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SAMPLING & ANALYSIS PLAN
FOR
SEDIMENT CHARACTERIZATION AT PIER D

U.S. NAVY PUGET SOUND SHIPYARD
BREMERTON, WASHINGTON

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TABLE OF CONTENTS

Table of Contents (Continued)

Table of Contents (Continued)

LIST OF FIGURES AND TABLES: **Page**

1.0 INTRODUCTION

1.1 Project Description. The U.S. Navy Puget Sound Naval Shipyard, Bremerton, WA, proposes to upgrade Pier D in Sinclair Inlet (see vicinity and location maps, Figures 1 and 2) to provide flexibility to homeport the following vessel mooring combinations: two AOE Class vessels; one CVN-68 (NIMITZ-size carrier) and one AOE; one CVN-68 and two smaller class (DDG or FFG) ships; or two CVN-68's. This project includes dredging two mooring basins: one along each side of Pier D. Each mooring basin will be 158-ft. wide by 1050 ft. along the pier and dredged to a design depth of -49.4 ft., MLLW (45 ft. navigation depth at Extreme Low Water, ELW = -4.4 ft., MLLW) (see Figures 4 and 5). Existing bottom depths are on the order of -40 ft. Estimated total dredging quantity for both basins is approximately 170,400 cyds, including side slopes and one-foot overdepth.

Dredging will be by clamshell and barge. Depending on the results of PSDDA sediment characterization proposed in this sampling plan, disposal will be either inwater to the PSDDA Elliott Bay site by bottom dump barge, or upland to the Kitsap County landfill (Olympic View Landfill) by offloading and truck haul. It is possible that each site may receive some of the dredged materials.

1.2 Sediment Description. PSDDA guidance identifies Sinclair Inlet as an area of high concern for sediment contamination. Limited available data show that sediments to be dredged at Pier D consist of a 2 to 4 ft. surface layer of black, soft silts and fine sands (mud) overlying a more dense, gray silty fine-to-medium sand. A pilot sediment characterization study at Pier D was conducted for the Navy in 1989 (see APPENDIX A). Results indicated that PSDDA screening levels (SL's) were marginally exceeded for some parameters in each of four representative surface layer composite samples, and that maximum levels (ML's) were exceeded at one station for DDT and for silver. Based on these limited results, the Navy proposes to conduct a comprehensive sediment characterization program by collecting and analyzing representative core samples in accordance with PSDDA requirements for each of the two mooring basins to be dredged. The tiered chemistry/biological testing approach will be used. These results will be provided to the PSDDA agencies as the basis to identify the acceptable disposal option(s).

The Pier D area was last dredged in the mid-1940's to a design depth of -40 ft., MLLW, as part of an area-wide dredging project for the Navy shipyard. The most recent hydrographic survey (GeoMetrics-November 1990) shows that less than four feet of infill has since occurred.

1.3 Site History. The upland area directly north of Pier D was purchased by the Navy in 1891 as part of the original purchase for the Shipyard, however the original development of the industrial area of the Shipyard began about a mile east of this site.

Between 1910-1923 fill extended the natural shoreline to the currently existing quay wall at the head of Pier D. The area was beginning to be developed by this time, with a coaling pier in use about 200 ft. east of Pier D and commercial oil tank farms in use on property northwest of the Shipyard about 1000 ft. This property was later purchased by the Shipyard in 1942 and used for barracks, steel storage and parking.

The fill area directly north of Pier D became heavily used for storage/support functions by the 1930's and these uses continue to this day but are not major sources of contamination. The major industrial activity of the Shipyard is still located from 1500 ft. to over a mile from Pier D.

In 1946, an area along the entire west shoreline of the Shipyard was dredged to -40 ft., MLLW, to allow use of this area as inactive ship storage. Pier D, along with Pier B and Moorings A, E ,F and G, were constructed in 1947 for this purpose.

This area continues to be used for the storage of inactive ships with associated minor maintenance and painting activities. The Navy has, however, never used tributyltin as an antifouling agent during any of its painting activities at the Bremerton shipyard. Analysis for tributyltin therefore should not be necessary.

