 g aliquot removed for extraction. The remaining 90 g of sediment will be re-frozen and held for up to one year in the event re-analysis is required.

For each cell, sediment profile images will be collected at 25 stations (15 stations within the cell boundary and 10 stations outside the cell). Side-scan and subbottom profiling images will be collected along 8 transects, with a 100 m spacing, within each cell.

3.1 Sampling Objectives

Sediment Coring and Chemical/Geotechnical Analyses

The objective of sediment coring is to provide baseline chemical and physical data for characterizing existing sediment characteristics in each of the pilot capping cells.

SPI, Side-Scan Sonar, and Subbottom Profiling

The objective of remote sensing for the baseline monitoring program is to support characterizations of the physical and geotechnical properties of bottom sediments within and around the pilot capping cells.

3.2 Sampling Frequency

Sediment cores will be collected for the baseline monitoring once prior to cap placement at each sampling location. Similarly, remote sensing using SPI, side-scan sonar, and subbottom profiling will occur once prior to placement of the pilot cap.

3.3 Sampling Locations

Sediment cores will be collected along a prescribed grid pattern within each of the four pilot cells. The sample locations will be placed at the intersections of side-scan and subbottom profile survey lanes. Sampling stations for cores and SPI, and transects for side-scan sonar and subbottom profiling, are shown in the Field Sampling Plan.

All sampling stations will be located by the use of a Differential Global Positioning System (DGPS) with an accuracy of ±1 to 3 m. Station depths range from approximately 40 to 70 meters.

3.4 Major Sampling Equipment

Field sampling operations will use research vessels equipped with a hydraulic A-frame and winches, at least 2,500 feet of hydrographic wire or line, and complete electronic instrumentation (radar, depth finder, dGPS, radio). Vessels will meet all Coast Guard regulations.

Sediment Coring

Sediment cores will be acquired using a conventional gravity corer. This device consists of a 4 to 8-ft long aluminum or steel core barrel, having an outside diameter of 4-in, attached to a weight stand (core head). The weight stand is constructed of heavy-gauge steel and is designed to accommodate varying amounts of weight. The individual lead weights are donut-shaped, weighing approximately 50 lb. each. Additionally, the weight stand is equipped with a check valve, at the top of the spindle and in line with the core barrel, to allow water to pass freely

through the aperture on descent through the water column. Further, there are four "fins" at the top of the weight stand to minimize rotation on descent.

A supply of core barrels will be pre-cut to accommodate 2.5-ft (76 cm) cores, as this will be sufficient to achieve the required minimum penetration depth of 20 cm while preventing severe over-penetration and allow better control of the sediment core during deployment and recovery. For each coring station, a 3.5-in inside diameter butyrate core liner will be inserted into the core barrel and retained mechanically by a steel core cutter which is attached at the end of the core barrel to facilitate impact with the seafloor. The core cutter/catcher assembly is attached to the core barrel using rivets or other mechanical fasteners.

Sediment Profile Imaging

SPI images will be acquired using a Benthos Model 3731 sediment profile camera. The camera consists of a wedge-shaped prism with a Plexiglas face plate; light is provided by an internal strobe. The back of the prism has a mirror mounted at a 45-degree angle to reflect the profile of the sediment-water interface toward the camera which is mounted horizontally on the top of the prism. The prism is filled with distilled water, through which the photographs are obtained. Because the object (sediment) to be photographed is directly against the face plate, turbidity of the ambient seawater is not a limiting factor. The camera prism is mounted on an assembly that can be moved up and down by allowing tension or slack on the hydrowire. The rate of prism penetration into the bottom sediment is controlled by an adjustable, "passive" hydraulic piston.

The equipment and expendable supplies associated with the SPI sampling operations are listed below:

SPI Sampling Components:

- Benthos Model 3731 Sediment Profile Camera
- 25 lb lead weights (2 sets of 5)
- 7.2 volt rechargeable battery packs
- Benthos pinger and hydrophone
- ASA 100 color slide film (36 exposures per roll)
- "Mud" doors to prevent over penetration into soft sediment
- Glass cleaner and paper towels
- Distilled water
- Winch and hydrowire
- Swivel for hydrowire
- Field notebook and sampling logs
- DGPS navigation system and sampling stations
- SPI tool kit with stainless hardware spares

Plan view images of the seafloor will be acquired using a downward-looking PhotoSea underwater 35 mm camera and strobe which are mounted on the Benthos sediment profile camera frame. Primary components that will be mobilized for the baseline sampling include:

Plan View Camera Components:

- PhotoSea Underwater 35 mm Camera and Strobe
- Synchronized Camera and Strobe Trigger Assembly
- ASA 100 Color Slide Film (250 exposures per bulk roll)

Side-Scan Sonar

For the baseline survey, a state-of-the-art side-scan sonar system will be used for acquisition of two-dimensional seafloor data in the vicinity of the four pilot cells. The system will consist of an Edgetech DF1000 digital side-scan towfish interfaced to a Triton-Elics ISIS® top-side sonar data acquisition system. The DF1000 is a dual-frequency system capable of simultaneously emitting and receiving sound waves at both 100 and 500 kHz frequencies. All sonar returns are digitized to 12-bit high-resolution data within the towfish, merged with vessel heading information from the built-in compass, and transmitted to the top-side data acquisition unit via a high-speed digital uplink. Aboard the survey vessel, the DF1000 interfaces to the Triton-Elics ISIS® sonar acquisition system for archiving and display of the digital side-scan data. The ISIS® integrates the raw sonar image data with towfish position information provided by the onboard, DGPS-based HYPACK vessel navigation system. The merged data are stored on Magneto-Optical disks for playback and post-processing. In addition to data storage, ISIS® displays the high-resolution sonar imagery in real-time on a computer monitor. Vessel speed over the ground and slant range corrections are applied in real-time to the data so that images are displayed with the correct aspect ratio. In this manner, the geodetic position of targets and other seafloor features can be determined in near real time.

Subbottom Profiling

High-resolution subbottom profile data will be acquired using an Edgetech XStar Model 216S Full Spectrum Digital Subbottom Profiler. The acoustic transducers of the XStar system are mounted in a towfish and lowered using the winch aboard the survey vessel. The electronic signal cable from the towfish is mated to a mechanical tow cable with brass clips. The amplified return signal of the XStar transducers are sent through an A/D converter to an on-board data acquisition system for data storage to 8 mm magnetic tape, real-time color data display, and hard-copy printouts of profile data.

3.5 Field Sampling Methods

Field survey methods are discussed in detail in the Field Sampling Plan. All methods are standardized to maintain consistent and high quality data collection. The following sections outline protocols used to acquire data and samples for the baseline monitoring program, as well as the associated QC that will be integrated with the field sampling protocols.

Sediment Coring

The objective of the sediment coring is to collect cores with a minimum length of 20 cm without contaminating the sample or distorting the existing layering.

The aft deck of the survey vessel will be washed periodically with filtered seawater to keep the sampling area clean of debris. The gravity corer used to collect sediment chemistry samples initially will be decontaminated and thereafter will be rinsed thoroughly with filtered seawater between samples in the field (see FSP Section 3.4.6). Coring and core processing procedures have been refined to minimize the amount of excess sediment to be washed overboard. New core tubes or butyrate core liners will be used for each coring attempt. Therefore, decontamination of core liners is not necessary.

Once on station, the gravity core will be assembled by adjusting the weight and attaching the core barrel. Generally, one or two test cores are required to fine-tune the weight requirements for a project site. The weight stand is designed to accommodate a maximum of 800 to 900 lb., but this weight will not be needed for the relatively shallow penetration required for the baseline sampling program. The core barrel is inserted into a collar using clamps on the lower side of the weight stand. A supply of core barrels will be pre-cut to accommodate 2.5-ft cores, as this will be sufficient to achieve the required minimum penetration depth of 20 cm and will allow better control of the sediment core during deployment and recovery.

The whole device is manipulated by either a crane or winch and A-Frame via a lifting bail on top of the weight stand. The corer will be lowered by controlled descent until contact with the bottom. Contact with the bottom is determined by slack cable and a change in the sound of the winch. When the corer is brought aboard following collection of a bottom sample, the corer is held in a horizontal position, the core cutter and catcher are then removed from the lower end of the core barrel, a core cap is placed on the end of the liner and taped in place, then the core liner is removed from the barrel. Next, the core liner is held vertically and a small hole is drilled into the core liner about 1 cm above the sediment-water interface to allow any water that may be trapped above the sediment sample to be removed. (If this interface is not immediately visible, then the core liner is held vertically until all suspended sediment has settled and the interface is apparent.) Then, any excess length of core liner above the sediment top will be cut off while the core liner is held vertically; this is done with significant care to ensure that the core sample is not disturbed in the process. Lastly, a core cap is taped in place on the top of the corer liner, and the liner is labeled according to station number, core replicate (if multiple cores were acquired at the same station), and core top/bottom are indicated. The cores will be stored in a dark container at 4° C until brought ashore at the end of the sampling day.

A second (duplicate) core will be obtained at two of the nine sampling stations per cell. One of the duplicate cores will be obtained at the center station and one will be obtained at a second station chosen at random. The duplicate cores will be used to obtain sediment samples for analyses of vane shear, Atterberg Limits, and bulk density.

These cores will be handled and processed in the same manner as the other cores.

At a shore-based laboratory, the core can be subsampled with a minimal amount of disturbance within 24 hours of collection. The core will be split in half longitudinally, visually inspected for sampling artifacts, and photographed. A detailed description of each core (core log) will be recorded by hand using an ink pen in a laboratory notebook. The core description will include the following information:

1) Core length
2) Log of intervals that were photographed
3) Description (lithology, grain size, texture, odor, presence/thickness of hair mats, number/type of organisms, color, apparent water content)

Only undisturbed cores will be retained for subsampling. Disturbed cores will be discarded. The core length will then be measured and the core will be sectioned into discrete 4-cm sections. Subsamples will be collected using decontaminated stainless steel or Teflon coated scoops (see FSP section 3.4.7 for decontamination procedures). If possible, samples for chemical analyses will be removed from portions of the core that have not contacted the surface of the core liner. Each core section will be placed in a certified pre-cleaned glass container. Sediment chemistry samples will be frozen on dry ice (-20° C) and held for shipping. The samples aliquoted for grain size and density analyses will be placed in a cooler at 4°C and held for shipment.

Sample storage, preservation methods, and holding times are presented in Table 3-2. Following collection, an SAIC field scientist will carefully package the sediment chemistry samples (to avoid breakage of sample containers) in insulated coolers, and these samples will be sent along with completed chain of custody forms to the analytical laboratory(s) via overnight courier. Full chain-of-custody procedures will be followed throughout all stages of sample collection and analysis. An example chain of custody form to be used for shipment of sediment chemistry samples to Woods Hole Group Laboratory is provided in Figure 3-1.

Sediment Profile Imaging System

The SPI camera system is attached to a hydrowire, and the camera is lowered to the seafloor. Once the camera frame contacts the bottom the prism vertically cuts the seafloor. The camera trigger is tripped by the impact with the bottom and, after a 13 second time delay to allow the prism to stabilize, a photo is taken. The film is automatically advanced by a motor drive, the strobes are recharged, and the camera can be raised and then lowered immediately for another replicate image. When the camera is brought to the surface, the frame count is verified via a digital readout. A detailed description of the sampling procedures is given in the Field Sampling Plan.

Side-Scan Sonar Sampling

The side-scan sonar data acquisition system will be configured to collect seafloor imagery data 100 m to either side of the towfish, resulting in a total swath coverage of 200 m along each survey lane. With the 100-m lane spacing, side-scan data coverage within and around each cell will be approximately 200%. During survey operations along each lane, the survey vessel will maintain a constant course and speed of approximately 4 knots to achieve clear seafloor images. Towfish position will be determined continuously, and to an accuracy of approximately 5 to 10 m, using the HYPACK DGPS navigation system, based on the vessel position, speed, heading, and length of cable behind the vessel.

Four channels of data (port and starboard channels from both the 100 kHz and 500 kHz frequencies) will be both archived on disk and displayed in real time aboard the survey vessel. During survey operations, the towfish will be maintained at an altitude above the seafloor equivalent to 8 to 20% of the range scale selected (e.g., 8 to 20 m above the seafloor for the 100 m range scale) to achieve optimum surveying resolution.

Woods Hole Group
Environmental Laboratories

Chain-of-Custody Record

375 Paramount Drive
Raynham, MA 02767

TEL: (508) 822-9300
FAX: (508) 822-3288

PAGE ___ OF ___

COMPANY INFORMATION	COMPANY'S PROJECT INFORMATION	SHIPPING INFORMATION	VOLUME/CONTAINER TYPE/ PRESERVATIVE (NOTE 4)
Name:	Regulatory Protocol:	Carrier:	
Address:	For the State of:	Airbill Number:	
	Project Name:	Date Shipped:	
	Project Number:	Quote #:	
Telephone:	P.O. #		
Facsimile:	Sampler Name(s):		
Contact Name:	TAT ___ 10 Day ___ 5 Day ___ 3 Day ___ 48 Hr ___ 24 Hr ___ Other		

WHG LAB #	SAMPLE ID (NOTE 1)	COLLECTION DATE	COLLECTION TIME	COMPOSITE GRAB	MATRIX	ANALYSIS/REMARKS (NOTE 2, 3)	NUMBER OF CONTAINERS

Relinquished by: (signature)	DATE	TIME	Received by: (signature)
Relinquished by: (signature)	DATE	TIME	Received by: (signature)
Relinquished by: (signature)	DATE	TIME	Received for Laboratory by: (signature)

NOTES TO SAMPLER (S): (1) Limit Sample Identification to 6 characters, if possible; (2) Indicate designated Lab Q.C. sample and type (e.g.; MS/MSD/REP) and provide sufficient sample; (3) Field duplicates are separate sample; (4) e.g.; 40ml/glass/H_2SO_4

Notes to Lab:

We cannot accept verbal changes - Please Fax written changes to (508) 822-3288

Figure 3-1. Example of chain of custody form to be used for shipment of sediment chemistry samples to Woods Hole Group environmental laboratory.

Subbottom Profile Sampling

The XStar system is capable of generating three separate sweep ranges: 2 to 10 kHz, 2 to 12 kHz, and 2 to 15 kHz. The overall vertical resolution (thickness of sediment) of the subbottom profile system is ±20 cm. The pulse rate will be set to 8 pulses per second for optimum performance of the output devices. At 8 pulses per second, traveling at an average vessel speed of 4 to 5 knots, a subbottom measurement will be acquired every 34 to 43 cm along the vessel track. Each subbottom return signal will be recorded digitally and stored with a geodetic positional fix.

The XStar profiler generates a relatively narrow (13°) acoustic beam which translates to a 12-m wide swath on the seafloor along each survey lane for an average water depth of 55 m, as encountered in the pilot study area. Swath width will vary proportionally with water depth and the depth at which the fish is towed. For the baseline survey, the towing depth will be approximately 10 m. With a lane spacing of 100 meters, approximately 12% bottom coverage will be obtained over the survey area.

3.6 Field Sampling Documentation

All information pertinent to field activities will be recorded in a field sampling log book. Entries will be made in water-resistant ink and will include the items listed below:

- Field sampling personnel
- Date and time
- Survey number and station, sampling depth (where appropriate)
- Descriptions of all problems encountered that may affect the samples and field measurements
- Other pertinent observations (e.g., floating particulates, surface sheens, plankton blooms).

The following logs are maintained separately from the field logs described above:

- Station coordinate log sheet: records station coordinates and depth initially at the start of sampling.
- Gravity core tracking sheet: records information about the disposition (i.e., acceptable or unacceptable quality) of each core sample.
- Sampling status data sheet: records sampling dates, numbers of cores, and comments which initiate the sample tracking process.

These logs also will be filled out in water-resistant ink and signed by the team leader. Corrections will be lined-out and initialed.

4.0 SAMPLE CUSTODY

A critical aspect of sound sample collection and analysis protocols is maintenance of strict chain-of-custody (COC) procedures. Sample custody procedures include inventorying and documenting each sample during collection, shipment, and laboratory processing. A sample is considered to be in an individual's custody if the sample is (1) in the physical possession or view of the responsible party, (2) secured to prevent tampering, or (3) placed in a restricted area by the responsible party.

4.1 Sample Labeling

Sediment Core Samples

Core liners containing sediment cores will be labeled immediately following sediment collection. The core tube itself will be labeled on the outside using indelible ink. . Specific sample information is written in indelible ink for the following:

- Project number and title
- Survey number
- Station identification
- Date and time collected
- Sample replicate number
- Top/ bottom core indicators
- Collector's name or initials
- Sample depth (if appropriate)

Sample labels are attached to the core using clear tape to prevent the label from washing off or dissolving. At the end of each day of survey operations, cores will be transferred to the person responsible for shore-based core processing.

Individual sediment samples will be removed from the core and placed in the appropriate sample jars. A label is attached to each sample jar prior to filling. The pre-printed label identifies the date/time of sample collection, project title (site ID), sample number (to be recorded under site ID), preservative (if any), requested analysis and the name of the individual who prepared the sample in the field (Figure 4-1).

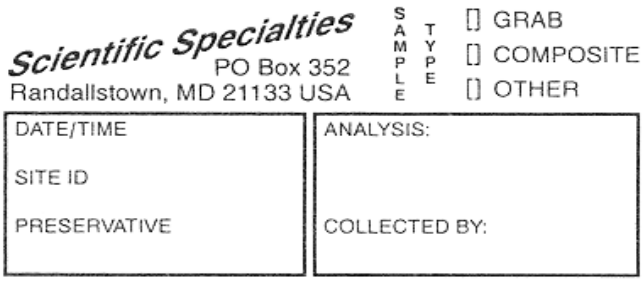

Figure 4-1. Example label for sediment chemistry samples removed from cores.

Cores will be processed within 24 hours of collection. Cores will be split longitudinally, inspected, photographed and sampled. Laboratory logs will be kept for each core including the visual description of the core based on inspection, this log will also track sampling intervals; the depth the sample was collected at and the analyses being conducted on the sample. Samples will be collected with decontaminated scoops in the selected interval collecting the desired amount of material needed for analyses. Samples collected for chemistry will be placed in precleaned jars provided by the analyzing laboratory while samples for geotechnical analyses will be placed in recloseable plastic bags. All geotechnical samples will be 'double' bagged to avoid leakage and loss of moisture. The sample itself will be labeled with the survey number, station identification, date and time sample was collected, collector's initials, analysis to be conducted, and depth interval at which the sample was collected within the core. Individual sample labels are routinely supplied by the laboratory doing the analyses, these will be affixed to the sampling contains with clear tape to avoid the label washing off (see Figure 4-1). Custody seals will be used on all samples being shipped to laboratory(s). Chain of custody sheets will accompany all samples (see Figure 3-1).

Photographing the core involves obtaining multiple digital images of the core at 20 cm intervals, allowing for 5 cm of overlap between images to facilitate preparation of a final composite core image. For photography, the core is placed in a cradle alongside a marked scale that is integrated with a color-coded bar to allow for tone adjustments of the final images if needed. Core identification labels are placed alongside the scale. All of the final core images will be compiled and entered into the project GIS database.

<u>SPI Image Custody and Documentation</u>

During sample acquisition, date, time, station, replicate number, and coordinates are recorded in the field log by the field technician for each image acquired. The field technician is also responsible for processing the film at the end of each day and for storing the film data until it is relinquished to the image analyst. The sampling location (coordinates) is also electronically logged on the navigation system. The SPI camera is equipped with a data-back which displays the current time when the photograph is taken. The digital time stamp recorded on each image and

the numerical order of the images are used to identify the correct station and replicate number. The project name, date, time, station number, and replicate number are then recorded on each slide by the image analyst. All slides from a survey are inserted into clear plastic slide holder sheets and maintained in a three-ring binder as one data set. The project binder containing original images, edited REMOTS® Data Sheets, survey navigation diskettes, and other related information is labeled with the project name and date, and stored in a secure Data Archive Room located at the SAIC facility in Newport, RI.

Side-Scan Sonar and Subbottom Profiling Data

The side-scan and subbottom profiling data are stored on board the survey vessel as electronic files and as hard-copy printouts of profile data. Sampling information and documentation are included in the data files.

4.2 Chain-of-Custody Record

Sample custody is initiated through detailed record keeping by the field sampling personnel. COC establishes the documentation and control necessary to identify and trace a sample from collection to final analysis. It includes sample labeling to prevent mix-up and secure custody, and provides the recorded support information for potential litigation. For the baseline monitoring program, chain-of-custody procedures will apply primarily to sediment core samples.