Historical site uses and possible sources of past contamination are shown in Figure 3. There are no active sources, such as stormwater outfalls, in the immediate vicinity of Pier D.

1.4 Permitting. A permit application for Pier D dredging and disposal was submitted by the Navy to US Army Corps of Engineers, Seattle District, in April 1989 (Application No. OYB-1-012791, see APPENDIX A). Permitting actions required include a Corps of Engineers Section 10/404, State of Washington Hydraulic Project Approval and Section 401 Water Quality Certification, City of Bremerton Shorelines Development permit and a DNR Open-water Disposal Site Use permit. Designation of acceptable disposal site(s) based on results of sediment characterization proposed herein is a critical remaining element prior to final project design and permit applications.

An EIS for the proposed Pier D upgrade project, including dredging and disposal, is being prepared by the Navy (AOE Homeporting EIS).

INSERT FIGURE 1 HERE

INSERT FIGURE 2 HERE

INSERT FIGURE 3 HERE

2.0 PROGRAM OBJECTIVES AND CONSTRAINTS

The sediment characterization program objectives and constraints are summarized below:

- To characterize sediments to be dredged in conformance with PSDDA requirements to enable the PSDDA agencies to designate approved disposal option(s);

- To optimize the prospect of identifying all Dredged Material Management Units acceptable for disposal at the Elliott Bay PSDDA disposal site while assuring that unacceptable sediments are disposed of at an approved upland site.

- To collect, handle and analyze representative sediment core samples characterizing the full dredging prism in accordance with protocols, timing, and QA/QC requirements outlined in the PSDDA Evaluation Procedures Technical Appendix (June 1988), the updated procedures documented in Chapter 5 and Appendix A of the PSDDA Phase II Management Plan Report (September, 1989), modifications made through the PSDDA and Sediment Management Annual Review Process and procedures presented in PSEP Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound.
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3.0 PROJECT TEAM AND RESPONSIBILITIES

The sediment characterization program will include 1) project planning and agency coordination, 2) field sample collection, 3) laboratory preparation and analysis, 4) QA/QC management and 5) final data report. Staffing and responsibilities are outlined below:

3.1 Project Planning and Coordination. Mr. Peter Ramsey, US Navy Field Engineering Station, Silverdale, WA, will be the overall project manager responsible for developing and completing the sampling program. As the applicant's principal representative he will also provide the primary contact for PSDDA agencies. John Torres, ProTech Consulting, Seattle, WA will assist Mr. Ramsey in technical matters pertaining to the sediment characterization plan and program and its relation to dredging and disposal methods. Following plan approval by the PSDDA agencies, Mr. Torres will be responsible for monitoring and administrative coordination to assure timely and successful completion of the project. Mr. Torres will provide a copy of the approved sampling plan along with the PSDDA-agency approval letter to all sampling and testing subcontractors. Any significant deviation from the approved sampling plan will be coordinated with the Dredged Material Management Office.

3.2 Field Sample Collection. Mr. Jim Bailey, GeoMetrics, Tacoma, WA, will provide overall direction to the field sampling and laboratory analysis programs in terms of logistics, personnel assignments, field operations and analytical laboratory selection. Mr. Brad Smaller, GeoMetrics, will supervise field collection of the sediment core samples. Mr. Smaller will also be responsible for assuring accurate sample positioning; recording sample locations, depths and identification; assuring conformance to sampling and handling requirements including field decontamination procedures; photographing, physical evaluation and logging the samples; and for chain-of-custody of the sample cores until they are delivered to GeoMetrics's sample preparation laboratory.

3.3 Laboratory Preparation and Analyses. The delivered core samples will be physically evaluated, composited and placed in appropriate sample containers by Mr. Jim Bailey or Mr. Brad Smaller and assistants at the GeoMetrics sample preparation laboratory. Appropriate protocols for decontamination, sample preservation and holding times will be observed. Mr. Bailey will be responsible for documenting sample preparation, observations and chain-of-custody up until the time he delivers the samples for analyses to ChemTest, Inc., analytical laboratory in Bothell, WA. He will also instruct the analytical laboratory on the need to maintain required handling and analytic protocols including meeting PSDDA minimum detection limits. Mr. Bailey will ensure that bioassay and archived sediments are stored under proper conditions.

Mr. Mark Havey, Technical Director, at ChemTest will be responsible for physical and chemical analysis. ChemTest will handle and analyze the submitted samples in accordance with PSDDA analytical testing protocols and QA/QC requirements. A written report of analytical results and QA/QC procedures will be prepared by ChemTest and included as an appendix in the final report.

Mr. Timothy Michaels, BioScience, Inc., Edmonds, WA, will be responsible for the sediment bioassay analyses and reporting. BioScience will analyze the submitted samples in accordance with PSDDA biological testing and QA/QC requirements. A written report of analytical results

and QA/QC procedures will be prepared by BioScience and included as an appendix in the final report.

3.4 QA/QC Management. Ms. Julia Farr, GeoMetrics, will serve as Quality Assurance Representative for the sediment characterization project. She will perform assurance oversight for both the field sampling and laboratory programs. She will keep fully informed of field program procedures and progress during sample collection and laboratory activities during sample preparation. She will record and correct any activities which vary from the written sampling and analysis plans. She will also review the laboratory analytical and QA/QC data to assure that data is valid and procedures meet the required analytical quality control limits. Upon completion of the sampling and analytical program she will incorporate findings into a QA/QC report.

3.5 Final Data Report. Mr. Jim Bailey, GeoMetrics, will be responsible for preparation of the final sediment characterization report describing sample locations and depths; sampling, handling and analytical methods; QA/QC; and data results.

4.0 SAMPLE COLLECTION AND HANDLING PROCEDURES

4.1 Definitions. The following definitions apply to this sampling program:

- Dredging Prism: the entire volume of sediments to be dredged, including both (east and west) mooring basins, related side-slopes and one-foot overdepth (to -50.4 ft., MLLW).

- Sediment Bore: the entire cumulative length of sediment core extracted by the coring device. This extends from the sediment/water interface down to the total sampling depth of the hole. Each sediment bore is a sampling location identified by number on the sampling plan.

- Core Section: each core section is 4 feet long, except where the total sediment bore (length) leaves a core section less than 4 feet at the bottom of the dredging prism. Core sections for each sediment bore are designated alphabetically, beginning with "A" for the 4-foot surface layer and proceeding downward from the top in 4-foot increments...A, B, C, etc., to the bottom core section. Core sections are composited within Dredge Material Management Units for laboratory analyses.

- Dredged Material Management Unit (DMMU): the volume of dredged material for which a separate decision on suitability for unconfined open-water disposal can be made. DMMUs are typically represented by chemical and biological testing of a single sample, composited from one or more core sections within the DMMU.

- Surface Sediments: sediments located within a 4-foot thick surface layer. Surface sediment samples are represented by core sections designated by the capital letter "A".

- Subsurface Sediments: sediments located beneath the 4-foot layer of surface sediments. Subsurface sediment samples are represented by core sections designated by the capital letters "B", "C", etc.

- "Z" samples: sediments below the dredge prism which will be exposed by dredging and represent the surface that will remain when dredging is completed.

4.2 Number of Samples and Analyses Required. PSDDA ranks all of Sinclair Inlet, including the Pier D dredging area, as an area of high concern for sediment contamination. In accordance with PSDDA requirements, full sediment characterization requirements for a dredging area ranked high concern are outlined below:

Surface Sediments: (0 to 4 ft.)	One core section and one laboratory analysis for each 4000 cubic yards.
Subsurface Sediments: (> 4 ft.)	One core section for each 4000 cyds, and one laboratory analysis for each 12,000 cyds

The estimated total volume of materials to be dredged from both basins is 170,400 cyds, including one-foot overdepth. The quantity and related sampling requirements are distributed as follows:

Depth Interval	Volume (cu.yds.)	Minimum No. of Core Sections	Minimum No. of Analyses
0-4 ft.	77,600	20	20
>4 ft.	92,800	24	8 (composites)
	170,400 (Total)		

4.3 Conceptual Dredging Plan, Sampling and Compositing Scheme. The sampling and analysis program is developed with consideration of site-specific project and environmental factors. A key requirement is assuring that if an individual DMMU (represented by one or more core sections) is found unsuitable for unconfined open water disposal, then that unit can be feasibly dredged independently from surrounding clean sediments so that the contaminated material can be disposed of at an alternate approved upland site. The sampling program for the Pier D dredging project was developed as follows:

- Prepare Conceptual Dredging Plan. Criteria for a dredging plan were established for this site based on the depth and physical characteristics of the sediments, the dredge layout plan including side slopes, appropriate dredging methods and equipment, and conventional construction practices at similar dredging projects in Puget Sound.