COC forms are used to document the integrity of all samples and to maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory (see Figure 3-1). The COC form will contain the following information:

- Sample number (for each sample in shipment)
- Collection date (for each sample shipment)
- Time sample was obtained/or collected
- Number of containers of each sample
- Sample description (environmental matrix)
- Analyses required for each sample
- Shipment number
- Shipping address of the laboratory
- Date, time, and method of shipment
- Spaces to be signed as custody is transferred.

The individual in charge of shipping samples to the laboratory is responsible for completing the COC form. This individual will also inspect the form for completeness and accuracy. Any changes made to the COC form shall be initialed by the person making the change.

4.3 Transfer of Custody and Shipment

Sample transfers will be accompanied by an approved COC record. When the possession of samples is transferred, the individual relinquishing the samples signs and records the date and time on the COC document. The individual receiving the samples repeats the procedure. This record represents the official documentation for all sample custody transfers until the samples have arrived at the laboratory. For the baseline monitoring program, SAIC's team leader for core processing (Ms. Pam Walter) will be responsible for preparing the cooler and samples for shipment to the chemistry and geotechnical laboratories. A temperature blank will be included in each cooler being shipped. Temperature blanks will be prepared by filling 40-mL vials with refrigerated (i.e., to 4°C) portable water and placed in the cooler with the environmental and field QC blank samples immediately before the sample cooler is packaged for shipping to the laboratory. The temperature of the cooler blank will be taken immediately after the sample cooler is opened at the laboratory and the data recorded on the chain-of-custody form. Cooler blank data assess the effectiveness of the ice used to maintain the cooler temperature between 4°C and 8°C.

The following is a description of the procedure followed when transporting environmental samples from the sampling site to the laboratory:

- Sample collection points, depth increments, and sampling devices are identified and documented.
- Log book entries, sample tags, COC forms, and field record sheets with sample identification points, date, time, and names or initials of all persons handling the sample in the field are completed.
- After the cooler is filled, the appropriate COC form is placed inside the cooler for shipment to the laboratory.
- Glass sample containers are wrapped or placed with plastic material to prevent contact with other sample containers or the inner walls of the cooler.

4.4 Laboratory Custody Procedures

This section describes the laboratory custody procedures associated with sample receipt, storage, preparation, analysis, and security. Samples submitted to the laboratory are logged in as soon as possible. Any sample that is suspected of being contaminated, improperly stored or preserved, or improperly prepared, is reported immediately to the Laboratory Manager and SAIC Project Manager.

The sample receiving process includes the following steps:

- Sample containers are inspected for condition (damage).
- Sample documentation is checked (i.e., COCs, number of samples, receipt date, etc.).
- Each sample received is given a unique internal identifier. Labels are made and applied to the original sample containers.
- Samples remain in appropriate sample storage until removal for sample preparation or analysis.
- If requested, transfers of samples into and out of the storage area(s) can be documented on an internal chain-of-custody record. The sample custodian will control the internal custody of samples.

- After a sample has been removed from storage for analysis, the analyst is responsible for returning the sample to the storage area.

Sample Receipt

Samples are received at the laboratory by a designated Sample Custodian. The Sample Custodian removes the samples from the cooler and compares the sample labels with the information provided on the COC form.

The paperwork accompanying the samples is checked for consistency and transcription accuracy. Samples are assigned a unique laboratory identification number that is then physically affixed to the sample container(s). This unique laboratory number is the mechanism to track samples throughout the laboratory. Any discrepancies in the information are noted and reported to the Laboratory Manager and SAIC's Project Manager for corrective action. The resolution of discrepancies will be noted either on the COC form, the log-in sheet, and/or an individual phone log. In general, samples will not be logged in until all discrepancies are resolved.

4.5 Sample Security

Samples will be kept in locked storage areas except during analysis. All laboratory personnel who receive samples are responsible for the care and custody of samples from the time each sample is received until samples (or empty containers) are returned to the Sample Custodian. All subsets (extraction, digestates, etc.) of the samples shall be kept in storage which is controlled by the appropriate laboratory section head.

The following security measures will be employed:

- Doors to the laboratory will be closed and secured at all times.
- Only authorized personnel and visitors under escort shall have access to the chemistry lab.
- Outside exit doors will be closed and locked at all times.
- All laboratory personnel should question and determine legitimacy of a stranger's presence in the laboratory.
- Deliveries will be escorted to the laboratory from the main reception area or from the loading dock.

4.6 Sample Storage and Disposal

The Sample Custodian shall be responsible for the following:

Sample Storage

1. Samples and extracts shall be stored in a secure area.

2. Samples shall be removed from the shipping container and stored in their original containers unless damaged.

3. Damaged samples are documented and the Laboratory Manager is contacted immediately about the damaged samples.

4. Storage area is kept secured at all times. Sample Custodian will control access to the storage area. (Duplicate keys for locked storage areas should be maintained only by authorized personnel.)

5. Samples removed from storage will be documented. All sample transfers are documented in the internal COC.

6. Standards are not stored with samples.

Sample Disposal

1. Upon completion of the analysis, any remaining sample will be placed into long-term storage until sample disposition instructions are received.

2. When sample analysis and all QC checks have been completed and a final report has been issued, the unused sample portion, extract, digestate, etc., shall be stored under proper conditions until release and/or disposal is authorized.

SAIC will notify the USACE and request transfer of archived samples and residue materials to the USACE's custody. SAIC will prepare the necessary COC forms for transfer of these samples.

5.0 CALIBRATION PROCEDURES AND FREQUENCIES

Calibration is the comparison of a measurement standard or instrument with another standard or instrument to report or eliminate by adjusting any variation (deviation) in the accuracy of the item being compared. This section describes preparation of calibration standards, and calibration procedures used for instrumentation and equipment.

5.1 Laboratory Standards

Traceability of Standards

Organic analytical standards utilized for instrument/methodological calibration and preparation of quality control samples shall be traceable to a recognized authority for the preparation of such materials (e.g., National Institute of Standards and Technology, (NIST)). Primary standards must be obtained from reliable, certifiable sources and be of the highest possible purity. Calibration solutions from NIST (e.g., SRMs 1492 and 2261) shall be used in establishing initial calibration. Any commercial standards prepared must be verified against appropriate SRMs.

For the analysis of p,p'-DDE in sediment samples obtained from the PV shelf cores during the baseline monitoring program, the following objectives are established for calibration checks: 15% relative standard deviation (RSD) for initial calibration verification (ICV) and 20% RSD for continuing calibration verification (CCV).

Expiration or Holding Time Criteria

All standards obtained or purchased from commercial vendors, as well as reference materials, are dated when opened. The expiration date is also noted and, if not available, will be obtained from the supplier or manufacturer. If no information is available from the supplier, the lab holding time or shelf-life for the materials shall be half the normal shelf-life (i.e., assuming 1 year for most compounds, then it would be a 6-month shelf-life).

Standards are protected from degradation, deterioration, and contamination based on storage requirements (e.g., polyethylene containers for alkaline solution, glass containers for organics, and brown glass for light-sensitive solutions; temperature storage and segregation of standards based on reactivity).

Stock and working standard solutions are prepared fresh as required by their stability, and they are checked regularly for signs of deterioration (i.e., discoloration, formation of precipitates, and changes in concentration). Standards prepared as stock or working standards are properly labeled as to name of compound mixture, concentration, solvent/medium, date and preparer, and expiration date. This information is also recorded in a laboratory notebook. Information required to trace the standard back to the vendor and lot number should also be kept in a laboratory logbook.

Guidelines for Standard Preparation

Guidelines for preparation of analytical standards used as spiking solutions and/or calibration standards are as follows:

1. Laboratory analysts experienced in calibration and use of analytical measurement tools are assigned standard preparation tasks.

2. Analytical reagent grade materials are utilized in the preparation of analytical/control sample standards. Whenever possible, guaranteed assay materials with supporting chromatograms are requested from the manufacturers.

3. Solvents used for dilution of standards are checked for background contamination.

4. Analytical measuring tools such as balance, volumetric glassware, syringe, etc. are calibrated to obtain accurate measurements.

5. All data generated (e.g., weights of standard used, volume aliquot taken, lot number, solvent used, date of preparation, concentration of the solution, etc.) are documented immediately in a standard preparation logbook.

6. A sequential standard log number (SL #) is assigned to the prepared standard solution. This standard identification code is noted in the standard log, on all run logs associated with the instrument analysis of the solution for traceability evaluation, and on any storage vessels which are used to contain the original solution or any aliquots of the prepared solution.

7. Standards are analyzed prior to use for any analytical measurement by use of the instrumentation system for which it was intended.

8. When a standard of the same material is available from a second source (e.g., NIST), it will be used as a quality control traceability reference standard.

9. Both the new standard solution and the reference standard are analyzed on the same instrument and within the same time frame to maximize analytical precision. The new standard solution is quantified against the reference standard as an unknown to determine its acceptability.

10. Once the standard solution has passed QC evaluation for traceability, it is aliquoted appropriately, sealed, and stored appropriately to maintain its integrity until required.

Labware

Class A volumetric glassware is used by the laboratory for measuring trace constituents for organic analysis.

A standard operating procedure (SOP) for glassware and labware cleaning is implemented to minimize potentials for laboratory contamination. The SOP is followed to ensure the removal of all traces of parameter(s) of interest and contaminants that could interfere with analysis.

5.2 General Laboratory Equipment Calibration

Laboratory equipment requiring calibration, but not operational calibration, is checked for accuracy on a routine basis. These include the following:

- Balances
- Ovens
- Refrigerator/Freezer
- Pipettes
- Thermometers

Balances

Balances are checked for calibration daily or before every use with standard Class-1 calibration weights to within the specifications established by the laboratory. Balances that fail the calibration check are not used until they have been serviced. Balances are calibrated annually by a licensed specialist across the full weight range of the balance. In addition, calibration weights are re-calibrated and certified (on a bi-annual frequency) by a licensed specialist.

Ovens

Oven temperatures will be recorded each working day in oven logs and maintained at the required temperature $\pm$ 5°C at the operating range of 60-300 degrees Celsius. If the temperature is out-of-control during analysis, the results of that analysis will not be reported. The analysis will be repeated after the oven has stabilized for 8 hours.

Refrigerators/Freezers

The temperature in all the refrigerators shall be recorded each working day in the refrigerator logs and maintained at 4°C $\pm$ 2°C degrees. Freezers will be maintained at -10°C. In cases where temperatures are out of these limits, the thermostat will be adjusted accordingly with the laboratory section supervisor's approval.

Pipettes

Pipette volume accuracy is evaluated quarterly by weighing a known volume of water which equates to a specific mass on a calibrated balance. Pipette adjustments are made accordingly to ensure delivery of a desired volume.

Thermometers

Every thermometer must be checked annually against a second thermometer of equal or greater precision (i.e., one calibrated against an NIST certified thermometer). The procedures of ASTM E77-92 for calibration at ice point and other fixed points are followed. Errors in temperature indications of the thermometer being verified should not exceed the "scale errors" as expressed in Table 1 of ASTM E1-83. Thermometers will be calibrated across the anticipated range of operation.

5.3 Instrumentation

Specified calibration procedures and frequencies are used to enable the analyst to establish the linear working range of the instrument for quantitation purposes, the "cleanliness" of the system relative to the presence of interferences, the precision and accuracy of the measurement, and the temporal stability of the instrumentation. Upon successful completion of calibration procedures, calibration is checked at various time intervals during sample analysis as an indication of whether the instrumentation is still functioning properly. Specific guidelines detailed in the Laboratory's SOPs for performing periodic calibration checks over the course of the analyses are used to evaluate acceptability of the calibration data; if the specific calibration data quality indicators do not meet the SOP criteria, the instrument is checked for problems, and the samples associated with the problematic calibration must be reanalyzed after the identified problem(s) are corrected.

For analyses of sediment p,p'-DDE, initial calibration will be based on a 5 point curve. The coefficient of determination for the standard curve must be equal to or greater than 0.990.

Calibration will be verified with analysis of a continuing calibration standard each day at the beginning of the analytical shift and each 12 to 16 h, or every 10 samples, whichever is more frequent. The difference for each analyte must be less than or equal to 25% relative to the initial calibration curve. If the difference exceeds 25%, a new calibration must be performed. Additionally, a performance evaluation mixture will be analyzed to evaluate degradation and injection port stability every 12 to 16 h or at the beginning of each analytical shift. Column degradation is indicated if the percent degradation of 4,4'-DDT exceeds 15%, and the analysis will be stopped, the injection port serviced, and/or other maintenance is performed.

5.4 Reference Materials

A non-certified Regional Reference Material (RRM), prepared from PV Shelf sediments for the Bight '98 regional monitoring program, will be provided by SAIC to the laboratory for analyses prior to initiating processing (initial performance evaluation) and for analysis along with each batch of field samples (accuracy-based laboratory control material). The initial performance evaluation will involve triplicate analysis of the RRM. In addition, as part of the initial performance evaluation, a Standard Reference Material will be analyzed in duplicate. The appropriate SRM is NIST 1944 (New York/New Jersey Waterway Sediment). The average measured concentration of p,p'-DDE in the SRM reported by the laboratory for the initial performance evaluation must be within 35% of the reference value (86 ug/kg). The average reported concentration for the non-certified RRM must be within 35% of the consensus mean value (10,127 ug/kg) and within the acceptance range of 6,556 to 15,297 ng/g (see Section 6.1.1 for actual performance evaluation results).

5.5 Field Survey Equipment Calibration

Sediment Profile Imaging

At the beginning of each survey day, the camera data back time setting is synchronized to the navigation computer time. The data back records a digital time stamp on each image that matches the navigational fix time. After the film has been processed, the correct station and replicate identification for each image is determined using this time stamp.

A real-time verification of successful image acquisition is provided by the Benthos pinger, which is attached to the camera frame and doubles its ping rate when the camera fires successfully. A test shot is taken at the beginning of each new roll of film. This shot records the film roll number and date. This is done to verify that the Benthos pinger and frame counter are working properly, and also provides a unique identifier for each roll of film. At regular intervals during each survey day, the frame counter is checked to make sure that the desired numbers of replicates have been taken. If images have been missed or the penetration depth is insufficient, then proper adjustments are made (e.g., weight is added to the frame) and additional replicates are taken. Two weight packs, each capable of holding 125 pounds of lead (in 25 lb. increments), can be loaded to increase penetration (e.g., for work in sandy or high shear strength, compacted sediments). If penetration is too great, adjustable stops can be lowered to control the distance the prism can descend. In addition, "mud" doors can be attached to each side of the frame to increase the bearing strength of the entire unit.

A computer image analysis system is used to make linear measurements of the images, such as prism penetration depth, and is also used to detect differences in optical reflectance used to determine the apparent RPD depth. The image analysis system is calibrated at the beginning of each analysis day. A digital image is taken of a calibration slide that is marked at 10 cm increments. The card is measured using the image analysis system and the calibration data are stored. The system is recalibrated whenever focus or zoom adjustments are made on the video camera.

Side-Scan Sonar

Prior to the survey operations, SAIC field personnel will install all necessary navigational and positioning equipment on the survey vessel. The sonar acquisition system will be installed and data communication interfaces will be tested for proper operation. Offset distances between the tow point and the GPS positioning antenna will be determined to facilitate accurate calculation of towfish position during survey operations.

Subbottom Profiling

Prior to the survey operations, the subbottom profile system will be installed and data communication interfaces will be tested for proper operation. The subbottom signal cable will be mated to a mechanical tow cable mounted on the vessel's winch. Offset distances between the tow point and the GPS positioning antenna will be determined to facilitate accurate calculation of towfish position during survey operations.

6.0 ANALYTICAL PROCEDURES

Analytical procedures apply to laboratory analyses of sediment cores for chemical and physical parameters. Laboratory analyses are also applicable to processing of SPI, side-scan sonar, and subbottom profiling data.

6.1 Analysis of Sediment Cores

The core obtained at each station will be split and subsampled (five 4-cm intervals per core) to obtain sediment for analysis of grain size, bulk density, and a chemical marker (p,p'-DDE).. In addition, measurements of vane shear will be made on each of the five 4-cm intervals. At the center station within each of the four pilot cells and at one other station chosen at random in each cell, a second (duplicate) core will be obtained. These duplicate cores will be split and subsampled to obtain sediment for analysis of Atterberg Limits and bulk density. In addition, vane shear measurements will be obtained from the duplicate cores. The number of vane shear measurements and Atterberg Limits/bulk density samples will vary based on the number of distinct horizons observed in the cores. At a minimum, if no distinct horizons are observed, at least two samples for Atterberg Limits and bulk density analyses, and two vane shear measurements, will be obtained from each of the duplicate cores (one from each of the following two core intervals: 0 to 10 cm and 10 cm to 20 cm). If distinct sediment horizons are observed, then up to five Atterberg Limits/bulk density samples and up to five vane shear measurements will be obtained from each core (one from each distinct horizon).

Table 6-1 provides a summary of the methods to be employed for the p,p-DDE, grain size, bulk density, Atterberg Limits, and vane shear analyses; additional detail is provided in the sections to follow. Thechemical and geotechnical analyses will yield a data set that will be used to characterize the vertical distributions of key sediment conditions in each sediment core. This information will be important for evaluating contaminant mixing or resuspension during the pilot capping process.

6.1.1 Analysis of Sediment for p,p'-DDE

Woods Hole Group Environmental Laboratories (WHG) of Raynham, Massachusetts will perform the analysis of the core sediment samples to determine the concentration of p,p'-DDE. As indicated in Table 6-1, the analytical protocol to be followed by WHG is based on the following published methods:

- Method 8081A and Method 8000B, *Test Methods for Evaluating Solid Waste*, SW-846, Third Edition, Final Update III, December 1996 (USEPA Office of Solid Waste and Emergency Response, Washington, D.C.)

A complete set of WHG Standard Operating Procedures for sediment analysis of p,p'-DDE are provided in Appendix A of this QAPP. The following is a summary of these SOPs and any modifications therein to be used by WHG for analyzing the sediment samples from the PV Shelf for p,p'-DDE:

Table 6-1. Summary of analytical methods to be employed for analysis of core sediment samples (see text for more detailed descriptions).

PARAMETER	METHOD REFERENCE
p,p'-DDE (primary method)	Method 8081A and Method 8000B, *Test Methods for Evaluating Solid Waste*, SW-846, Third Edition, Final Update III, December 1996 (USEPA Office of Solid Waste and Emergency Response, Washington, D.C.)
p,p'-DDE (confirmatory analysis)	Method 8081A and Method 8000B, *Test Methods for Evaluating Solid Waste*, SW-846, Third Edition, Final Update III, December 1996 (USEPA Office of Solid Waste and Emergency Response, Washington, D.C.)
grain size	Plumb, R. H. 1981. Procedure for handling and chemical analysis of sediment and water samples. Prepared for the U.S. Environmental Protection Agency/Corps of Engineers Technical Committee on Criteria for Dredge and Fill Material. Published by Environmental Laboratory, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Technical Report EPA/CE-81-1
bulk density	U.S. Army Corps of Engineers Engineer Manual. Method EM 111--2-1906
Atterberg Limits	American Society for Testing and Materials (ASTM) Method D4318 (wet multipoint procedure)
vane shear	American Society for Testing and Materials (ASTM) Standard D-4648 (vane shear test).

Sample Receipt

1. Samples received by WHG will be inspected and logged for analysis after measurement of cooler temperature. Samples will be transferred to a freezer at -10° to -20° C for frozen storage as soon as practically possible following receipt. Samples should be aliquoted for determination of percent solids and for screening prior to freezer storage. Procedures are described in WHG *Sample Management Standard Operating Procedure (Revision 4)*.

Sample Screening

1. Aliquot 1 g of each sample into a 40-mL glass vial. Add approximately 1 g of a drying agent (diatomaceous earth) and 10 mL hexane. Mix the sample in hexane by shaking for 5 min.

2. Allow sample/solvent mix to settle for 30 min. and aliquot 1 mL of the hexane extract into a GC vial.

3. Analyze by GC/MS using procedures in WHG SOP for Method 8270C, modified as follows: a) calibrate with two calibration standards for 4,4'-DDE using a selected ion monitoring acquisition method that includes the base peak and at least two other ions for 4,4'-DDE, b) screen extracts using the same SIM method developed for the calibration, c) run screens without applicable tuning or CCV procedures.

4. Report screening measurements to the GC supervisor, who will indicate surrogate spike amounts for extraction of each sample assuming 10 g extracted. The GC supervisor will also estimate the approximate extract final volume necessary for a 10-g extract of each sample to provide 4,4'-DDE response within the GC-ECD calibration range (1 ng/mL to 200 ng/mL calibration solution concentrations).

Sample Analysis

1. Aliquot approximately 10 g wet weight of each sample, spike with the amount of surrogate compounds tetrachloro-meta-xylene (TCmX) and decachlorobiphenyl (DCB) indicated by the GC supervisor following the screening analysis.

2. Extract samples following procedures for sonication (Method 3550B) described in Section 7.4 of WHG SOP *Method 8081A Organochlorine Pesticides by Gas Chromatography/ Electron Capture Detection (Revision 0)*.

3. Extract up to 20 field samples with the following batch quality control (QC) samples: 1 method blank, 1 spiked method blank, 1 matrix spike/matrix spike duplicate pair, and 1 regional reference material (RRM PV7C provided to WHG by SAIC).

4. Exchange methylene chloride extracts into hexane and clean with activated copper following procedures in WHG SOP *Method 3660B Sulfur Cleanup (Revision 1.0)*.

5. Adjust "neat extracts" to a measured volume of 10.0 mL in hexane. **Note:** At a nominal extract volume of 10 mL, which when coupled with a 10-g sample wet weight provides a nominal wet-weight reporting limit of 1 ug/Kg, further extract cleanups will not likely be necessary. Use the first extraction batch as an indication of whether cleanups may be necessary.

6. If further extract cleanup appears necessary, an aliquot of the extract in hexane may be cleaned through amino-propyl gel following procedures in WHG SOP *Amino-Propyl Cleanup of Tissues and Sediments (Revision 0)*. If further cleanup appears necessary, gel permeation chromatography may be employed on methylene chloride extracts following automated high-performance liquid chromatography procedures in WHG SOP *Gel Permeation Chromatography (Revision 0)*.

7. Submit 1 mL of extracts to GC laboratory for any dilutions and analysis by GC/ECD following procedures in WHG SOP *Determination of Polychlorinated Biphenyls (PCBs) as Congeners and Organochlorine Pesticides by Gas Chromatography/Electron Capture Detection (Revision 1.1)*.

8. Implement the following modifications to the SOP cited in step 7:

- Use only Rtx-5 and Rtx-1701 columns for the dual-column analysis
- Evaluate all initial calibrations using the linear calibration criterion and use average relative response factors for analyte quantification (calibrate for 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, TCmX and DCB)
- Use a 15% D acceptance criterion for CCVs
- Evaluate and report MS/MSD recoveries for 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT; quantify all three only in the native sample associated with the MS/MSD
- Report recoveries for both surrogates, but DO NOT adjust 4,4'-DDE measurements for surrogate recovery

9. Any initial dilutions of the 10.0-mL "neat extracts" will be performed using a gas-tight syringe by the GC analyst setting up the analysis run. Sample chromatograms with 4,4'-DDE response falling outside the calibration response range for either the primary or confirmatory column will require reanalysis at an adjusted dilution.

10. Report any batch or matrix QC noncompliance to the Laboratory Project Manager prior to implementing corrective action. Instrument QC noncompliance should be addressed by the analyst in consultation with the GC supervisor and corrective action implemented without need for notification of the Laboratory Project Manager.

Confirmatory Analysis

1. The Laboratory Project Manager, in consultation with SAIC, will select 10% of the samples to be confirmed for identification and quantification of 4,4'-DDE by GC/MS-SIM following instrumental procedures in SOP *Analysis of Polynuclear Aromatic Hydrocarbons by Gas Chromatography/Mass Spectrometry with Selected Ion Monitoring (Revision 1.0)*.

2. The GC/MS-SIM SOP will be modified to target 4,4'-DDE and the surrogate compounds TCmX and DCB, and the internal standard from the GC-ECD analysis. Each compound will be represented in the SIM acquisition by no fewer than two and no more than three ions. SOP criteria for initial calibration will follow SOP limits for linear calibration with average relative response factors and %D $\leq$ 15% for CCVs. DDT breakdown will not be monitored for the confirmatory analysis.

3. Analyze the associated batch QC samples (method blank and spiked blank) for each sample set. Matrix batch QC (MS/MSD, RRM, SRM) will not be confirmed.

4. Confirmation analyses from multiple (approximately five) extraction batches will be combined into each GC/MS analysis run; these will be reported in a single data package.

5. Confirmatory analysis results will be reported to SAIC to support data validation. Corrective actions will be limited to GC/MS corrective actions specified for QC noncompliance in the SOP. GC/MS results will not be used to trigger corrective actions for GC-ECD analyses.

Method detection limit (MDL) studies have been conducted by WHG in accordance with the approved EPA protocol (CFR 40, Part 136) to determine the minimum quantity that can be reliably measured by the analytical methods used for this project. The MDL for samples quantified using the primary column is 0.048 ng/g, while the MDL for samples quantified using the secondary column is 0.0958 ng/g.. The practical quantitation limit used for samples from this project is 1 ng/g dry weight.

An initial performance evaluation study also was undertaken by WHG. This initial performance evaluation consisted of analyzing for p,p'-DDE three replicate aliquots of Regional Reference Material (RRM) PV7C, as well as duplicate aliquots of Standard Reference Material (SRM) 1944 (New York/New Jersey Waterway Sediment). The results are presented in Table 6-2. In the case of RRM PV7C, the "true" value shown in the table represents the consensus value based on analysis of this material by multiple laboratories. In the case of SRM 1944, the true value was determined by the certifying agency (NIST). The average value reported by WHG for the RRM (13,667 ug/kg) is within 35% of the true value and within the acceptance range. The average reported value for SRM 1944 (63.5) is also within 35% of the true value. These results are considered indicative of the laboratory's ability to meet the program's measurement quality objectives documented in this QAPP.

Table 6-2. Summary of laboratory results for the initial performance evaluation. All concentrations = ug/kg.

PE SAMPLE	"TRUE" VALUE	ACCEPTANCE RANGE	WHG RESULTS	AVG. % DEVIATION
RRM PV7C	10,127	6,556 to 15,297	rep 1 = 13,000 rep 2 = 14,000 rep 3 = 14,000 avg = 13,667	34.9%
SRM 1944	86	NA	rep 1 = 60 rep 2 = 67 avg = 63.5	26.2%

The laboratory must continuously track and evaluate performance using control charts for recoveries of: surrogate compounds, matrix spike compounds, and p,p'-DDE in the Regional Reference Material PV7C. . The results for various QC samples will be reviewed by laboratory personnel immediately following the analysis of each sample batch. The results will be used to determine whether control limits have been exceeded and, if so, corrective actions needed before analyses proceed. The relative accuracy of the RRM analyses will be determined by comparing the laboratory's value for p,p'-DDE against the RRM consensus value of 10,127 ug/kg and the RRM acceptance range of 6,556 to 15,297 ug/kg. On average, the laboratory's value should be within 35% of the consensus value, as well as within the laboratory's own control chart limits.

Final sample concentrations for p,p'-DDE will be reported on a dry weight basis. Sample results will not be corrected for either surrogate compound recovery or blank contributions. The concentrations of individual analytes in method blanks must be less than 3 times the corresponding method detection limit.

6.1.2 Sediment Grain Size Analysis

Applied Marine Sciences, Inc. (AMS) of League City, Texas will perform the analysis of the core sediment samples to determine grain size, bulk density and Atterberg Limits. A complete set of AMS' Standard Operating Procedures for these analyses is provided in Appendix B. Sediment grain size samples will be analyzed using the wet sieve and pipette method of Plumb(1981), capable of providing percent by weight distributions of particles within 0.5 phi intervals between –1 to 4 phi, and 1.0 phi intervals for particles smaller than 4 phi.

6.1.3 Sediment Bulk Density Analysis

Sediment bulk density samples will be analyzed by Method EM 1110-2-1906 (U.S. Army Corps of Engineers Engineer Manual). Assuming no void space due to air, the wet mass divided by the volume yields bulk density. Bulk density typically is determined by pushing a cylinder of known volume into the sediment, leveling off each end, and then weighing it.

6.1.4 Sediment Atterberg Limits Analysis

Sediment Atterberg Limits will be analyzed by ASTM Method D4318, following the wet multipoint procedure.

6.1.5 Vane shear

SAIC laboratory personnel responsible for splitting and processing the sediment cores will obtain the vane shear measurements. SAIC has prepared an SOP for these measurements based on both ASTM Standard D-4648 and the Wykeham Farrance International WF23500 Laboratory Vane Equipment Manual.

6.2 Sediment Profile Imaging

The SPI images will be analyzed with a full-color image analysis system. This is a PC-based system integrated with a Javelin video camera and frame grabber. Color slides are digitally recorded as color images on computer disk. The image analysis software is a menu-driven program that incorporates user commands. The system displays each color slide on the color monitor while measurements of physical and biological parameters are obtained. Software allows the measurement and storage of data on up to 21 different variables for each image obtained. Automatic disk storage of all measured parameters allows data from any variables of interest to be compiled, sorted, displayed graphically, contoured, or compared statistically. All measurements are printed out on data sheets for a quality assurance check by an SAIC senior scientist before being approved for final data synthesis, statistical analyses, and interpretation.

SPI images will be analyzed for the following parameters:

- Sediment type: major mode and sorting
- Boundary roughness
- Optical prism penetration depth
- Mud clasts
- Apparent RPD
- Layering
- Methane
- Infaunal successional stage
- Organism-sediment index

Sediment Type Determination: The major modal grain size that is assigned to an image is the dominant grain size as estimated by area within the imaged sediment column. In those images that show layering (e.g., sand over mud), the dominant major mode assigned to a replicate depends on how much area of the photograph is represented by either sediment type. A description of textural layering, if present, is included under “comments” on each data sheet. These textural assignments may or may not correspond to traditional sieve analyses depending on how closely the vertical sampling intervals are matched between the grab or core sample and the depth of the imaged sediment.

The sediment grain size major mode and range are estimated visually from the photographs by overlaying a grain size comparator that is at the same scale. This comparator was prepared by photographing a series of Udden-Wentworth size classes (equal to or less than coarse silt up to granule and larger sizes) through the REMOTS® camera. Seven grain size classes are on this comparator: >4 ϕ, 4-3 ϕ, 3-2 ϕ, 2-1 ϕ, 1-0 ϕ, 0-(-1) ϕ, and <-1 ϕ. The lower limit of optical resolution of the photographic system is about 62 microns (4 ϕ), allowing recognition of grain sizes equal to or greater than coarse silt. The accuracy of this method has been documented by comparing estimates with grain size statistics determined from traditional laboratory sieve analyses.

Sediment sorting is estimated in the following way: If all of the grain-sizes within an imaged sample falls within one Udder-Wentworth size class, the sample was classified as well sorted. If texture was distributed between (among) two (usually adjacent) Udder-Wentworth classes, the sample is described as moderately sorted. If most of the grains fall into three or more Udder-Wentworth classes, the sample is described as poorly sorted.

Boundary Roughness: Small-scale surface boundary roughness is measured from an image with the computer image analysis system. This vertical measurement is from the highest point at the sediment-water interface to the lowest point. This measurement of vertical relief is made within a horizontal distance of 15 cm (the total width of the optical window). Because the optical window is 20 cm high, the greatest possible roughness value is 20 cm. The source of the roughness is described if known. In most cases this is either biogenic (mounds and depressions formed by bioturbation or foraging activity) or relief formed by physical processes (ripples, scour depressions, rip-ups, mud clasts, etc.).

Optical Prism Penetration Depth: The optical prism penetrates the bottom under a static driving force imparted by the weight of the descending optical prism, camera housing, supporting mechanism, and weight packs. The penetration depth into the bottom depends on the force exerted by the optical prism and the bearing strength of the sediment. If the weight of the camera prism is held constant, the change in penetration depth over a surveyed site will reflect changes in geotechnical properties of the bottom. In this sense, the camera prism acts as a static-load penetrometer. The depth of penetration of the optical prism into the bottom can be a useful parameter, because dredged and/or capping materials often will have different shear strengths and bearing capacities than ambient sediments.

Mud Clasts: When fine-grained, cohesive sediments are disturbed, either by physical bottom scour or faunal activity (e.g., decapod foraging), intact clumps of sediment are often scattered about the seafloor. These mud clasts can be seen at the sediment-water interface in SPI images. During analysis, the number of clasts is counted, the diameter of a typical clast is measured, and their apparent oxidation state is assessed. The size and shape of mud clasts (e.g.,

angular versus rounded) are also considered. Overall, the abundance, distribution, oxidation state, and angularity of mud clasts are used to make inferences about the recent pattern of seafloor disturbance in an area.

Measurement of Dredged Material and Cap Layers: Distinguishing dredged material from SPI images is usually based on the presence of anomalous sedimentary materials within an area of ambient sediment. The ability to distinguish between ambient sediment and dredged or cap material demands that the survey extend well beyond the margins of a placement site so that an accurate characterization of the ambient bottom is obtained. The distributional anomalies may be manifested in topographic roughness, differences in grain size, sorting, shell content, optical reflectance, fabric, or sediment compaction (i.e., camera prism penetration depth). Second-order anomalies may also provide information about the effects of dredged material on the benthos and benthic processes such as bioturbation and successional status (see following sections).

Apparent Redox Potential Discontinuity (RPD) Depth: Aerobic near-surface marine sediments typically have higher optical reflectance values relative to underlying anoxic sediments. Sand also has higher optical reflectance than mud. These differences in optical reflectance are readily apparent in SPI images; the oxidized surface sediment contains particles coated with ferric hydroxide (an olive color when associated with particles), while reduced and muddy sediments below this oxygenated layer are darker, generally grey to black. The boundary between the colored ferric hydroxide surface sediment and underlying grey to black sediment is called the apparent redox potential discontinuity (RPD).

The relationship between the thickness of this high reflectance layer and the presence or absence of free molecular oxygen in the associated pore waters must be made with caution. The boundary (or horizon) which separates the positive Eh region (oxidized) from the underlying negative Eh region (reduced) can only be determined accurately with microelectrodes. For this reason, we describe the optical reflectance boundary, as imaged, as the “apparent” RPD, and it is mapped as a mean value.

The original RPD of the EA sediment will provide a useful marker for identifying this sediment in relation to any overlying capping sediment and will also be useful to assess erosion or mixing. Because the RPD influence (ferrous-oxide minerals) will persist in the sediments for weeks to months after cap placement, it will be a useful visual marker. Following capping, if the depth of the RPD is unchanged, it will provide evidence that mixing and erosion did not occur. If there is some loss of this layer, the degree of loss can be used to assess the degree of mixing. Total loss would suggest greater mixing. It is possible that a range of conditions will be observed: loss of the RPD at the point of impact of the capping sediments, moderate loss a few meters away and none where the placement energy was largely lateral.

Sedimentary Methane: At extreme levels of organic-loading, pore-water sulfate is depleted, and methanogenesis occurs. The process of methanogenesis is detected by the appearance of methane bubbles in the sediment column. These bubbles are detected when they reach a size of ≥1 mm (lower limit of optical detection). These gas-filled voids are readily discernible in SPI images because of their irregular, generally circular aspect and glassy texture (due to the reflection of the strobe off the gas). If present, the number and total areal coverage of all methane pockets are measured.

Infaunal Successional Stage: The mapping of successional stages is based on the theory that organism-sediment interactions in fine-grained sediments follow a predictable sequence after a major seafloor perturbation (e.g., passage of a storm, disturbance by bottom trawlers, dredged material deposition, hypoxia). This theory states that primary succession results in the predictable appearance of macrobenthic invertebrates belonging to specific functional types following a benthic disturbance. These invertebrates interact with sediment in specific ways.

An important aspect of using this successional approach to interpret benthic monitoring results is relating organism-sediment relationships to the dynamical aspects of end-member successional stages. This involves deducing dynamics from structure. The application of this approach to benthic monitoring requires *in situ* measurements of salient structural features of organism-sediment relationships as imaged through SPI technology.

Organism-Sediment Index (OSI): The multi-parameter Organism-Sediment Index (OSI) has been constructed to characterize habitat quality, which is defined relative to two end-member standards.

The OSI is a sum of the subset indices shown in Table 6-3. The OSI is calculated automatically by software after completion of all measurements from each photographic slide. The index has proven to be an excellent parameter for mapping disturbance gradients in an area and documenting ecosystem recovery after disturbance (Germano and Rhoads 1984, Revelas et al. 1987, Valente et al. 1992). The lowest OSI value is given to those bottoms which have low or no dissolved oxygen in the overlying bottom water, no apparent macrofaunal life, and methane gas present in the sediment (see Rhoads and Germano 1982, 1986, for criteria for these conditions). The OSI for such a condition is -10. At the other end of the scale, an aerobic bottom with a deeply depressed RPD, evidence of a mature macrofaunal assemblage (e.g., Stage III), and no apparent methane gas bubbles at depth will have an OSI value of +11.

6.3 Side-Scan Sonar Data

Following the survey, side-scan data will be processed with Triton-Elics Delph Map software. Data from each survey lane will be analyzed for surficial sediment texture and identification/location of objects or features on the seafloor. Screen grabs of the individual targets will be generated and stored in the project GIS so the location and the image can be accessible for future analyses.

The side-scan data from each survey lane will be mapped and composited using the position data. This process results in a geo-referenced, raster image called a "mosaic" that is compatible with a variety of software programs for analysis and mapping of spatial datasets with GIS-based systems.

Table 6-3. Calculation of the Organism-Sediment Index (OSI) Value

A. CHOOSE ONE VALUE:		
	Mean RPD Depth	Index Value
	0.00 cm	0
	> 0 - 0.75 cm	1
	0.75 - 1.50 cm	2
	1.51 - 2.25 cm	3
	2.26 - 3.00 cm	4
	3.01 - 3.75 cm	5
	> 3.75 cm	6
B. CHOOSE ONE VALUE:		
	Successional Stage	Index Value
	Azoic	-4
	Stage I	1
	Stage I to II	2
	Stage II	3
	Stage II to III	4
	Stage III	5
	Stage I on III	5
	Stage II on III	5
C. CHOOSE ONE OR BOTH IF APPROPRIATE:		
	Chemical Parameters	Index Value
	Methane Present	-2
	No/Low Dissolved Oxygen**	-4
REMOTS® ORGANISM-SEDIMENT INDEX =		Total of above subset indices (A+B+C)
	RANGE: -10 - +11	

** Note: This is not based on a Winkler or polarigraphic electrode measurement. It is based on the imaged evidence of reduced, low reflectance (i.e., high oxygen demand) sediment at the sediment-water interface.

6.4 Subbottom Profiling Data

Subbottom profile data stored on 8mm tape will be reviewed and analyzed to identify any subbottom horizons or features that may be used as benchmarks to evaluate cap thickness from subsequent surveys. The subbottom data will be displayed on the PC monitor as both a continuous profile, duplicating the shipboard display, as well as individual pulses. The processed digitized data are stored in data files containing the geodetic position and the vertical distance (depth) from the first return (sediment-water interface) to the subsurface layer for each sonar ping. A relational database of survey lanes and screen images of subbottom profiles will be compiled and incorporated into the project GIS.

7.0 DATA REDUCTION, VALIDATION, AND REPORTING

Data reduction, validation, and reporting are on-going processes that involve the field personnel, analysts, QA personnel, and the Project Manager. The following section describes the data handling process and outlines responsibilities of the various personnel. Data collected for the baseline program shall not be reported or released outside of the program organization without the written authorization of USACE and/or EPA.

7.1 Sediment Chemistry (p,p'-DDE) Data

All bench chemists document sample preparation activities in bound laboratory notebooks or benchsheets. These serve as the primary record for subsequent data reduction. The data for GC analyses are generated by stand-alone computers and integrators. Results of each analysis are transferred onto analytical results forms (or electronic spread sheets) specific to the particular analysis. Concentrations of the analytes are expressed according to the required units, depending on the sample matrix. The validity of instrument-generated data shall be supported by maintenance and inspection of the following records:

- Description of the calibration performed
- Description of routine instrument checks (noise levels, drift, linearity, etc.)
- Documentation of the traceability of instrument standards, samples, and data
- Documentation of analytical and QC methodology
- Description of the controls taken to determine and minimize interference from contaminants in analytical methods
- Description of routine maintenance performed

<u>Laboratory Data Review and Reporting</u>

Data review is the systematic procedure of reviewing a body of data against a set of criteria to provide assurance of its validity prior to its intended use.

Reviews of sediment p,p'-DDE data generated by WHG will be documented in a series of data review checklists that include the following:

- Pesticides Initial Calibration Review Checklist
- Pesticide by GC/ECD Daily Continuing Calibration Review Checklist
- Pest/PCB Data Review Checklist.

The process of data quality review is accomplished through routine audits of the data collection and flow procedures and by monitoring QC sample results. This process includes the following: dated and signed entries by analyst and section managers on the worksheets and logbooks used for all samples; use of sample tracking and numbering

systems to track the progress of samples through the laboratory; and use of quality control criteria to reject or accept specific data.