- Prepare Sampling Scheme. Basic criteria for selecting sampling locations and compositing for analysis are contained in PSDDA guidance documents relative to sediment volumes to be characterized. The approach is to delineate sediment sampling grid units as basic building blocks for identifying DMMUs capable of being dredged independently.

- Integrate the dredging plan with the sampling and compositing scheme. This step consisted of using judgement to relate the operational aspects of dredging to the compositing scheme to ensure that specific sediment volumes represented by sampling and analytical results can be feasibly dredged independently from adjacent volumes. A primary consideration was to provide common lateral boundaries between the surface DMMUs and the underlying subsurface DMMUs as much as practicable to enable full depth dredging with each dredge setup where sampling results allow use of the same disposal site.

4.3.1 Conceptual Dredging Plan. Criteria for dredging are:

- Dredge by clamshell and bottom-dump barge

- Most practicable dredge cut widths are in the range of 50-90 ft.

- Full box-cutting of dredge slopes will not be allowed along the pier in order to protect the piling from potential slope failure due to overcutting, i.e., the pierside slope will be excavated as close to the 1V-on-4H design slope as practicable.

- Dredged removal of the pierside slope will be conducted by advancing the dredge cut longitudinally along the pier length. This will take advantage of increased bucket control by side swing (compared to more difficult control by raising and lowering the boom as would be required by advancing into the side slope perpendicular to the pier). Advancing parallel to the pier will also enhance operator control by creating a pattern of repetitive excavation along the slope cut in reference to the pier face.

- Remaining dredge cuts will also be oriented longitudinally along the pier, i.e., parallel to the pier face and the pierside slope cut. However, if USN ship movement and/or interim berthing requirements become controlling factors during dredging it is also practicable to orient selected dredge cuts perpendicular to the pier; however, this would require more dredge positioning to initiate the additional cuts and alignments.

- Except for the pierside slope cut (which may require successive passes), the full allowable depth of removal, based on testing results, will be accomplished as the dredge advances into the cut.

4.3.2 Sampling and Compositing Scheme. The basic approach for establishing the sampling array and compositing scheme included the following criteria:

- Array sediment grid units in rows parallel to the dock consistent with the dredging plan.

- Arrange sediment grid units in two rows along each side of the pier to provide testing of at least surface sediments both near and away from the dock.

- Maintain common lateral boundaries between surface and subsurface sediment units as much as practicable to enable full depth dredging where allowed by testing results.

- Where possible utilize the same sediment bore location for characterizing both surface and subsurface sediments.

An additional factor is that ships and barges are moored at Pier D within the area to be sampled. Several can be moved or do not interfere with sampling access. However, movement of two existing mooring combinations would present considerable difficulty and expense:

1. The three-barge installation for personnel berthing located at the southeast corner of Pier D. These barges house approximately 500 Navy personnel and are connected to shoreside utilities (water, electricity, sewage and communications), which would be displaced or disrupted by temporary relocation for sampling access. One of the two outer barges can be drifted shoreward to enable limited sampling access between the barges.

2. The 800+ ft. carrier BON HOMME RICHARD located along the outer west side of Pier D. The procedure for moving the carrier is complex, requiring 3-4 major tugs at an estimated cost of $60-70,000, and is contingent upon locating alternate moorage space that can be temporarily vacated elsewhere on the base.

Because of the considerable difficulty and expense in moving either the two main berthing barges or the carrier, the following sampling and compositing scheme is proposed to provide representative sampling without removing these vessels for sampling access.