Validation Requirements

The minimum requirements for each analytical run are:

- Method-specified and manufacturer-specified calibration procedures
- Continuing calibration check standards
- Laboratory control samples/QC samples
- One method blank per matrix and concentration level for every sample batch analyzed
- Matrix spike and duplicate analyses per concentration level and matrix

Steps and checks used to validate precision and accuracy of the measured parameters, and support representativeness, comparability, and completeness, include:

- Correlation coefficient > 0.995 (coefficient of determination ≥ 0.990) or other predetermined calibration acceptance criteria
- Predetermined accuracy and precision objectives
- Documentation of the traceability of instrument standards
- Documentation of analytical methodology and QC methodology from the analyses SOP
- Routine maintenance performed and documented in instrument logs
- Documentation of sample preservation, transport, and storage.

Review of QC Sample Data

When analyses of a sample set are completed, the results will be reviewed and evaluated to assess the validity of the data set. General principles for all parameters and methods apply as follows:

- Blank Evaluations- Method blank results are evaluated for high readings characteristic of background contamination. If high blank values are observed, laboratory glassware, air, and reagents will be checked for contamination, and the analysis halted until the system is brought under control. A high background is defined as a background value sufficient to result in a difference in the sample value, if not corrected, greater than or equal to the smallest significant digit.

- Matrix Spike Pair Evaluation- If the observed recovery of the spike accuracy and/or precision values exceeds the acceptance criteria for the given parameters, the Laboratory and Project Managers are notified. The sample set may be reanalyzed for the parameter in question.

- Calibration Standard Evaluation- The calibration curve is evaluated to determine linearity through its full range and to verify that sample values are within the range defined by the low and high standards. If the curve is nonlinear, an appropriate algorithm can be used to fit a nonlinear curve to the standards.

- Regional Reference Material (RRM) Evaluation - The laboratory's values for RRM PVC7 are compared with the consensus value and and acceptable range. Values outside the acceptable range require corrective action to determine the source of error and provide corrective action. All sample analyses should be halted pending this evaluation. Following correction of the problem, the RRM should be reanalyzed.

GC/MS Confirmation Analyses

- Sample results with method detection limits and laboratory reporting limits
- Surrogate recoveries with control limits
- Method blank results
- Method blank spikes/laboratory control sample results with control limits
- GC/MS tuning results
- Initial calibration results with control limits
- Continuing calibration results with control limits
- Internal standard area and retention time results

7.2 Sediment Grain Size and Bulk Density Data

For the sediment grain size analysis, the weight of each sediment fraction should be reported to the nearest 0.0001 gram dry weight. For both grain size and bulk density, the laboratory should report the results for all samples analyzed (including QC duplicates) both in hard copy and in a computer-readable format (Microsoft Excel® or equivalent spreadsheet). In addition, both the paper and electronic data packages should include a cover letter with a summary of all quality control checks performed and a narrative explanation of any problems that may have influenced data quality.

It is the responsibility of SAIC's DAN-LA database manager (Ms. Chris Seidel) to acknowledge initial receipt of the data package(s), verify that the four data evaluation steps identified in the following paragraph are completed, notify the laboratory of any additional information or corrective actions deemed necessary as a result of the SAIC's data evaluation and, following satisficatory resolution of all "corrective action" issues, take final action by notifying the laboratory in writing that the submitted results have been officially accepted as a completed deliverable in fulfillment of contract requirements. It is the responsibility of the SAIC's QA Officer to closely monitor and formally document each step in the data evaluation process as it is completed. This documentation should be in the form of a data evaluation tracking form or checklist that is filled in as each step is completed. This checklist should be supplemented with detailed memos to the electronic and paper project files outlining the concerns with data omissions, analysis problems, or descriptions of questionable data identified by the laboratory.

Evaluation of the data package should commence as soon as possible following its receipt, since delays increase the chance that information may be misplaced or forgotten and (if holding times have been exceeded) can sometimes limit options for reanalysis. The first part of data evaluation is to verify that all required information has been provided in the data package. On the PV Shelf baseline monitoring program, this should include the following specific steps:

- SAIC's Database Manager will verify that the package contains a cover letter signed by the laboratory manager, hard copies of all results (including QA/QC results), and accompanying computer diskettes.

- The electronic data file(s) will be parsed and entered into the DAN-LA database to verify that the correct format has been supplied.

- Once the data have been transferred to the DAN-LA database, checks will be performed to verify that results have been reported for all expected samples and all analytes.

SAIC's Project Manager or his designee will contact the laboratory and request any missing information as soon as possible after receipt of the data package. If information was omitted because required analyses were not completed, the laboratory should provide and implement a plan to correct the deficiency. This plan may include submittal of a revised data package and possible reanalysis of samples.

Data validation, or the process of assessing data quality, will begin after SAIC has determined that the data package is complete. Data validation for grain size data will consist of the following: 1.) a check to verify that all reporting units and numbers of significant figures are correct; 2.) a check to verify that the cumulative percentage of each particle size fraction never exceeds 100% (i.e., a failed range check); 3.) a check to verify that the results for duplicate samples do not differ by more than 30%.

For bulk density data, data validation will consist of the following: 1.) a check to verify that all reporting units and numbers of significant figures are correct; 2.) a check to verify that the results for duplicate samples do not differ by more than 30%.

Upon completion of all data evaluation steps, a memo summarizing the QA review of the data package will be prepared, samples will be properly stored or disposed of, and laboratory data will be archived both in a storage file and in the DAN-LA database. Memos summarizing the results of the QA review of the data package will summarize all conclusions concerning data acceptability and should note significant quality assurance problems that were found. These memos are useful in providing data users with a written record of data concerns and a documented rationale for why certain data were accepted as estimates or were rejected. The following specific items should be addressed in the data evaluation memo:

- Summary of overall data quality, including a description of data that were qualified.

- Brief descriptions of sample collection and analysis methods.

- Description of data reporting, including any corrections made for transcription or other reporting errors, and description of data completeness relative to objectives stated in the QA plan.

7.3 Sediment Profile Imaging, Side-Scan Sonar, and Subbottom Profiling Data

SPI Data Review and Data Reporting

At the end of each survey day the film of the acquired images is processed and dried. When the film is dry the images are reviewed and stations requiring re-sampling are noted. After the survey is complete and the slides are mounted and labeled, the images are analyzed (see Section 6.2).

During image analysis, the various parameters are measured, and the data for each image are stored in its own REMOTS® Data Sheet (RDS) file. Upon completion of analyses, all RDS files are printed out and reviewed with the slides by a senior scientist. Edits are noted on the hard copy RDS printouts and then entered into the electronic file. Re-measurement of parameters using the image analysis system is done at this time. When all edits and re-measurements are complete, the data from all RDS files are exported into bulk data spreadsheet format. The bulk data spreadsheet is compared to the edited RDS hard copies to ensure accuracy. The REMOTS® images are scanned to create electronic files in .TIF format. An archive CD is created to store all the image files, RDS files, and the spreadsheet of the exported bulk data. Data products (tables and maps) are created from the bulk data spreadsheet. The original images and edited RDS sheets are stored in a binder in an archive room.

Side-Scan Sonar Data Review and Data Reporting

Side-scan data are collected and processed on board the survey vessel. Preliminary data products including a side-scan coverage map and high-resolution screen grabs for selected features or objects will be provided within two days of survey completion. Within two weeks, all processed side-scan results will be input to the project GIS.
Final results will be presented and described in the summary report for the Baseline Program. This report will contain graphical data products including a side-scan mosaic of the pilot study area, a tabular listing of targets observed on the seafloor and their location, as well as example images of targets and seafloor substrates presented at full resolution.

Subbottom Profiling Data Review and Data Reporting

Subbottom profiling data are collected and processed on board the survey vessel. Preliminary data products including a survey trackline map and subbottom profile images for individual lanes will be provided within two days of survey completion. Within two weeks, all processed subbottom results will be input to the project GIS.
Final results will be presented and described in the summary report for the Baseline Program. This report will contain graphical data products including subbottom profiles for selected lanes of the pilot study area.

7.4 Data Collection and Flow Audits

Laboratory data and flow audits for sediment chemistry and grain size/density data include the following:

- Review by the analyst(s) of sample documents for completeness at each step of analysis
- Review of instrument logs, and analyst performance by the Laboratory QAO and/or Manager
- Review of performance indicators such as blanks, surrogate recoveries, MS/MSD, RRM, etc., by analysts, the Laboratory QAO and/or Laboratory Manager
- Random calculation checks
- Review of all reports prior to and subsequent to data entry
- Review and approval of the final data package by the Laboratory Manager.

7.5 Data Review

Sediment Core Data

Review of data from the chemistry laboratories involves several levels of evaluation. In general, the analysts, Laboratory QAO and/or Project Manager are responsible for reviewing data relative to instrument calibration, standard preparation, method blanks, raw data, calculations, and transcriptions. The analyst should check 100% of the raw analytical data generated, including the calibration data and all calculations. The data quality indicators (such as method blanks, replicate analyses, and spike recovery determinations) should be compared to the acceptance criteria described in the analytical procedures. The emphasis is on the data acceptability relative to the data quality indicators and on the accuracy of the final data summaries.

All analytical problems encountered during sample analysis are properly addressed to provide explanations for data users. The technical documentation is checked against the following criteria during the internal laboratory review:

- Stated QA objectives of the QAPP
- Analysis date versus the applicable holding times
- Percentage of QA analyses conducted
- Field and laboratory blank contamination
- Laboratory accuracy (percent recovery versus control limits)
- Laboratory and field precision (RPD versus control limits).

Data sets are reviewed for completeness and accuracy by the Laboratory QAO or Manager. The data review is documented, and then the data are delivered to the SAIC database management personnel for loading into the database. After data from the laboratory are loaded into the database and formatted, the data are reviewed by SAIC to verify correct values, correct sample information, and correct formats. One hundred percent (100%) of the data values are checked against the hard-copy data reports to verify that the original data have not been altered during the conversion and formatting step. Additionally, sample record information (station, replicate number, instrument code, wet weight, and percent dry weight) in the database is checked against the data sheets. Computer programs are run to match the sample record information with the sample (chemical) data sets to check for missing data.

SPI Data Review

All the RDS sheets are printed out and slides are reviewed by a senior scientist. Edits are noted on the RDS hardcopy and then entered into the electronic file. Re-measurement of parameters using the image analysis system is done at this time. When all the edits and re-measurements are complete, the data from all the RDS hard copies are exported into bulk data spreadsheet format. The bulk data spreadsheet is compared to the edited RDS sheets to ensure accuracy.

Side-Scan and Subbottom Profiling Data Review

Side-scan data will be processed with Triton-Elics Delph Map software. Data from each survey lane will be analyzed for surficial sediment texture and identification/location of objects or features on the seafloor. The side-scan data from each survey lane will be mapped and composited using the position data that are merged with the side-scan data.

Subbottom profile data stored on 8mm tape will be reviewed and analyzed to identify any subbottom horizons or features that may be used as benchmarks to evaluate cap thickness from subsequent surveys. The processed digitized data are stored in data files. A relational database of survey lanes and screen images of subbottom profiles will be compiled and incorporated into the project GIS.

7.6 Data Management

In general, laboratory analytical data are to be delivered to SAIC on 3.5 inch floppy disks in a Microsoft Excel®, Microsoft Access®, or equivalent spreadsheet/database file format for incorporation into DAN-LA.

Sediment Core Data

Data management, quality control, and quality assurance are achieved through a rigorous sequence of computer software and visual checks systematically ensuring the consistency and completeness of the data. Data are entered into the database management system as raw data files. These files are then established as a working database. From the database, computer data-checking programs are run to check values (ranges, maximum-minimum values), formats (missing replicates and data), and codes (chemical codes). If the computer checks reveal problems, the data are rechecked visually, raw data files are corrected if needed, and the computer data-checking program is rerun to verify that the data have been corrected.

One hundred percent (100%) of the data are verified against the original data sheets to check for errors. Once the data have been verified and any necessary corrections to the raw data file have been made, the database establishment program is run again to create a master database.

Independent data validation is not required for this project. However, for the sediment chemistry analysis data (i.e., p,p'-DDE data), SAIC will perform 100% validation of the data packages from WHG. Complete validation will be conducted on two of the data packages containing sediment chemistry (p,p'-DDE) results. Two data packages are approximately equal to 40 sediment samples, or 20 percent of the total sediment p,p'-DDE data set. Complete validation on all samples will be conducted only in the event that systematic laboratory failures (e.g., using incorrect calculation or peak identification programs at the instrument level) are discovered. A QC summary validation will be conducted on the remainder of the marine sediment samples collected, as described in the following sections:

Laboratory Data Package Verification

Data package verification shall be performed by the specific analytical section leader, the laboratory section QC coordinator, and the laboratory QC Manager. Verification will be accomplished through routine audits of the data collection and flow procedures and monitoring of QC sample results. Data collection and flow audits shall include the following checks:

- Review of sample documents for completeness by the analyst at each step of the analysis scheme
- Daily review of instrument logs, performance test results, and analyst performance by the analytical task manager
- Unannounced audits of report forms, notebooks, an other data sheets by the laboratory QC manager
- Daily review of performance indicators, such as blanks, surrogate recoveries, duplicate analyses, and matrix spike analyses, by the analytical task manager
- Checks on a random selection of calculations by the laboratory QC manager
- Review by the laboratory manager of all reports before and after computerized data entry
- Review and approval of final report by the laboratory QC manager.

All laboratory data are validated and approved for incorporation into DAN-LA by the Project Quality Assurance Officer. The following are the basic activities that will be conducted as part of the laboratory data approval process:

- Validation of all laboratory data using relevant and applicable criteria described in the USEPA *National Functional Guidelines for Organic Data Review* (EPA540/R-99/008, October 1999)*, Test Methods for Evaluating Solid Waste Physical/Chemical Methods* (SW-846, May 1996), and this QAPP. QC summary validation will be limited to reviewing the information contained in the QC summary forms and comparing the results to the QAPP requirements. Complete validation will include the QC summary form review in addition to the validation procedures described in the above referenced EPA guideline document (i.e., raw data review for system performance indicators, target compound identification, and compound quantification and project-required reporting and method detection limits).

- Reconciliation of all data received with that proposed in the PWP and the analyses requested on the chain-of-custody forms. Compilation of all missing data points and notification of the USACE Project Manager or her designated technical point-of-contact, and the laboratory QC manager.

- Review of laboratory QC check data applicable to all samples in one analytical batch for all sample shipments received. Compilation of all check points outside method control ranges. Assessment of the impact of laboratory QC data on data quality.

- Review of field QC check data applicable to all samples in one sample shipment and for all shipments from

the Palos Verdes Study Site to the laboratory. Calculation of RPD values from concentrations of p,p' DDE in the field duplicates, as well as compilation of all blank contamination. Assessment of the impact of field data on data quality.

Minimum Criteria for an Out-of-Control Condition

A laboratory process for a particular compound will be considered out of statistical control whenever, as a minimum, any one of the following conditions is demonstrated by a control chart monitoring that compound:

- Any one point is outside of the control limits
- Any three consecutive points is on the same side of the center line
- Any six consecutive points such that each data point is larger (or smaller) than its immediate predecessor
- Any obvious cyclic or repeated pattern seen in the data points.

Laboratory Data Reporting

Results of the laboratory analyses of environmental samples will be reported in an appendix to the Baseline Monitoring Report and grouped with the appropriate QC samples. To facilitate data validation and data usability assessment, the minimum laboratory reporting requirements are listed below:

General Analytical Reporting Requirements

- Laboratory sample identification number
- SAIC identification number
- Sample collection and laboratory receipt dates
- Volume or mass of sample purged or extracted
- Percent moisture for each sediment sample
- Upper and lower control limits of percent recovery and RPD calculations for all applicable QC check analyses

General Laboratory Data Package Requirements

- Case narrative specific to the data package submitted
- Copies of all signed chain-of-custody forms specific to the data package submitted
- Analytical results reported as received and in the same order listed on the applicable chain-of-custody form. Each analytical data group shall be reported with all applicable laboratory QC data.
- All analytical results report to one significant figure for values less than 10 and two significant figures for values greater than 10.
- All analytical results reported in mg/Kg dry weight

GC/MS Confirmation Analyses

- Sample results with method detection limits and laboratory reporting limits
- Surrogate recoveries with control limits
- Method blank results
- Method blank spikes/laboratory control sample results with control limits
- GC/MS tuning results
- Initial calibration results with control limits
- Continuing calibration results with control limits
- Internal standard area and retention time results

GC Analyses

- Sample results with method detection limits and laboratory reporting limits
- Method blank spikes/LCS results reported with control limits
- Surrogate recoveries with control limits
- MS/MSD results with control limits
- Method blank results
- Initial calibration results with control limits for primary and confirmation columns
- Continuing calibration results with control limits for primary and confirmation columns
- SRM/RRM results
- Instrument performance check results
- Clean up check sample results

SPI Data Management

All the RDS hard copies are printed out and the measurement results are reviewed by a senior scientist. Edits are noted on the RDS hard copies and then entered into the electronic file. Re-measurement of parameters using the image analysis system is done at this time. When all the edits and re-measurements are complete, the data from all the RDS sheets are exported into bulk data spreadsheet format. The bulk data spreadsheet is compared to the edited RDS sheets to ensure accuracy. All of the REMOTS® electronic images (.TIF files created by scanning the originals), data sheets, and summary spreadsheet files for each project are copied onto a CD-ROM for archival storage. The original REMOTS® data sheets and images also placed into 3-ring binders for permanent storage in a secure archive room.

Side-Scan and Subbottom Profiling Data Management

Side-scan data will be processed with Triton-Elics Delph Map software. The side-scan data from each survey lane will be mapped and composited using the position data that are merged with the side-scan data. Within two weeks, all processed side-scan results will be input to the GIS.

Subbottom profile data stored on 8mm tape will be reviewed and analyzed, the processed digitized data are stored in data files. A relational database of survey lanes and screen images of subbottom profiles will be compiled and incorporated into the GIS database.

7.7 Data Reporting

Data will be submitted to the USACE in a hard copy format and in an electronic format that is compatible with and can be readily incorporated into the project GIS. Final results will be presented and described in the summary report for the Baseline Program. This report will contain graphical data products.

7.8 Verification of Software

All computer software used to acquire, process, or report data shall be verified upon initial use and re-verified after any modification. Depending on the purpose of the software, either test problems or reference standards will be processed by the software and the results compared to the "true" results (hand calculated or calculated by another procedure) or to certificates for the reference materials.

All paperwork generated during software verification, such as computer printouts and supporting calculations, shall be documented and filed in the laboratory operations file, including the following information at a minimum:

- Software name
- Instrument or analysis associated with software
- Date of verification
- Signature of verifier

7.9 Documentation

The objective of records management is to assure that all documents for a given program are accountable and traceable. It includes COC records, all logbooks, graphs, remote sensing images and data displays, and other miscellaneous items. Any correction to the data is documented by the originator of the correction, and the change is communicated to all involved project staff.

7.10 Record Keeping

Laboratory Data

Documentation in the laboratory is initiated by the Sample Custodian (SC) who receives samples, assigns laboratory numbers, and generates COC forms which document sample movement in the laboratory. Each shipment of samples received is given a unique batch number (project number). A batch consists of a number of samples carried through the entire analytical procedure, along with samples and standards. All work performed on a sample batch is documented in bound laboratory logbooks which are described as follows:

1. Sample Receiving Logbook is used to record computer-generated sample summary forms which were entered into the laboratory sample data base on a sample receipt basis. It is compiled on a monthly basis to document sample receipt information.

2. Instrument Maintenance Logbook is used to record the maintenance performed on the analytical instruments.

3. Standards Logbook is used to record the preparation and use of all standards in the laboratory. It notes date of preparation and by whom, concentration, as well as date of expiration of the standards or reagents.

4. Chemist's Notebook and/or Worksheets are used to record the raw data and final data of every batch. It is used to document all activities associated with the analytical process. Laboratory notebooks of each staff represent functional records and are pre-numbered.

5. Instrument Benchsheet Logbook is used to record sample run sequence or injections done in a day's or shift's run.

SPI, Side-Scan Sonar, and Subbottom Profiling Data

Documentation associated with SPI, side-scan sonar, and subbottom profiling consists of field logs, notes and narratives associated with data processing, review, and interpretation, and sections of the baseline monitoring program addressing these sampling tasks.

Rules Governing the Use of Logbooks

a. Bound logbooks with pre-numbered pages are the preferred record-keeping forms. Loose sheets are not used unless permanently affixed to the logbooks.

b. Field logbooks should contain waterproof paper.

c. Only assigned laboratory notebooks or logbooks are used for record keeping (e.g., Instrument Run logbook, Maintenance logbook, Standards logbook, etc.).

d. All writing must be legible and shall be completed in water-resistant ink. All numbers must be clear. Corrections should be made by drawing one line through the incorrect entry, entering the correct information, initialing, and dating the change.

e. Complete information should be entered so that in an examination, it can be determined what was done, when, and what the results were.

f. If any data are determined to be invalid, reasons are indicated.

g. All relevant information is included (e.g., the manufacturer and lot number of a chemical, the specific procedure used for sample preparation and analysis, instrumental conditions, etc.).

h. When work is continued in another notebook or logbook, the number of the first notebook is written in the first page of the second notebook and vice-versa.

7.11 Document Control

Document control is accomplished through the use of a centralized repository of document inventories and all documents generated in conjunction with the project or contract. All project files, analytical data files, and documentation related to sample analysis are maintained by designated personnel. SOPs and copies of the QA manual will be controlled by the Laboratory QAO through numbered distribution listings. Revisions are subject to SAIC QAO approvals. Revisions will be noted on header pagination used for these controlled documents. SAIC will retain all data records and documents for a period of one year following submittal of the final program deliverables, unless instruction is received from project sponsors (U.S. Army Corps of Engineers or U.S. EPA) specifying a different required record retention time.

Document Handling

Designated laboratory personnel are responsible for the collection, organization, maintenance, and security of all documents, and will establish a client/contract file for all documentation regarding a project or a contract.

Active files shall be maintained in locking metal file cabinets. Only authorized personnel shall have access to the files. The file drawers shall be kept locked when not in use. Archived files must also be secured and access shall be limited to authorized personnel.

The following records will be maintained by the laboratory:

- Logbooks (Field, COC, Bench, Analytical Run, Temperature, and Oven)
- Instrument Calibration Data
- Instrument Maintenance Logs
- Computer Software Verification
- Performance Evaluation Records
- Certification Program Records
- QC Sample Analysis
- Control Charts
- Corrective Action Forms
- Purchased Material Certificates
- QC Coordinator Reports
- QC Audit Reports
- Standard Operating Procedures
- Equipment Manuals
- Personnel Qualifications and Training
- In-House Forms.

Consistency of Documentation

Before releasing analytical results, the laboratory assembles and cross checks the information in field logs, sample tags, custody records, laboratory bench sheets, personal and instrument logs, and other relevant data to ensure that data pertaining to each particular sample or case is consistent throughout the record.

Document Inventory

Document tracking and control are facilitated through the use of an inventory checklist for document tracking.

Document/Data Package Shipping

The delivery schedule of the data package is defined by the USACE. The date of shipping is documented and a list of data/documents shipped is retained for the record. A copy of the data package sent is kept by the laboratory to be filed for future reference in case of future requests for information.

7.12 Standard Operating Procedures

SOPs are maintained for each laboratory section and describe standard procedures for use of logbooks, benchsheets, traceability of standards, instrumentation, samples, and environmental data.. In addition to the detailed instructions for performing each test or analysis, laboratory procedures shall address all applicable quality control techniques and activities necessary to maintain the required accuracy and precision of results. These quality control factors include calibration of instruments and equipment, specifications for reagents and supplies, labeling and logging of samples, preservation and storage of samples, standardization of instruments and methods, replicate and blind check samples, blank and spiked samples, control of environmental conditions, tolerance of measurements, recordkeeping requirements, statistical quality control methods and charts, performing and checking calculations and results, and interlaboratory quality control tests or analyses. SOPs are also maintained for the various imaging equipment and describe standard procedures for use of this equipment. Methods for handling incorrect or defective samples shall be specified. Results shall be traceable to the sample.

Responsibilities for Document Preparation and Approval

The Laboratory QAO shall be responsible for the format and content of the Laboratory Quality Assurance Manual. Prior to initial issuance and any subsequent major revisions, it shall be reviewed and approved by the Laboratory Manager. The Laboratory QAO shall compile, issue, distribute, and maintain the QA Manual, record the distribution, and review the contents on an annual basis.

Each Section Manager shall create or approve all internally generated procedures and forms for his/her assigned area of work. The Section Manager shall be responsible for initially verifying the technical accuracy and adequacy of internal procedures and forms based on approved external methods and his/her technical expertise.

All SOPs and their subsequent revisions shall be reviewed and approved by the Section Manager and the QAO. Each reviewer is responsible for assuring that the procedure or form is accurate and adequate based on his/her area of expertise. In-house data forms shall be reviewed and approved by the Section Manager and the Lab QAO. Project-specific manuals shall be reviewed and approved by the USCOE, the Lab QAO, and the SAIC Project Manager.

Document Revision

Documents are updated for any revision made to reflect the actual procedures being followed. Before any revision is made, such documents shall be submitted to the Laboratory QAO for approval of the proposed revisions.

Changes to documents, other than those defined as minor changes, shall be considered as major changes and shall be reviewed and approved by the same organizations that performed the original review and approval unless other

organizations are specifically designated. The reviewing organization shall have access to pertinent background data or information upon which to base their approval.

Minor changes shall be defined as those changes that do not affect the content or quality of the action being prescribed in the document, such as punctuation or grammatical changes, aesthetic changes or, in the case of data forms, small changes made strictly for the convenience of the user that do not affect the accuracy or integrity of the document.

An addendum, subject to all review and approval criteria as defined above, may be attached to a document to reflect policy and procedural changes that become effective between revisions. These changes will then be incorporated into the body of the document at the time of the next revision.

If the revision is justified for the changes to be done, the Project Manager submits the proposed revision of a section of a document or SOP to the QAO for approval.

Document revision shall also include policy changes that could substantially impact the QA/QC plan as follows:

- Personnel changes relating to QA/QC responsibilities
- Method changes
- Procedural changes in establishing control limits and/or the preparation and use of control charts.

7.13 Field Data Control

Field Data Reduction

All field measurements and observations are recorded in project log books, field data records, or similar types of record-keeping books. All data are recorded directly and legibly in ink in field logbooks or worksheets with all entries signed and dated. If entries must be changed, the change should not obscure the original entry. The reason for the change should be stated, and the correction and explanation should be signed and dated or identified at the time the correction is made. Field data records are organized into standard formats whenever possible and retained in permanent files.

Field Data Quality Review

Quality reviews of field data will be performed. Data will be reviewed by the Field Supervisor to ensure the correct codes and units have been included. After data reduction into tables or arrays, the Field Supervisor reviews data sets for anomalous values. Any inconsistencies discovered shall be resolved immediately, if possible, by seeking

clarification from the field personnel responsible for data collection. The Field Supervisor is also responsible for ensuring that defensible and justifiable data were obtained by following the field objectives described below:

- Adherence to the project work plan
- Equipment and instruments properly calibrated and in working order
- Sample collection according to standard operating procedures
- Sufficient sample volume collected to maintain sample integrity and conduct all required analyses
- Properly preserved samples
- Applicable blanks and field QC samples are provided with each sample set
- Complete COC documentation is kept throughout the duration of the field sampling effort and copies are included with each sample shipment
- Field samples arrive at the laboratory in good condition.

Random checks of sampling and field conditions are made by the Field Supervisor, who checks recorded data at that time to confirm observations. Whenever possible, peer review also is incorporated into the data validation process in order to maximize consistency between field personnel.

Once both field and analytical data have been combined, the resulting technical documentation is reviewed for quality against the following:

- Stated QA objectives of the QAPP
- Analysis date versus the applicable holding times
- Percentage of QA analyses conducted
- Field and laboratory blank contamination
- Laboratory accuracy (percent recovery versus control limits)
- Laboratory and field precision (RPD versus control limits).

Descriptive statistics for completeness are calculated and reported.

8.0 INTERNAL QUALITY CONTROL CHECKS AND FREQUENCIES

8.1 Field Quality Control Checks

Collection and analysis of field replicates are intended as QC checks on the integrity of sample collection and handling procedures and equipment decontamination procedures.

8.2 Laboratory Quality Control Checks

Quality control checks will be conducted for sediment chemistry and geotechnical samples. Internal laboratory quality control checks for the sediment chemistry analysis including method and system blanks will be performed routinely. Matrix spike/matrix spike duplicate analyses will be performed, where appropriate, on 10% of all samples. The general scheme for each type of analysis includes analysis of the Regional Reference Material (RRM PV7C), analysis of a method and system blank, and MS/MSD analysis (where appropriate). All blanks and spiked samples are processed and analyzed in the same manner as the actual samples. Internal laboratory quality control checks for the geotechnical samples (grain size, bulk density, Atterberg Limits) include duplicate analyses.

The quality control samples for sediment chemistry analyses listed in Table 8-1 will be analyzed at the stated frequencies. Acceptance criteria for these samples are listed in Table 2-3. Quality control sample acceptance criteria for the geotechnical analyses are presented in Table 2-4.

8.3 SPI, Side-Scan Sonar, and Subbottom Profiling Data Quality Control Checks

<u>SPI Images</u>

A first-order QC review of SPI images will be performed to ensure that a sufficient number of images of acceptable quality were obtained. Unacceptable images include:

- Underpenetration/No penetration. Check the number of weights and, if more can be added, revisit the site. If the site looks rocky, penetration may not be possible. Check the other replicates and make a best estimate whether a good image can be collected.
- Overpenetration. Check and reduce the number of weights, possibly use the mud doors, and revisit the site. Some material may be too soft to support the weight of the camera.
- Pull out. The camera prism has started to pull away and is not flush with the sediment when the image is taken; revisit the site.
- Mud Smears. The wiper blade may not be near enough to the prism glass or material may be very sticky. Revisit the site after checking the wiper blade.
- Black image. No strobe; check the strobe and revisit the site.
- Water shot. Revisit the site.

Table 8-1. QC Samples, Frequencies, Criteria, and Corrective Actions

TYPE	PURPOSE	FREQUENCY	TARGET CRITERIA	CORRECTIVE ACTION
Method Blank	Verifies clean reagents and instrument system and lab environment	1/sample batch	See Table 2-3	Clean system. re-extract and re-analyze samples
Laboratory Control Sample (Blank Spike)	System performance check	1/sample batch	See Table 2-3	Check system
Initial Calibration Verification (ICV)	Establish linearity of analytical range	See method	See method	Recalibrate and reanalyze affected sample batch
Continuing Calibration Verification (CCV)	Verifies calibration curve	$\geq$ 1/analysis day	See method	Check system; recalibrate
Matrix Spike/ Matrix Spike Duplicate Sample Pair	Checks recovery from real matrix; Precision and Accuracy checks	10% of samples	See Table 2-3	Check for matrix interferences
Regional Reference Material (RRM)	Determine accuracy versus "true values" or "consensus values" and show comparability	1/sample batch	See Table 2-3	Evaluate sample results and reanalyze if necessary
Surrogate Standards	Determine recoveries, control limits, matrix effects	All GC/MS and GC samples	See method	Check for matrix interferences; reanalyze sample

Upon completion of the image analysis, a senior scientist will conduct a QC review of the measurement data for each image using the RDS hard copy. The QC check following image analysis will flag any potential errors from the image analysis. Some variables that can be incorrectly measured include the maximum grain size, successional stage, or RPD depth. Corrections are noted on the RDS hard copy and edits are made to the electronic files.

Once the RDS hard copies have been corrected and re-measurements made using the image analysis system, the data will be exported into a summary spreadsheet. Variables such as successional stage and OSI measurement need to be examined closely for accuracy.

Side-Scan Sonar Data

Duplicate side-scan sonar records will be compared. There should be 100% agreement between the two records in the sediment type determination and the identification of surface features. The two records should agree within ±10 m with respect to the location (coordinates) of specific targets or features.

Data on surface sediment type (i.e., grain size) at the side-scan sonar lane points of intersection, obtained from both the sediment coring and sediment profile imaging surveys, will be used as an independent check or ground truth of the side-scan sonar interpretation. At 90% of the stations, there should be agreement between the sediment-profile imaging and coring grain size results versus the sediment type determination obtained through side-scan sonar interpretation.

Subbottom Profiling Data

Duplicate subbottom profile records, obtained at the points of intersection of survey lanes, will be reviewed to determine whether measurements of subbottom layer thickness from the two records agree within ±20 cm and whether the two records show the same number and pattern of subbottom reflectors. Sediment coring and sediment profile imaging data obtained at the subbottom points of intersection will be compared to determine whether there are any discrete depositional layers on or near the sediment surface with thickness less than about 20 cm as a means to independently ground-truth the subbottom results.

9.0 PERFORMANCE AND SYSTEM AUDITS AND FREQUENCY

System and performance audits may be conductedperiodically under the auspices of SAIC's Quality Assurance Officer. In addition, the USACE Quality Assurance Officer may conduct periodic audits of field, laboratory, and data processing activities at a frequency specified by the USACE Program Manager.

An audit is defined as a systematic check to determine the quality of operation of field or laboratory activities. It comprises the following:

- Performance audit-checks to determine the accuracy of the total measurement system, or portions. Test samples are analyzed and results evaluated.
- System audit-an evaluation of all components of a laboratory's measurement systems to determine their proper selection and use, including QC procedures.

Audits should include an evaluation of quality assurance practices, procedures, and instructions; the effectiveness of implementation; and conformance with policy directives. The performance audit should include evaluation of work areas, activities, processes, and items and review of documents and records, storage of standards and reagents, housekeeping, good laboratory practice, analytical procedures, and quality control.

The auditor shall document the audit and sign the audit report. The audit report should contain sufficient information to be a stand-alone document.

All audit reports must be transmitted to the audited activity within thirty (30) days after completion of audit. All audit report findings must be answered within thirty (30) days from receipt of the audit report. The auditor will evaluate the audited activity's response, verify its implementation, if possible, and accept or request further corrective action. The auditor will use all acceptable responses to close the audit report. All audit reports, initial and closed, will be sent to upper management for review.

To verify subcontractor conformance to program requirements, SAIC may perform quality checks, perform field inspections and verification tests, review subcontractor prepared documentation, and perform system audits. SAIC will submit copies of all audit correspondence to the USACE.

If subcontractor activities require the submittal to SAIC of documents such as instrument performance, material certifications, test results, etc., the Project Manager is responsible for obtaining the documents prior to the sub-contractor's work being closed. The QAO will determine the need for, and frequency of, subcontractor audits.

10.0 PREVENTIVE MAINTENANCE PROCEDURES AND FREQUENCY

10.1 Maintenance Program

Preventive maintenance is defined as an orderly program of positive actions for preventing failure of equipment and ensuring that the equipment is operating with the reliability required for quality results. The actions include specification checks, calibrating, cleaning, lubricating, reconditioning, adjusting, and checking.

A preventive maintenance program for instrumentation ensures fewer interruptions of analyses, personnel efficiency, and lower repair costs. It eliminates premature replacement of parts, and reduces discrepancy among test results. It increases reliability of results.

The following preventive maintenance program will be established:

1. Each type of equipment/instrument has a written Standard Operating Procedure (SOP) which describes the methods for routine inspection, cleaning, maintenance, testing, calibration, and/or standardization of the equipment. Instrument operating manuals are kept near the instrument or where analysts have easy access.

2. Analysts using the instruments are properly trained and have developed troubleshooting skills that will enable them to recognize problems, their causes and appropriate corrective actions, quickly and accurately to reduce equipment failure and reduce dependence upon outside servicing agencies. In complicated cases, the servicing agency or supplier is called to solve the problem.

3. Written instrumentation and equipment records are kept to document all inspection, maintenance, troubleshooting, calibration, or modifications. Whenever maintenance is performed on an instrument, it is properly documented in a preventive maintenance logbook, which is kept near the equipment to monitor the adequacy of maintenance schedules. The records contain the date (month, day, year), description of the maintenance done, and the actual findings, the name of the person doing the maintenance, and a statement of whether the maintenance operations were routine and if those operations followed the written SOP and/or the operating manual.

4. Performance criteria are established for judging when data from instrument performance checks indicate the need to make adjustments in the instrument operating conditions.

Preventative maintenance schedules should be available in the Laboratory's standard operating procedures manual or the maintenance logbooks.

10.2 Backup Equipment

The analytical chemistry laboratory is responsible for obtaining and maintaining backup instrumentation. Backup equipment is available so that, in the event of failure of the primary instrumentation, the analyses can be completed without jeopardizing the sample holding times. SAIC is responsible for obtaining and maintaining backup equipment for field surveys to ensure efficient and complete field data collection.

10.3 Equipment Maintenance

The following maintenance and calibration is performed on laboratory equipment:

- Analytical balances are calibrated annually.
- Pipettes are calibrated quarterly.
- Thermometers are calibrated annually.

Other equipment and instrumentation particular to each laboratory are also routinely maintained. Records, service, maintenance, and calibration of equipment are detailed in equipment maintenance logbooks.

The following maintenance and calibration is performed on field sampling equipment:

Sediment Profile Imaging

As part of survey mobilization all SPI field equipment will be "bench tested" to ensure everything is working properly before departure. The equipment includes, but is not limited to, the electronic components of the REMOTS® camera and the Benthos pinger. Upon return from the survey, demobilization of all field equipment will include a fresh water rinse and servicing such as checking o-rings and batteries. The equipment will be re-checked and, if it is not functioning properly, repairs are made at this time (i.e., replace electronic boards within the camera). Routine maintenance is also accomplished at this time (i.e., replace prism window and/or mirror).

Side-scan Sonar and Subbottom Profiling Equipment

As part of survey mobilization, side-scan sonar and subbottom profiling equipment will be tested to ensure everything is working properly before departure. Following the survey, demobilization of the equipment will include rinsing and servicing. Repairs are made at this time if the equipment is not functioning properly. Routine maintenance is also accomplished at this time.

11.0 SPECIFIC ROUTINE PROCEDURES

The following procedures are recommended for evaluating the precision and accuracy of all environmental measurement data generated in the project.

11.1 Precision

Precision is usually expressed as Relative Percent Difference (RPD) based on duplicate analyses of a sample. The RPD is calculated as:

$$\text{RPD (\%)} = \frac{X_1 - X_2}{(X_1 + X_2) / 2}$$

where X_1 and X_2 are, respectively, the first and second values obtained for the analysis. For some methods, a different procedure is specified wherein precision is evaluated via the use of Matrix Spike (MS) and Matrix Spike Duplicate (MSD) samples.

11.2 Accuracy

Accuracy is usually expressed as percent recovery (% R). The % R for spiked samples is calculated as:

$$\text{\% R} = \frac{X_s - X_u}{C_t} \times 100$$

where X_s is the measured concentration in the spiked sample, X_u is the measured concentration in the unspiked sample, and C_t is the true concentration of the spike. Standard Reference Materials available from NIST will also be used to assess accuracy. In this case, the relevant calculation is:

$$\text{\% R} = \frac{X_l}{C_t} \times 100$$

where X_l is the measured concentration in the SRM and C_t is the certified or "true" concentration.

11.3 Completeness

Completeness will be determined as the percentage of the sample data for which the associated QC data are found to be acceptable.

11.4 Control Charts

For methods where quality control acceptance limits are not specifically established, control charts are used to evaluate laboratory performance. These are prepared based on routine types of QC samples: LCS or blank spike recoveries; matrix-spiked sample recoveries; and duplicate or MS/MSD pair recoveries; SRM results; and surrogate recoveries. For each major method performed and sample matrix analyzed routinely by the laboratory, representative concentrations of target analytes are spiked into selected samples. Percent recovery and duplicate precision are calculated, then the mean and standard deviations are calculated when at least 20 data points are available. Control charts are constructed with warning and control limits at, respectively, two and three standard deviations from the calculated mean. Corrective actions are taken and recorded for out-of-control data points. Limits are updated after 20 subsequent points. Control charts should be made available to the laboratory staff so that they can be used to reveal shifts, trends, biases, and conditions where parts of the analytical system are out-of-control and appropriate corrective action may be taken.

11.5 Significant Figures

Conventions described in Standard Methods for the Examination of Water and Wastewater, Section 104, "Expression of Results," will be used for determining the reporting significant figures. Unless otherwise required, results are reported to two significant figures.

12.0 CORRECTIVE ACTION

An out-of control event is defined as any occurrence failing to meet pre-established criteria. A nonconformance is a deficiency in characteristic, documentation, or procedure sufficient to make the quality indeterminate or unacceptable. An out-of-control event is a subcategory of nonconformance.

When either situation is identified, it will be categorized as follows:

- Deficiency: Recognition of a specific requirement (e.g., program, process, or procedure) that has been violated.
- Observation: Recognition of an activity or action that might be improved but is not in violation of a specific requirement. Left alone, the activity or action may develop into a deficiency.

12.1 Criteria Used for Determination of an Out-of-Control Event

Factors that affect data quality (failure to meet calibration criteria, inadequate record keeping, improper storage, or preservation of samples) require investigation and corrective actions. Some factors can be easily assessed through the use of control charts. Control charts can reveal shifts, trends, biases, and conditions where parts of the analytical system are out-of-control. The detection of one of these conditions is an indication that the analytical system is out-of-control. The out-of-control value(s) are placed on the control chart, circled, and documented in a corrective action form. The Laboratory QAO is notified and both the analyst and QAO investigate and determine whether the condition indicates a procedure that is truly out-of-control, or a possible random error. The QAO shall document corrective actions taken (i.e., whether the sample run was repeated or whether the data was received and released for reporting to the client) on the corrective action form.

When a nonconformance is recognized, each individual involved with the analysis in question has an interactive role and responsibility; these are as follows:

- The Analyst: He/she must be able to recognize nonconformances and immediately notify the Laboratory Section Manager and work with the Laboratory QAO to solve the problem. Each analyst is responsible for documenting and correcting problems that might affect data quality.
- The Laboratory Section Manager: He/she must review all analytical and QC data for reasonableness, accuracy, and clerical errors; he/she is also responsible for monitoring control charts (in terms of control limits). In an out-of-control event, the Laboratory Section Manager works with the analyst and QAO to solve the problem and prevents the reporting of suspect data by stopping work on the analysis in question and insuring that all results that are suspect are repeated, if possible, after the source of the error is determined and remedied.
- Laboratory QAO: In the event that an out-of-control situation occurs that is unnoticed at the bench or supervisory level (i.e., performance failure on a QC sample), the QAO will notify the Laboratory Section Manager; help identify and solve the problem where applicable; ensure the work is stopped on the analysis; and

verify that no suspect data are reported. The Laboratory QAO must review and approve all corrective action reports, and submit them to the Laboratory Manager for review. The Laboratory QAO is responsible for reviewing nonconformance report forms, recommending or approving proposed corrective actions, maintaining an up-to-date nonconformance log, verifying that corrective actions have been completed, releasing nonconforming item tags, distributing and filing nonconformance report forms, and assisting in resolving disagreements.

12.2 Procedures for Stopping Analysis

Whenever the analytical system is out-of-control, investigation-correction efforts are initiated by all concerned personnel.

If the problem is instrumental or specific only to preparation of a sample batch, samples prepared after the out-of-control event are reprocessed after the instrument is repaired and recalibrated, provided holding times are not exceeded. The analytical chemistry laboratory will ensure that backup equipment/instruments are available so that holding times are not jeopardized by instrument problems.

If a sample batch is still out-of-control after reanalysis, all method-related activities shall stop immediately. A detailed laboratory-wide investigation shall be conducted to isolate and correct faulty operations. Sample security, integrity of standards, reagents, glassware, laboratory notebooks, instrument performance, and adherence to the methods shall be included in the investigation.

All actions taken shall be documented and placed in their respective case/contract file.

12.3 Corrective Action

The need for corrective action comes from several sources: equipment malfunction, failure of internal QA/QC checks, failure of follow-up on performance or system audit findings, and noncompliance with QA requirements.

When measurement equipment or analytical methods fail QA/QC requirements, the problems will immediately be brought to the attention of the Laboratory Manager and Laboratory QAO. Corrective measures to be taken will depend entirely on the type of analysis, the extent of the error, and whether the error is determinant or not. The corrective action to be taken is determined by either the Laboratory Section Manager (i.e., analytical task leader), the analyst, the Project Manager, and the Laboratory QAO, or by all of them in conference, if necessary. Final approval, however, is the responsibility of the Project QAO and/or Project Manager.

Specific corrective actions must be determined on a case-by-case basis. If failure is due to equipment malfunction, the equipment will be controlled by segregation or tagging until repaired; precision and accuracy will be reassessed,

and the analysis will be rerun. All attempts will be made to reanalyze all affected parts of the analysis so that, in the end, the product is not affected by failure of QC requirements.

When a result in a performance audit is unacceptable, the laboratory will identify the problems and implement corrective actions immediately. A step-by-step analysis and investigation to determine the cause of the problem shall take place as part of the corrective action program. If the problem cannot be controlled, the laboratory will analyze the impact on the data.

When a system audit reveals an unacceptable performance, work shall be suspended until corrective action has been implemented and performance has been proven to be acceptable.

If an external audit (system or performance) report identifies deficiencies that require corrective action, the Project QAO shall notify the responsible supervisor and log the pertinent information, including the date a response is due, in the nonconformance log.

The Laboratory QAO and the responsible supervisor shall assure that corrective action is taken. The Project QAO shall verify that the problem has been corrected. With the responsible supervisor, the Project QAO shall prepare a formal written response to the external organization, if required. The Laboratory Manager shall transmit the response to SAIC.

All incidents of QA failure and the corrective action tasks will be documented and reports will be placed in the appropriate case/contract file. Also corrective action will be taken promptly for deficiencies noted during the spot-check of raw data. When corrective actions are implemented, evidence of correction of deficiencies will be presented. Corrective action documentation will be forwarded to the SAIC Project QAO and the Project Manager for evaluation and approval. QA failures and corrective actions are summarized in the monthly progress/QA reports.

12.4 Documenting Corrective Action

If, at any time during analyses, a process is out-of-control, corrective action shall be taken, and documented, with regard to the following:

- What actions were taken to bring the process back into control?
- What actions were taken to prevent recurrence of the out-of-control situation?
- What was done with the data obtained while the process was out-of-control?

This is accomplished by preparing a Corrective Action Memo. This memo is initiated either by the Laboratory Section Manager (analytical task leader) or the Laboratory QAO, depending on where the problem is recognized. The memo will include the following information:

- Project affected
- Procedure affected
- Reporter of the problem
- Description of the problem encountered
- Sample(s) and Analytical Parameter affected
- Date recognized, By whom
- Date occurred, By whom
- Date corrected, By whom
- Personnel problem reported to
- Description of corrective/preventative action taken to remedy the problem
- Notification and approval of final corrective action (Reporter, Team Leader, QA Officer, Project Manager signatures and associated dates)

12.5 Field Corrective Action

The initial responsibility for monitoring the quality of field measurements lies with the field personnel. The Field Supervisor is responsible for verifying that all QC procedures are followed. This requires that the Field Supervisor assess the correctness of the field methods and the impact a procedure has upon the field objectives and subsequent data quality. In addition, the Field Supervisor is responsible for ensuring that the QA objectives are met. If a problem occurs that might jeopardize the integrity of the project, cause a QA objective to not be met, or impact data quality, the Field Supervisor will immediately notify the Project Manager and the Laboratory Manager, if appropriate. Corrective action measures are then decided upon and implemented. The SAIC Project Manager is notified if the situation warrants it. The Field Supervisor documents the situation, the field objective affected, the corrective action taken, and the results of that action. Copies of the documentation are provided to the Project Manager and the Project QAO.

<u>Sediment Profile Imaging, Side-Scan Sonar, and Subbottom Profiling Sampling</u>

During field survey operations it is apparent immediately if there is a problem with the SPI camera or the pinger. During the test shot with the housing off of the camera the auto-winder is audible, the strobe flash is visible, the pinger doubling is audible, and the film counter is checked. If any one of these actions fails, trouble-shooting begins until the problem is resolved. Similarly, side-scan sonar and subbottom profiling data are collected and evaluated in real-time on the survey vessel. If the data record is interrupted or distorted, sampling will cease until the problem is identified and corrected.

13.0 REPORTS TO MANAGEMENT

13.1 Quality Assurance (QA) Reports to Management

The SAIC Project QAO will review current quality related activities, and provide updates to the SAIC Project Manager for incorporation into any progress reports which are required to be submitted to the USACE. The quality assurance updates shall include the following topics, as appropriate:

1. Findings of any internal or external audits
2. Nonconformances, data affected, and effectiveness of corrective action taken
3. QC summary data
4. SOPs implemented
5. Personnel and instrumentation changes
6. QA Project Plans written/reviewed/revised or amended.

Project specific audits, nonconformances, or changes which may affect quality will be reported, verbally and in writing. The USACE and SAIC Project Managers will determine, with the Project QAO, appropriate actions.

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APPENDIX A
Standard Operating Procedures for Laboratory Analysis of Chemistry Samples

APPENDIX B
Standard Operating Procedures for Laboratory Geotechnical Analyses

Project Work Plan
for the
Palos Verdes Pilot Capping Project:
Baseline Monitoring Activities

HEALTH AND SAFETY PLAN

Prepared for:

U.S. Army Corps of Engineers
Los Angeles District
Environmental Construction Branch

U.S. Environmental Protection Agency
Region IX
Superfund Division (SFD-7-1)

February 2001

Prepared by:

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SAIC Report Number 486

Site Specific Health and Safety Plan Approvals

Dr. Scott McDowell, SAIC Project Manager	Date
John Nakayama, SAIC Project Health and Safety Officer	Date
Ms. Eleanor Nevarez, USACE Project Manager	Date
TBD, USACE Project Health and Safety Officer	Date

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1.0 INTRODUCTION

1.1 Scope and Applicability

The information provided in this Health and Safety Plan (HSP) was developed for use by Science Applications International Corporation (SAIC) and its subcontractors in support of the field pilot study of in-situ capping of Palos Verdes Shelf contaminated sediments. This HSP was prepared in accordance with the requirements contained in SAIC's Corporate Environmental Compliance & Health and Safety Manual (Procedure 20, Hazardous Waste Operations) and assigns responsibilities, establishes personal protection standards and mandatory safety procedures, and provides for contingencies that may arise while SAIC operations are conducted. SAIC disclaims responsibility for any other use of this information other than the express purpose for which it is intended and assumes no liability for the use of this information for any other purpose. The evaluation of potential hazards and their controls reflect professional judgements subject to the accuracy and completeness of information available when this plan was prepared.

All subcontractors for the Palos Verdes baseline monitoring program must comply with this plan. This HSP does not relieve any subcontractor of the responsibility to provide a safe workplace for its employees. This HSP does not cover all hazards that may be associated with the work of SAIC subcontractors. Subcontractors must supplement the requirements of this HSP with standard procedures or other means, as necessary, to ensure the safety of their employees and prevent exposure of SAIC employees to health or safety hazards. Failure to comply with the requirements of the plan is grounds for immediate dismissal from the program.

1.2 Project Description

In-situ capping is being considered for DDT and PCB contaminated sediment restoration on the Palos Verdes Shelf off the coast of Los Angeles, CA. The overall objective of the field pilot study is to demonstrate that a cap can be placed on the shelf as intended by the design, and to obtain field data on the short-term processes and behavior of the cap as placed. The shelf area under consideration for capping lies between the 40- and 70-meter depth contours. Four pilot capping cells are proposed for the Field Pilot Study, with each cell having dimensions of 300 meters by 600 meters. Details of the project are provided in the Overview Section of the Project Work Plan.

1.3 Project Work Scope Overview

Table 1-1 describes the objectives for baseline monitoring activities. Additional detail on the field methods for each monitoring activity are described in the Field Sampling Plan of the Project Work Plan. Evaluation of hazards associated with each activity is provided in the following sections.

Table 1-1. Baseline Monitoring Objectives

Field Task	Monitoring Applications	Period over which task will be performed*
Sediment coring	Sediment layer thickness, layer mixing, grain size, chemical profile,	4 days, assuming a minimum of 8 hours of coring per day
Sediment profile imaging (SPI)	Sediment layer thickness, lateral extent, layer mixing, grain size, biological condition	2 days SPI sampling for each of 4 cells
Side-scan sonar survey	Sediment distribution, bottom disturbance features, bottom topography	2 days**
Sub-bottom profile survey	Stratigraphy	2 days**

* All field activities will be performed during daylight hours.
** Both systems will be operated simultaneously.

1.4 Project Organization and Responsibilities

Table 1-2 identifies the individuals who have key responsibilities for site health and safety. The responsibilities of these key personnel, as well as the responsibilities of the field team members, are described below.

Table 1-2. Individuals Responsible for Site Health and Safety for the Palos Verdes Baseline Monitoring Program

Position Title	Name	Phone Number
Project Manager	Dr. Scott McDowell	(401) 848-4772 (office)
Project Health and Safety Officer	John Nakayama	(425) 482-3313 (office)
Field Team Manager	John Evans	(858) 826-7476 (office) (310) 519-3172 (Field: SCMI)
Site Health and Safety Officer	John Nakayama	(310) 519-3172 (Field: SCMI)

Responsibilities

Project Manager

- Designates qualified Site Health and Safety Officer(s)
- Ensures HSP is prepared and approved before field work commences.
- Reviews and approves the HSP.
- Authorizes the performance of all field work.
- Enforces the requirements in the HSP.
- Serves as central point of contact with the USACE Project Manager.
- Identifies to the Project Health and Safety Officer the names of all individuals assigned to perform field work covered under this HSP.

Project Health and Safety Officer

- Obtains a qualified technical review of the HSP.

- Ensures that all personal protective equipment specified in the HSP is available for use at the site.
- Ensures that subcontractors are provided a copy of the HSP and complete and return the acknowledgement form (Appendix A, Form 1)
- Ensures that all field personnel have completed the required training (Section 4.1) and medical surveillance (Section 4.3).
- Completes the Project Debriefing Questionnaire (Form 5) in Appendix A upon completion of the field work.

Field Team Manager

- Ensures that the HSP is implemented during the performance of all field work.
- Enforces the safety requirements contained in this plan.

Site Health and Safety Officer(s)

- Documents the implementation of the HSP.
- Conducts site specific health and safety training.
- Conducts daily inspections (Form 4, Appendix A) to verify compliance with the HSP and notifies the Project Safety Officer and Field Team Manager of violations or hazardous conditions.
- Initiates corrective action(s) for identified violations or hazardous conditions.
- Suspends field operations if site conditions are unsafe, until the problem is corrected.
- Ensures that personnel (SAIC employees, subcontractors, and visitors) allowed access inside exclusion zones or other controlled areas have completed the required training and received medical clearance.
- Ensures that monitoring equipment is properly calibrated and used.
- Ensures daily work schedules are appropriate for the specific work, levels of effort, and outside temperature and weather conditions.
- Ensures a copy of the HSP is available on-site and that emergency medical care and procedures are posted.

Field Team Members

- Comply with the HSP and all other required health and safety guidelines
- Take all precautions necessary to prevent injury to themselves and to their fellow employees
- Immediately inform the Site Health and Safety Officer of any hazardous conditions
- Perform only tasks that they are qualified to do and believe they can do safely
- Notify the Site Health and Safety Officer of any special medical conditions (i.e., allergies, contact lenses, diabetes) which could affect their ability to safely perform site operations
- Prevent spillage and splashing of materials
- Practice good housekeeping by keeping the work area neat, clean and orderly
- Immediately report all injuries, no matter how minor to the Site Health and Safety Officer
- Maintain site equipment in good working order and report defective equipment to the Site Health and Safety Officer
- Properly inspect and use the personal protective equipment (PPE) as directed by the Site Health and Safety Officer and Field Team Manager

2.0 SITE DESCRIPTION

The Palos Verdes Shelf and slope are located off the Palos Verdes peninsula that separates Santa Monica and San Pedro Bays. Since the first outfall diffusers became operational in 1937, particulate matter discharged through the outfalls has settled and built up an effluent-affected (EA) sediment deposit on the shelf and slope. The volume of the entire mapped EA layer has been estimated at approximately 9 million cubic meters, and the mapped layer covers a surface area of approximately 40 square kilometers. A detailed site description is provided in the Overview Section.

Field operations will generally take place on the survey vessel, described in Section 3.2.1. Sediment processing will either occur on the vessel, or onshore at the Southern California Marine Institute (SCMI) in Terminal Island, California.

3.0 SITE SPECIFIC HAZARD EVALUATION

Hazards encountered during sampling programs of this kind are generally classified as chemical, physical, or environmental. Chemical hazards are twofold: (1) contaminants or hazardous materials potentially present within the sediments sampled, and (2) chemicals used to decontaminate sampling gear. Physical hazards are associated with sampling gear, vessel, and process area hazards and work conditions over water. Environmental hazards are associated with physical exposure. Exposure to harmful microbiological organisms or other organisms in the sediments is not expected during this program. Therefore, biological hazards will not be discussed further.

3.1 Chemical Hazards

Chemicals found in EA sediments during previous investigations at Palos Verdes include DDT and PCBs. The maximum detected concentration of each of these chemicals is presented in Table 3-1. These chemicals can pose contact, inhalation, and ingestion hazards. These chemicals are relatively nonvolatile and do not pose a vapor hazard. Control measures to prevent skin contact and inhalation of dusts or mists during sample collection and processing are presented in the Hazard Monitoring and Control Section. Hydrogen sulfide may also be encountered in the sediments. If necessary, procedures for monitoring hydrogen sulfide are also presented in the Hazard Monitoring and Control Section. In addition to routes of exposure noted below, any of these compounds can be harmful if accidentally ingested as a result of inadequate decontamination procedures or personal hygiene practices. Material Safety Data Sheets (MSDS) for these chemicals can be found in Appendix B. Chemicals used in the decontamination of sampling equipment are described below.

Hexane, Hydrochloric acid, and Methanol: These chemicals are used to decontaminate sampling equipment. They are clear, colorless liquids with strong odors. Methanol and hexane are volatile solvents and are flammable. Hydrochloric acid will burn exposed skin on contact. Personnel are required to wear protective gloves and eyewear whenever handling these decontaminating agents. These liquids are used in the open air or under a hood. Personnel are to ensure that others are not down wind, and that methanol and hexane are stored and used in areas free of any potential sources of ignition. Smoking is prohibited within 50 feet of areas where methanol/hexane are used or stored.

Table 3-1. Summary of Chemicals of Concern in EA Sediment at Palos Verdes Reported in WES Technical Report EL-99-2 (Palermo et al. 1999)

Compound	Concentration Range (ppm)	Average Concentration* (ppm)	Station Maximum
Total DDT	0.014 – 253.000	7.70	556
Total PCBs	0.009 – 20.600	0.773	564

Table 3-2 provides an evaluation of the hazards associated with the chemicals that may be encountered during the monitoring program at Palos Verdes, including chemicals used in decontamination procedures.

Table 3-2. Chemical Hazard Evaluation [Values taken from OSHA (29 CFR 1910.1000) and ACGIH (1999 TLVs and BEIs), with the more conservative value reported.]

Chemical	TWA[1] (mg/m^3)	STEL[2] (mg/m^3)	Ceiling[3] (mg/m^3)	Exposure Routes	Symptoms
Total DDT*	1		---	Skin absorption and contact Ingestion Inhalation	Coughing, irritation, dizziness, convulsions
Total PCBs* **(Assumes 54% chlorine)**	0.5	---	---	Skin absorption and contact Ingestion Inhalation	May damage adult reproductive system, nervous system, liver damage, skin rash, chloracne
Hydrogen Sulfide	7 (5 ppm)[4]	---	21 (15 ppm)	Inhalation	Convulsions, eye and respiratory irritation, headaches, dizziness
Methanol	262 (200 ppm)	328 (250 ppm)	---	Skin absorption and contact Ingestion Inhalation	Headache, drowsiness, coughing, skin and eye irritation or burning, blindness, ingestion of 2 ounces can cause death
Hexane	176 (50 ppm)	---		Skin absorption and contact Ingestion Inhalation	Nasal and respiratory irritation, skin and eye irritation, lightheadedness, nausea, headache, numbness of the extremities, muscle weakness, dermatitis, giddiness
Hydrochloric Acid	---	---	7 (5 ppm)	Skin Contact Ingestion Inhalation	Severe burns to eye or skin, breathing difficulties, irritation

* Identified by NIOSH as a carcinogen

3.2 Physical Hazards

General physical hazards and their controls which are associated with the field work to be performed are listed below:

- Slips, trips, and falls will be minimized by keeping work areas dry and clear of equipment and debris.
- Electrical/mechanical equipment. All personnel will be instructed in the proper use of electrical and mechanical equipment prior to using the equipment. All electrical equipment will be properly grounded (i.e., use of three prong connector and GFCI). All equipment used in the field is cord and plug connected.

[1] TWA – Time weighted average concentration not to be exceeded for an 8-hour workday.

[2] STEL – Short term exposure limit averaged over a 15-minute time period which is not to be exceeded.

[3] Ceiling – Concentration not to be exceeded at any time.

[4] ppm = parts per million

- Personnel will not attempt to lift heavy equipment and samples without assistance. When two or more people are required to handle an object, it is important to ensure that the load is lifted uniformly, weight equally distributed between individuals, and that each person, if possible is facing the direction in which the object is being moved.

In addition, the buddy system will be in place at all times during sampling and processing operations. This system will be implemented to reduce the risk of injury and minimize the response time should an injury occur. More detailed physical hazards associated with specific field activities are described in the following sections.

3.2.1 Research Vessel Operations

Field sampling in Palos Verdes will be conducted in spring or early summer, aboard the R/V SEA WATCH or the R/V YELLOWFIN. Both vessels are approximately 70 feet long with a hydraulic A-frame. Sampling operations will consist of gravity coring, sediment profile (REMOTS®) camera work, side-scan sonar and sub-bottom profiling surveys. The physical hazards associated with the deployment and retrieval of large pieces of sampling equipment (such as the REMOTS® camera and gravity corer) are due to their weight and the method of deployment. The REMOTS® camera weighs 1000 pounds (including the stainless steel frame assembly). During deployment and retrieval in rough waters or strong winds, this equipment may shift on deck or swing (if at the end of the winch wire). Therefore, the camera and all other large sampling equipment will always be handled by two persons. During deployment and retrieval of samplers in rough waters or high winds, safety lines may be used to stabilize and control the load. The safety lines will be left in place until the sampler or camera clears the transom. During retrieval of the equipment, a person watching over the stern of the vessel will notify the winch operator when the equipment first comes in sight and again when it breaks the water surface. Only persons whose presence is required will be allowed on the deck during deployment and retrieval of the samplers.

Both the side-scan sonar and sub-bottom profiling equipment are encased in weighted and deployable tow fish. The physical hazards associated with deployment and retrieval of these sampling equipment are due to their weight and method of deployment. Care will be taken when deploying the equipment to ensure the equipment does not impact the bottom. The position of the tow fish will be monitored, such that one person is assigned the responsibility of following its position at all times. That individual will also be responsible for following the motion of the vessel (taking into account the turning radius of the vessel while towing equipment), mobility depending on obstructions on the vessel, and actual or potential fouling of the sampling gear. Hands and feet must never be placed underneath sampling gear.

Sample handling equipment, containers, deck lines, and water hoses not in immediate use will be kept clear of walkways and work areas until needed. Each time operations at a given station have been completed, any sediment on

the deck will be washed overboard to prevent slipping. All deck personnel will have Coast Guard-approved life vests or life jackets available for use. Under circumstances of potentially dangerous waves or winds, the vessel pilot and Field Team Manager will employ best professional judgment to ensure safe field operations. Emergency procedures for a person-overboard situation are discussed in Section 3.8. A hand-held radio or cellular phone will be onboard to allow for direct communication to shore. Emergencies will be handled via marine radio channel 16. Operations will require various notices to mariners notifications. The phone numbers of all related Harbor Patrol and USCG facilities will be posted on the survey vessel, as well as onshore at the Southern California Marine Institute (SCMI), and in the vehicles of field members.

3.2.2 Small Vessel Operations

A small boat (20 foot Whaler or Zodiac raft) may be used to transport personnel and/or equipment to the survey vessel. Conditions that may require the use of such a boat would be to send out replacement equipment or parts to the survey vessel, enabling the survey vessel to remain on-site. Some small boats can be unstable in the water; therefore, Coast Guard-approved life vests or life jackets will always be worn by field personnel. Prior to coming on-site, all persons will be trained on the operation of the vessel including boat safety, navigation rules, how to start/stop the motor, forward/reverse, fuel requirements, etc. Personnel shall be aware of, and not exceed, the limits for weight capacity and number of persons on the boat. A hand-held radio or cellular phone will be onboard to allow for direct communication to shore or the survey vessel. Under circumstances of potentially dangerous waves or winds, the Field Team Manager will employ best professional judgment to ensure safe field operations.

3.2.3 Environmental Exposure

Exposure to the elements and fatigue are two major causes of accidents onboard vessels. The sampling shifts may cover 10 hours or more and, in the marine environment, the weather can often be unpredictable. Working in rough waters can lead to seasickness, fatigue, and exposure. The combination of rough waters and fatigue increases the chances for a person-overboard situation. To prevent fatigue and overexposure in adverse weather conditions, field personnel will rotate tasks so that each person is periodically working inside the vessel's cabin. The frequency of the shift changes will be determined by the SHSO. Proper clothing will be brought to accommodate changes in weather.

Field work will be conducted during the spring or summer months when site personnel may be subject to the sun and high air temperatures. In these conditions, field teams must be prepared to wear proper protective clothing and to recognize symptoms of heat stress. Heat-related illnesses can occur at any time when protective clothing is worn. Workers wearing semi-permeable or impermeable encapsulating clothing (e.g., Tyvek) should be monitored for heat stress through regular checks of heart rate and by more comprehensive monitoring when the temperature in the work

area is above 21°C (70°F). A pulse rate in excess of 150 beats per minute may indicate heat exhaustion, although this rate will vary among workers. All personnel should know what their baseline pulse rate is before working in elevated temperatures, so as to monitor themselves. The SHSO will be trained in monitoring, treating, and recognizing the signs of heat stress. Heat stress can be manifested as both heat stroke and heat exhaustion:

- In **heat stroke**, the person's temperature control system that causes sweating stops working correctly. The body temperature rises so high that brain damage and death will result if the person is not cooled quickly. The main signs and symptoms of heat stroke are red or flushed, hot, dry skin, although the person may have been sweating earlier; and extremely high body temperature, often to 41°C (106°F). There may be dizziness, nausea, headache, rapid respiratory and pulse rates, and unconsciousness or coma.

  Treatment: Cool a victim of heat stroke quickly. If the body temperature is not brought down fast, permanent brain damage or death will result. Soak the person in cool but not cold water, sponge the body with rubbing alcohol or cool water, or pour water on the body to reduce temperature to a safe level - below 39°C (102°F). Then stop cooling and observe the victim for 10 minutes. If the temperature starts to rise again, cool the victim again. Do not give coffee, tea, or alcoholic beverages. When the victim's temperature remains at a safe level, get medical help immediately.

- **Heat exhaustion** is a state of very definite weakness or exhaustion caused by the loss of fluids from the body. This condition is much less dangerous than heat stroke, but it none the less must be treated. The major signs of heat exhaustion are pale, clammy skin, profuse perspiration, and extreme tiredness or weakness. The body temperature is approximately normal, pulse is weak and rapid, and breathing is shallow. The person may have a headache, dizziness, and may vomit.

  Treatment: Remove the person to a cool place, loosen clothing, place in a head low position and provide bed rest. Give a salt solution (1/2 teaspoon salt in 1/2 glass of water) every 15 minutes for three or four doses. Medical care is needed for severe heat exhaustion.

Heat Stress Monitoring and Work Cycle Management. For field activities that are part of ongoing site work activities in hot weather, the following procedures should be used to monitor the body's physiological response to heat, and to manage the work cycle, even if workers are not wearing impervious clothing. These procedures are to be instituted when the temperature exceeds 21°C (70°F).

1) Site workers will be briefed on the recognition and treatment of heat related illnesses. This training will include the signs, symptoms, and treatment of heat related illnesses.

2) Workers will be encouraged to drink a minimum of 16 ounces of liquids (water or electrolyte) prior to start of work in the morning, after lunch, and at end of work shift. Liquids containing caffeine should be avoided.

3) A shelter or shaded area will be provided where workers may be protected from sunlight during rest periods.

4) Monitoring of physiological heat stress will be performed using one of the two methods below to prevent and/or provide for early detection of heat induced stress:

   Measure Heart Rate. Heart rate should be measured by the radial pulse for 30 seconds before beginning work and as early as possible in the resting period. The heart rate at the beginning of the rest period should not exceed 100 beats/minute. If the heart rate is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 110 beats/minute at the beginning of the next rest period, the following work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 110 beats/minute.

   Measure Body Temperature. Body temperature should be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature at the beginning of the rest period should not exceed 37.4°C (99.40°F); if it does, the worker will be prohibited from continuing work until the oral temperature is maintained below 37.4°C (99.4°F).

   Manage Work/Rest Schedule. The following work/rest schedule shall be used as a guideline. Level D protection gear is anticipated. Therefore, this guideline should be considered conservative.

Adjusted Temperature (°F)	Active Work Time (min/hr) Using Level B/C Protective Gear
75 or less	50
80	40
85	30
90	20
95	10
100	0

Calculate the adjusted temperature:
T (adjusted) = T (actual) + (13 x fraction sunshine)

Measure the air temperature with a standard thermometer. Estimate fraction of sunshine by judging what percent the sun is out:

- 100-percent sunshine = no cloud cover = 1.0;
- 50-percent sunshine = 50 percent cloud cover = 0.5;
- 0-percent sunshine = full cloud cover = 0.0

Reduce or increase the work cycle according to the guidelines under heart rate and body temperature.

4.0 HAZARD MONITORING AND CONTROL

4.1 Training

All SAIC and subcontractor personnel and visitors who enter contamination reduction or exclusion zones (as described below in Section 4.5) at the Palos Verdes site must have the required training and/or documented equivalent experience. This includes any intrusive sampling activities, which consist of the sediment coring and processing. The SPI camera work will not be considered intrusive sampling, so long as any sediment adhering to the camera frame is rinsed off prior to bringing the camera on the vessel deck. Any personnel involved in any intrusive sampling activities for this program must have completed the 40-hour hazardous waste site training, annual 8-hour refresher courses as applicable and appropriate medical monitoring in accordance with CFR 1910.120. At a minimum, one SAIC personnel having completed the 8-hour supervisor training course will be on-site during intrusive sampling and processing operations. All personnel requiring this training will have documented on-site supervision for a period of three days or will work under direct supervision by a qualified individual for the first three days of the field effort. The barge/dredge vessel will not be considered a contamination reduction or exclusion zone as no hazardous material will be encountered. Therefore, any personnel or visitors onboard the barge/dredge vessel will not require the above training.

All SAIC and subcontractor personnel and visitors will be briefed on site-specific conditions during a one-time safety meeting to be conducted before commencement of each field program effort at the Palos Verdes site. It is anticipated that the baseline monitoring program will require the rotation of personnel due to the logistics of placing survey personnel on-site for extended periods of time. Additionally, at least two personnel with first aid and CPR certifications will be on-site during sampling and processing operations. Training certifications will be kept on file on-site and at the employee's home SAIC office. The Project Safety Officer and Site Safety Officers will be responsible for ensuring any new (rotated) personnel receive the initial one-time safety meeting before beginning work on-site. The following checklist will be used by the Project Safety Officer and Site Safety Officers for these safety meetings.

<u>Site Review and Work Plan</u>

- Area maps
- Pertinent site history
- Work description

<u>General Field Safety Techniques</u>

- Responsibilities
- Medical program
- Site control zones
- Potential hazardous contaminants present at the project site, chemical hazards at specific sites, and chemicals brought on-site (toxicity and symptomatology)
- Occupational exposure limits and action levels

- Use of field equipment and supplies
  - Coring equipment
  - Work tools
  - Survey equipment
  - Monitoring equipment
- Site control and security
- Buddy system
- Work limitations
  - Hours of work
  - Light conditions
  - Weather (including heat stress and cold stress)

Personal Protective Equipment and Clothing

- General
  - Work clothing
  - Eye protection
  - Foot protection
  - Head protection
  - Hearing protection
- Decontamination of clothing and equipment
- Disposal of contaminated clothing and equipment

Emergency Procedures

- Availability of emergency services and location of telephone numbers
- Transportation of emergency cases
- First aid/cardiopulmonary resuscitation
- On-site emergency assistance and review of hand signals
- Fire/explosion prevention and control

4.2 Personal Protective Clothing and Equipment

All scientific members are required to wear rain gear or tyvek, rubber steel-toed boots, safety glasses, and nitrile gloves (modified Level D) when performing intrusive activities (sediment sampling and processing), and while using hydrochloric acid, hexane, or methanol for decontaminating equipment. These requirements will also apply to all scientific members working in the core processing area. At a minimum, rubber steel-toed boots are required for performing non-intrusive activities (side-scan sonar, sub-bottom profiling surveys, and SPI camera work). A hard hat is required when an overhead hazard exists (e.g., deploying and retrieving sampling equipment). All field members performing sample handling and equipment decontamination activities must have available a half-mask or full-face respirator equipped with organic vapor cartridges and P-95 filters. The use of respirators during sediment sampling and processing is not expected to be required unless instructed by the SHSO. Coast Guard-approved flotation vests must be available for all crew while on the sampling vessel. Use of flotation vests will be directed by the SHSO, under circumstances of potentially dangerous waves or winds.

Visiting personnel will not require the PPE specified for scientific members (modified Level D) unless entering the exclusion zone or contamination reduction zone (CRZ) described in Section 4.5. Visiting personnel may wish to have available rain gear, rubber steel-toed boots, safety glasses, protective gloves, and a hard hat, depending on the anticipated hazards for the specific areas that they will be visiting.

Each field member is expected to bring clothing appropriate to the weather and task to minimize the hazards of exposure and heat or cold stress. Boots and rain gear or other waterproof clothing are required (or will be available), while sampling on the vessel.

Each field member is required to inspect his or her PPE for proper functioning (e.g., for leaks, tears, holes, missing fasteners, etc.) on a daily basis and to report any malfunctions to the SHSO. The SHSO shall maintain a record of any such malfunctions in order to monitor the effectiveness of the PPE program.

Additional safety supplies to be placed in the vehicles onshore, and on the vessels include: first-aid kit, eye wash, blanket, clean water, and ABC type fire extinguisher (minimum 20 pounds charged weight). Safety equipment and operating procedures required by the U. S. Coast Guard will be followed on the vessel.

4.3 Medical Surveillance

All scientific crew involved with intrusive sampling will have the appropriate medical monitoring, performed by or under the supervision of a certified occupational medical physician, in accordance with CFR 1910.120 for this program. No site-specific medical monitoring is required.

4.4 Monitoring Equipment and Procedures

It is not anticipated that any monitoring for volatile organic compounds will be required for the baseline monitoring program. However, monitoring of organic vapors will initially be conducted using an H-Nu photoionization detector. Measurements of organic vapors will be compared to background readings taken before sediments are processed. The organic vapor action level for field activities is 10 ppm above background in the breathing zone for 5 minutes or longer. If there is no indication of the presence of organic vapors based on this initial monitoring, no further monitoring for organic vapors will be required. Hydrogen sulfide may be encountered in the sediments, and will also be initially monitored, using a direct reading instrument or colorimetric indicating tube. If a hydrogen sulfide concentration greater than 5 ppm is detected in the breathing zone at any time, work shall be temporarily halted until hydrogen sulfide levels subside. After work continues, monitoring frequency will be increased. If there is no indication of the presence of hydrogen sulfide based on this initial monitoring, no further monitoring for

hydrogen sulfide will be required. Exposure to chemicals used during decontamination will be minimized, as decontamination activities will be performed outdoors where fresh air is being exchanged over the work area.

4.5 Site Control Measures

Three work areas—an exclusion zone, a contamination reduction zone (CRZ), and a support zone—will be established at each activity site. This procedure will help minimize the number of personnel in the work area, ensure that personnel are properly protected against the hazards present where they are working, and ensure that work activities and contamination are appropriately confined.

Exclusion Zone

The exclusion zone is the area where contamination does or could occur. The seafloor of Palos Verdes defines the exclusion zone for this project. During intrusive sampling, the exclusion zone also includes the area of the vessel in which sediments collected from the seafloor are handled. This part of the vessel is designated as the exclusion zone only when sediment is being handled on the vessel. When no sediment is onboard, the entire vessel is considered the support zone. Also, if sediment processing is performed onshore, an area (to be determined) of the shore processing area will be designated as the exclusion zone. Only authorized field personnel will be allowed in the exclusion zone. The initial level of protection required may be adjusted by the SHSO as conditions change. The barge/dredge vessel will not be considered an exclusion zone, as no hazardous materials will be encountered.

Contamination Reduction Zone

The contamination reduction zone (CRZ) is the transition area between the contaminated area and the clean area. The CRZ during sediment sampling is the vessel deck, except as noted in the preceding paragraph. The CRZ during processing will be determined. Decontamination of both personnel and equipment will occur in this zone to prevent the transfer of chemicals of concern to the support zone.

Support Zone

The support zone is where all personnel will suit-up in specified PPE before entering the exclusion zone. The support zone will be located onshore in an area outside the CRZ, or in the cabin or holds of the vessel, or on the vessel deck when contaminated sediment is not on deck. The support zone includes storage areas for "clean" equipment and resting and eating facilities for personnel.

4.6 Decontamination Plan

Personnel

Personnel will be required to decontaminate any known or suspected contamination before food or drink breaks, and before leaving the exclusion zone on the vessel. Full decontamination includes the following:

- Equipment drop
- Tape removal
- Outer glove wash with Alconox™ and water rinse; removal and placement in plastic bag (processing operations only)
- Safety boot washdown, using scrub brushes, with Alconox™ and water
- Tyvek removal and disposal, or rain-slick washdown with Alconox™ and water (for breaks, Tyvek or rain slicks may be removed to the waist)
- Inner glove removal and disposal
- Hand and face wash
- Thorough wash and shower at end of day

The SHSO will monitor the decontamination methods to determine their effectiveness. A potable water supply, toilet facilities, and washing facilities will be available both at the shoreside facility (SCMI) and on the research vessel.

In case of an emergency, gross decontamination procedures will be speedily implemented if possible. If a life-threatening injury occurs and the injured person cannot undergo decontamination procedures without incurring additional injuries or risk, he or she will be transported, wrapped in plastic sheeting if time allows and if consistent with the injury. The medics and medical facility will be informed that the injured person has not been decontaminated, and will be provided information regarding the most probable chemicals of concern.

Sampling Equipment

Intrusive sampling equipment will be decontaminated prior to initiation of sampling and between sampling locations. Decontamination methods described in the Field Sampling Plan will be used by field personnel prior to initialization of sampling and between sampling locations. Decontamination of intrusive sampling equipment (pans, utensils, etc.) and samplers used in this investigation may involve a combination of Alconox™ detergent, tap water, methanol, hexane, and hydrochloric acid.

4.7 Communication

A hand-held radio and/or cellular telephone will be on-board any vessels used, and on-site at a designated area onshore, to allow for direct communication to shore or to a vessel. Pertinent telephone numbers will be provided to all site and project personnel prior to initiation of field work.

4.8 Investigation-Derived Waste Management Plan

The control of investigation-derived wastes will be performed in accordance with the measures outlined in Section 5.0 of the Field Sampling Plan. It is expected that only unused site materials and decontamination reagents will be generated as waste. Excess sediments and other site-derived material not needed for analysis will be collected and retained in sealed and labeled containers. Spent decontamination reagents (hexane, methanol, and hydrochloric acid) will be collected and retained in sealed and labeled containers. These chemicals will be stored onsite at the SCMI facility. Hexane and methanol may be stored in the same container, and hydrochloric acid will be stored separately. It is anticipated that the hexane and methanol waste will be combined with appropriate waste streams at the SCMI facility and disposed of accordingly. The hydrochloric acid waste will be diluted and neutralized before disposing of at the SCMI facility.

4.9 Other Hazard Control Measures

Personnel will only work during daylight hours, and no field activities will be scheduled during the period of thirty minutes before dusk to thirty minutes before dawn. Additional site- and situation-specific hazard control measures shall be identified and incorporated as revisions or addenda to this HSP, as required.

4.10 Enforcement of the Health and Safety Plan

To protect all personnel visiting SAIC site activities from any adverse health effects that may result from those site activities, all employees, contractors, and visitors to the SAIC work site are required to follow the requirements of this plan. All visitors to the site must be granted admission to the site by the USACE and SAIC project representatives. All personnel involved with the investigation will check in with the Field Manager prior to site entry. All personnel must provide their own necessary PPE as specified in this HSP or by the Project Safety Officer. All personnel visiting the investigation area will be briefed on this HSP, as described in Section 4.1. Visiting personnel will not require the PPE specified in Section 4.2 (modified Level D) unless they will be entering the exclusion zone or contamination reduction zone (CRZ) as described in Section 4.5. If visiting personnel enter the exclusion zone or CRZ, whether on a research vessel or onshore, the training and medical monitoring requirements outlined in Sections 4.1 and 4.3 will apply. All SAIC and subcontractor field personnel are required to sign their acknowledgment of the requirements herein. A copy of this health and safety plan shall be maintained in designated areas both on the sampling vessels and at the onshore worksite at all times.

4.10.1 Safety Rules

All personnel working in the field will follow the rules and procedures listed below:

1) Before any field operations take place, all project personnel must review this site Health and Safety Plan (HSP) and become familiar with the required safety procedures. The Site Safety Officer will review safety procedures with the field team at the initiation of field operations. Measures to ensure that the HSP is being followed will include workday safety meetings and inspections that include checklists and documentation procedures.

2) The Site Safety Officer will contact key emergency services prior to the start of sampling activities to establish final procedures to be used in case of an onboard emergency and to inform them of the activities being performed on-site and the associated potential problems. The U.S. Coast Guard will be kept informed of the research vessel(s) operations/locations.

3) Copies of this Health and Safety Plan will be available on board the vessels and in each field vehicle. A waterproof copy of the completed Emergency Contacts sections will be posted near the ship-to-shore radio or cellular telephone. In addition, a waterproof map of the site including waterways and associated piers will be posted in the same location.

4) The Site Safety Officer, in conjunction with the vessel operator, will continually monitor weather conditions (e.g., storm fronts, lightning, or high winds). A radio capable of receiving the National Weather Service frequency for the Palos Verdes area will be onboard or onshore and monitored periodically. The Site Safety Officer will have the responsibility and the authority to halt operations if conditions are deemed to be unsafe.

4.10.2 Safety Briefings

All personnel will be given a health and safety briefing prior to performing any on-site task. This initial briefing will include a rehearsal of the Emergency Response Plan that will consist of a verbal walk-through of an emergency situation (e.g., a physical injury), emergency response actions (e.g., administration of first aid), notification of emergency services (e.g., 9-1-1 system), and transport to medical facility.

In addition, periodic health and safety briefings will be conducted to remind personnel of the potential on-site hazards or as conditions change.

5.0 SPILL CONTAINMENT PLAN

It is anticipated that all chemicals brought onsite will be stored in plastic bottles placed in plastic bags. These bottles will be stored in labeled, spillproof containers with a lid, such as a 5-gallon bucket or a cooler. Site- and situation-specific spill containment measures shall be identified and incorporated as revisions or addenda to this HSP as required.

6.0 RECORDKEEPING

All revisions or addenda to this HSP will be documented in the project file and copies of all modifications will be maintained on the job site at all times. Appendix A contains the following Health and Safety forms relevant to this project:

Form 1: Signature Page

Form 2: Modification to the Health and Safety Plan

Form 3: Employee Exposure/Injury Incident Report

Form 4: Daily Safety Inspection

Form 5: Hazardous Waste Site Task/Project Debriefing Questionnaire

The Site Health and Safety Officer will be responsible for completing these forms as necessary, and for forwarding all health and safety information pertinent to the project to the project manager and project safety officer. Form 5 will be completed by the Project Health and Safety Officer (or individual designated by the Project Manager) and reviewed by the Project Manager or other cognizant management within 30 days of the date of last activity at a site. Copies of all forms completed will be kept in the project file.

7.0 EMERGENCY RESPONSE PLAN

For all Health and Medical Emergencies, Notify the On-site SAIC Health and Safety Officer and Field Manager or Vessel Operator. Following an emergency, the SHSO will report incidents to Local, State, and other authorities, as appropriate. The SHSO will also provide an evaluation and critique the emergency response actions to the SAIC field and project managers.

SAIC PROJECT MANAGER:	Dr. Scott McDowell
Phone numbers:	(401) 847-4210 (office) (401) 683-7998 (home) (401) 864-1915 (cell)
SAIC FIELD TEAM MANAGER:	John Evans
SAIC PROJECT HEALTH AND SAFETY OFFICER:	John Nakayama
CLIENT CONTACT:	Ms. Eleanor Nevarez
CLIENT PHONE NUMBER:	(626) 401-4045
SITE PHONE NUMBER:	(310) 519-3172 (SCMI)
Personal Injury or Illness:	Administer First Aid Call Ambulance If necessary, transport to hospital See Emergency Medical Care and Procedures

Fire or Explosion: Turn off all motorized equipment; evacuate the work area; meet at designated upwind assembly area.

Hazardous Material Spill or Release: Turn off all motorized equipment; evacuate the work area in a direction upwind of the spill or release; meet at designated upwind assembly area; contact appropriate response personnel as necessary.

Person Overboard: Stop the vessel immediately. Turn off all motorized equipment, and cease all non-rescue activities. Flotation devices attached to lines will be thrown to the victim from the vessel. Keep the victim in sight as long as possible. No other person(s) shall enter the water except if the victim is unconscious or seriously injured. Rescuers must wear life preservers and be tethered to the research vessel. The victim will then be brought aboard the vessel; wet clothes will be removed and replaced with dry clothing. In the event the victim is injured or unconscious, activate the emergency medical alert system (911) and/or notify the U.S. Coast Guard.

Equipment Failure: If any other equipment on-site fails to operate properly, the Field Manager and SHSO shall be notified and they shall determine the effect of this failure on continuing operations on-site. If the failure affects the safety of personnel or prevents the proper completion of the tasks described in the work plan, all operations will be secured and all personnel shall cease activities until the situation has been evaluated and appropriate actions taken.

8.0 EMERGENCY MEDICAL CARE AND PROCEDURES

For all Health and Medical Emergencies, Notify the On-site SAIC Health and Safety Officer, Field Manager, or Vessel Operator

SAIC PROJECT MANAGER:	Dr. Scott McDowell
FIELD TEAM MANAGER:	John Evans
SAIC PROJECT HEALTH AND SAFETY OFFICER:	John Nakayama
CLIENT CONTACT:	Ms. Eleanor Navarez
CLIENT PHONE NUMBER:	(626) 401-4045
SITE PHONE NUMBER:	(310) 519-3172 (SCMI)

Nearest Emergency Medical Facility:
Local urgent care and emergency medical services are located within 15 miles of the Southern California Marine Institute. Four facilities capable of taking personnel for job-related injuries (two urgent care and two after hours/emergency room) are identified below. Additionally, these facilities have been approved for University and foundation employees.

Urgent Care Facilities

Mulliken Medical Center
5000 Airport Plaza Drive
Lakewood, CA
310.497.4759
8:00 am through 5:00 pm
Distance from SCMI: 13.50 miles

Long Beach Memorial Occupational Medical Services
450 East Spring Street
Long Beach, CA
310.933.0085
8:00 am through 11:00 pm
Distance from SCMI: 8.91 miles

After Hours/Emergency Room

Long Beach Community Medical Center
1720 Termino Ave.
Long Beach, CA
310.498.1000
All Hours
Distance from SCMI: 10.09 miles

Long Beach Memorial Medical Center
2801 Atlantic Ave.
Long Beach, CA
310.933.2000
All Hours
Distance from SCMI: 8.75 miles

Driving directions to the above facilities are on the following pages.

Emergency Phone Numbers:

Police Department, Emergency	911
Fire Department, Medical Emergency	911
U.S. Coast Guard	TBD

Emergency First Aid Procedures for Substances Present:
See attached data sheets for specific symptoms and treatments.

First Aid Equipment On-Site: (Placed in accessible area outside of the Work Zone)
First Aid Kit, Cellular Telephone, Fire Extinguishers (minimum of two), a portable eye wash capable of providing 15-minutes of uninterrupted water flow, Cool water/fluids (2 gallons/person/day)

Mulliken Medical Center

From:	SCMI 820 S Seaside Ave Long Beach, CA 90815-1260	To:	Mulliken Medical Center 5000 Airport Plaza Dr Lakewood, CA 90731-7330 310.497.4759

Your trip's estimated travel time is 20 minutes for 13.50 miles of travel, total of 15 steps.

These driving directions are provided only as a rough guideline. Please be sure to call ahead to verify the location and directions.

1) Begin at 820 S Seaside Ave on S Seaside Ave and go Northwest for 0.1 miles.

2) Turn right on Terminal Way and go Northeast for 0.5 miles.

3) Turn left on Earle St and go North for 0.4 miles.

4) Bear right on N Seaside Ave and go Northeast for 0.2 miles.

5) Turn right on Ferry St and go Southeast for about 100 feet.

6) Turn left on ramp and go Northeast for 0.4 miles.

7) Continue on CA-47 and go Northeast for 1.2 miles.

8) Continue on W Ocean Blvd and go East for 1.5 miles.

9) Continue on ramp and go Northeast for 0.7 miles.

10) Continue on I-710, Long Beach Fwy and go North for 3.5 miles.

11) Continue on ramp and go East for 0.8 miles.

12) Continue on I-405, San Diego Fwy and go East for 1.7 miles.

13) Bear right on ramp at sign reading "Spring St to Cherry Ave" and go East for 0.5 miles.

14) Turn left on E Spring St and go East for 1.7 miles.

15) Turn right on Airport Plaza Dr and go South for 0.2 miles to 5000 Airport Plaza Dr.

Long Beach Memorial Occupational Medical Services

From: SCMI
820 S Seaside Ave
Long Beach, CA 90806-1624

To: Long Beach Memorial Occupational
Medical Services
450 E Spring St
Long Beach, CA 90731-7330
310.933.0085

Your trip's estimated travel time is 15 minutes for 8.91 miles of travel, total of 12 steps.

These driving directions are provided only as a rough guideline. Please be sure to call ahead to verify the location and directions.

1) Begin at 820 S Seaside Ave on S Seaside Ave and go Northwest for 0.1 miles.

2) Turn right on Terminal Way and go Northeast for 0.5 miles.

3) Turn left on Earle St and go North for 0.4 miles.

4) Turn left on Altoona Pl and go Northwest for about 300 feet.

5) Turn right on Ocean Ave and go Northeast for 0.5 miles.

6) Continue on New Dock St and go Northeast for 1.4 miles.

7) Turn left on ramp and go North for 0.2 miles.

8) Continue on Terminal Island Fwy and go North for 3.2 miles.

9) Continue on ramp at sign reading "Carson/Long Beach" and go North for about 200 feet.

10) Turn right on W Willow St and go East for 1.5 miles.

11) Turn left on Pacific Ave and go North for 0.5 miles.

12) Turn right on W Spring St and go East for 0.3 miles to 450 E Spring St.

Long Beach Community Medical Center

From: SCMI
820 S Seaside Ave
San Pedro, CA 90731-7330

To: Long Beach Community Medical Center
1720 Termino Ave
Long Beach, CA 90804-2104
310.498.1000

Your trip's estimated travel time is 17 minutes for 10.09 miles of travel, total of 11 steps.

These driving directions are provided only as a rough guideline. Please be sure to call ahead to verify the location and directions.

1) Begin at 820 S Seaside Ave on S Seaside Ave and go Northwest for 0.1 miles.

2) Turn right on Terminal Way and go Northeast for 0.5 miles.

3) Turn left on Earle St and go North for 0.4 miles.

4) Turn left on Altoona Pl and go Northwest for about 300 feet.

5) Turn right on Ocean Ave and go Northeast for 0.5 miles.

6) Continue on New Dock St and go Northeast for 1.4 miles.

7) Turn left on ramp and go North for 0.2 miles.

8) Continue on Terminal Island Fwy and go Northeast for 2.0 miles.

9) Continue on ramp and go Northeast for 0.3 miles.

10) Bear right on CA-1,W Pacific Coast Hwy and go East for 4.4 miles.

11) Turn right on Termino Ave and go South for about 500 feet to 1720 Termino Ave.

Long Beach Memorial Medical Center

From: SCMI
820 S Seaside Ave
San Pedro, CA 90731-7330

To: Long Beach Memorial Medical Center
2801 Atlantic Ave
Long Beach, CA 90806-1737
310.933.2000

Your trip's estimated travel time is 15 minutes for 8.75 miles of travel, total of 12 steps.

These driving directions are provided only as a rough guideline. Please be sure to call ahead to verify the location and directions.

1) Begin at 820 S Seaside Ave on S Seaside Ave and go Northwest for 0.1 miles.

2) Turn right on Terminal Way and go Northeast for 0.5 miles.

3) Turn left on Earle St and go North for 0.4 miles.

4) Turn left on Altoona Pl and go Northwest for about 300 feet.

5) Turn right on Ocean Ave and go Northeast for 0.5 miles.

6) Continue on New Dock St and go Northeast for 1.4 miles.

7) Turn left on ramp and go North for 0.2 miles.

8) Continue on Terminal Island Fwy and go North for 3.2 miles.

9) Continue on ramp at sign reading "Carson/Long Beach" and go North for about 200 feet.

10) Turn right on W Willow St and go East for 1.8 miles.

11) Turn left on N Long Beach Blvd and go North for 0.2 miles.

12) Turn right and go East for 0.3 miles to 2801 Atlantic Ave.

9.0 PLAN APPROVALS

This site-specific health and safety plan has been written for the use of SAIC and its subcontractor(s)' project personnel. The project team claims no responsibility for its use by others. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if these conditions change.

PLAN PREPARED BY:	Mary K. S. Hubbard SAIC Marine Chemist
DATE:	March 17, 2000

PLAN APPROVED BY:

DATE:

10.0 REFERENCES

Palermo, M., P. Schroeder, Y. Rivera, C. Ruiz, D. Clarke, J. Gailani, J. Clausner, M. Hynes, T. Fredette, B. Tardy, L. Peyman-Dove, and A. Risko. 1999. Options for In-Situ Capping of Palos Verdes Shelf Contaminated Sediments. Technical Report EL-99-2. U.S. Army Corps of Engineers Waterways Experiment Station. 60 p. + figures and appendices.

APPENDIX A

HEALTH AND SAFETY FORMS

FORM 1

SIGNATURE PAGE

THIS HEALTH AND SAFETY PLAN APPLIES TO THE EMPLOYEES OF SAIC AND ITS SUBCONTRACTORS WHILE WORKING ABOARD THE RESEARCH VESSEL, PERFORMING MONITORING ACTIVITIES, AND WHILE PROCESSING SEDIMENTS. THE SAIC SITE SAFETY OFFICERS, SAIC PROJECT MANAGER, AND EVERY MEMBER OF THE FIELD INVESTIGATION TEAM ARE RESPONSIBLE FOR THE IMPLEMENTATION OF THIS HEALTH AND SAFETY PLAN. SAIC WILL PROVIDE A COPY OF THE HEALTH AND SAFETY PLAN TO ALL SAIC PERSONNEL AND ITS SUBCONTRACTORS, AND REQUIRES ALL PERSONNEL TO FOLLOW THESE PROTOCOLS.

Prepared by:

Name (Print)	Signature	Title	Date

Approved by:

Name (Print)	Signature	Title	Date

We, the undersigned, have read this Site Health and Safety Plan and will institute the provisions and abide by the requirements contained herein for the duration of this program. Failure to comply with these requirements may lead to disciplinary action and/or dismissal from the work site.

Name (Print)	Signature	Title	Date

FORM 2

MODIFICATION TO HEALTH & SAFETY PLAN
PALOS VERDES BASELINE MONITORING
DATE ___/___/___

Modification:_____

_____

_____

_____

Reason for Modification:_____

_____

_____

_____

Site Personnel Briefed:

Name:_____Date:_____

Name:_____Date:_____

Name:_____Date:_____

Name:_____Date:_____

Name:_____Date:_____

Name:_____Date:_____

Name:_____Date:_____

Name:_____Date:_____

Name:_____Date:_____

Name:_____Date:_____

Name:_____Date:_____

Name:_____Date:_____

<u>Approvals</u>

Site Safety Officer:_____

Project Safety Officer:_____

Project Manager:_____

Others:_____

FORM 3

EMPLOYEE EXPOSURE/INJURY INCIDENT REPORT

(Use additional page if necessary)

Date:_____Time:_____

Name:_____Employer:_____

Site Name and Location:_____

Site Weather (clear, rain, snow, etc.):_____

_____

Nature of Illness/Injury:_____

Symptoms:_____

Actions Taken: Rest:_____First Aid:_____Medical:_____

Transported By:_____

Witnessed By:_____

Hospital's Name:_____

Treatment:_____

Comments:_____

What was the person doing at the time of the accident/incident?_____

_____

Personal Protective Equipment Worn:_____

_____

Cause of Accident/Incident:_____

_____

What immediate action was taken to prevent recurrence?_____

_____

Additional Comments:_____

_____

Employee's Signature:

_____

Date

Supervisor's Signature:

_____

Date

Site Safety Representative's Signature

_____

Date

FORM 4

DAILY SAFETY INSPECTION

DAILY SAFETY INSPECTION	YES	NO	N/A
1. Access logs for the previous day were reviewed and the safety briefing acknowledgement form was signed by each new employee and visitor.			
2. Training documents and evidence of medical exams are in file for each new employee and/or visitor, where required.			
3. Workers in the exclusion zone are wearing the respiratory protective clothing specified in the HSP for the task they are performing.			
4. Workers in the exclusion zone are wearing the type of protective clothing specified in the HSP for the task they are performing.			
5. Protective clothing in use is free of visible contamination or defects.			
6. In hot weather, heat stress is monitored as specified in the "Physical Hazards" section of the HSP and appropriate work/rest schedules are followed.			
7. An adequately stocked first aid kit is available at each work location.			
8. A full-charged 20 lb.-ABC fire extinguisher is available at each work location.			
9. Radio and/or cellular telephone communication equipment is functioning properly.			
10. Deficiencies observed in previous inspection have been corrected.			
11.			
12.			
Use the space below to list any deficiencies and corrective actions taken:			
Inspection performed by:_____Date:			

FORM 5

HAZARDOUS WASTE SITE TASK/PROJECT
DEBRIEFING QUESTIONNAIRE

The purpose of this questionnaire is to serve as a checklist for documenting a formal review of environmental compliance and health and safety (EC&HS) status upon completion of a field effort at a hazardous waste site. This form is to be prepared by the Project Safety Officer (or individual designated by the Project Manager) and reviewed by the Project Manager or other cognizant management within 30 days of the date of last activity at a site.

1. Site Name:_____

2. Applicable SSHSP (title, date):_____

   _____

3. Duration of site work covered by this debriefing:

   Start Date:_____ Completion Date:_____

4. List SAIC Employees who worked at this site:

Name	Employee No.	Name	Employee No.
1.		6.	
2.		7.	
3.		8.	
4.		9.	
5.		10.	
Attach additional list on reverse of this page.			

5. List of subcontractors to SAIC who worked at this site:

Subcontractor Name	Address	Task

6. Were there any accidents or injuries involving SAIC or SAIC subcontractor personnel that required medical treatment? (Yes/No)

   If yes, give names of individual(s), date(s) of injury, and attach a copy of the supervisor's accident investigation report:

Name	Date	Employer

7. Did the subcontractors comply with applicable health and safety requirements? (Yes/No)

   If no, give details:_____

8. Were there any unplanned releases of contaminated material to the environment (spills to navigable water, non-compliant discharges to a POTW)? (Yes/No)

   If yes, what notifications were made (e.g. National Response Center, client, EPA, or State Agency)? Attach relevant correspondence.

9. Were employee exposures to chemical hazards monitored? (Yes/No)

   If yes, complete the following:

   A. Monitoring using OVA or H-Nu Instrument:

   Action level stated in the SSHSP:_____

   Was action level ever exceeded? (Yes/No)

If yes, indicate date(s) and action taken:

Date	Action

B. Monitoring using chemical-specific devices (such as Draeger tubes, H_sS monitor, samples collected for laboratory analysis):

Substance Measured	PEL	BZ or Area	Lowest Measured Exposure	Highest Measured Exposure	Respiratory Protection Used (Yes/No)

Comments:_____

10. A. Were employee exposures to noise measured at this site? (Yes/No)
    If yes, attach applicable reports.

    B. List significant sources of noise (indicate type of drill rig, compressors, pumps, and other noise generating equipment)
    1. _____
    2. _____
    3. _____
    4. _____

    C. Was hearing protection required? (Yes/No)
    If hearing protection was required, was it provided? (Yes/No)

D. Was the use of hearing protection in high noise areas enforced? (Yes/No)

11. Were radiation hazards monitored at the site?

If yes, complete the following:

Types of radiation:_____alpha_____beta_____gamma

Isotopes:_____

_____

Airborne radioactive contamination_____

Non-airborne radioactivity (fixed contamination, sealed sources, etc.)_____

_____

Cumulative radiation doses for site workers by job category (i.e., rig geologist, supervisor, field technician, visitors, subcontractors, other):

Job Category	**Cumulative Dose (millirem)**	**Number of Employees per Category**

12. Were any unusual conditions encountered at the site? (Yes/No)

If yes, please explain:_____

_____

_____

_____

_____

_____

13. Describe any lessons learned at this site, regarding hazard identification and control that should be communicated to other SAIC personnel working at hazardous waste sites_____

_____

_____

_____

_____

Prepared By:_____ **Reviewed By:**_____

Date:_____ **Date:**_____

APPENDIX B

MATERIAL SAFETY DATA SHEETS

APPENDIX C

OCCUPATIONAL HEALTH GUIDELINES