Surface Sampling Locations and DMMUs. The first step in defining the sampling grid was to estimate the relative volume distribution for dredging the similar sized basins on each side of Pier D. This analysis showed that surface and subsurface volumes are distributed roughly equally on each side of the pier. Therefore, a minimum of ten core samples and ten DMMUs would need to be located on each side of the pier to satisfy the requirement for a total of 20 surface sediment samples and DMMUs. This allocation is the basis for development of the sampling and compositing scheme for both surface and subsurface sediments as outlined below.

Ten approximately equal-volume rectangular DMMUs were laid out in two rows along each side of the pier to best reflect the dredging approach. Each surface unit is sized to meet the PSDDA requirement of 4000 cu.yds. or less (4 ft. depth of surface layer times average surface area, including side slopes). Each surface DMMU is identified either with an "S", which designates is as a single-station uncomposited DMMU (see Figure 4), or with a "C", which designates it as a composite of samples from two sampling locations.

The sediment core sampling locations are numbered sequentially in Figure 5 and Table I. The sampling location for each surface DMMU was established near the center of the unit except for those units occupied by the berthing barge and outboard of the carrier. Sample No. 10 at the berthing barges is located near the quarter point along the mid-line of the grid area (see Figure 5), and as close to the barge as possible. Note that sampling of surface sediments at location Nos. 13, 14 and 15 occupied by the carrier BON HOMME RICHARD will be collected by diver-operated shallow coring device. Each surface DMMU outboard of the carrier is represented by two core samples (corresponding to subsurface sampling locations, see below).

Estimated sediment volumes represented by each surface DMMU is shown in Table IIA. Surface DMMU estimated volumes range from 3500 cyds to 4000 cyds, and average about 3900 cyds.

Subsurface Sampling Units. The above pattern of surface grid units is also used as the basis for the subsurface sampling, except where floating access by the coring barge is precluded by the carrier BON HOMME RICHARD (diver-sampled surface core locations 13, 14 and 15). For this latter area, rectangular subsurface units are laid out perpendicular to the dock with core sampling locations situated outboard of the carrier hull. The resulting subsurface sampling grid units with corresponding location numbering are shown on Figure 6. Size (surface area) of the perpendicular subsurface units is comparable to that of units not affected by the carrier.

Surface core sections will be collected coincidentally with subsurface coring outboard of the carrier at each of the perpendicular subsurface units sample locations, i.e. at Nos. 18, 19, 20, 21, 22, and 23. Two of these surface core sections will be composited for analysis to represent the related outboard surface DMMU grid units (e.g., surface core sections from bore locations 18 and 19 will be composited for analysis representing surface unit C1; see Figure 4). This will ensure a good spatial representation for these DMMUs.

Subsurface DMMUs. Subsurface DMMUs were designated by aggregating adjacent subsurface sampling units (Figure 6) into eight composites for subsurface analyses. The resulting eight subsurface DMMUs are shown in Figure 7. This subsurface compositing scheme was developed in consideration of the dredging plan and the above sampling and compositing criteria and limitations.

The subsurface DMMU compositing scheme and related estimated sediment volumes are shown in Table IIB. Estimated sediment volumes for subsurface DMMUs range from 9300 cyds to 13,000 cyds, and average about 11,600 cyds.

It is noted that four composite samples (C5, C6, C7 and C8) slightly exceed the 12,000 cyd general compositing criteria for dredging areas designated high concern by PSDDA, although the PSDDA basic criteria is satisfied by the number of composites (8) and the average volume represented by DMMUs (11,700 cyds). In addition, such exceedance appears justified based on the following:

- The required eight DMMU composites are laid out to support the most practicable dredging plan by observing cuts parallel to the pier and maximizing common lateral boundaries between surface and subsurface DMMUs, except where subsurface units accommodate the BON HOMME RICHARD.

- Essentially all of the subsurface sediment lies below the previously dredged depth of -40 ft., MLLW. Since none of the sediment volume in these subsurface DMMUs has been dredged previously, the subsurface sediments are judged native materials.

- The amount of exceedance for any composite is minor, less than 10 percent.

Core Sampling Characteristics. Consistent with PSDDA guidance, sediment bores at each common surface/subsurface sampling location will be taken from the sediment-water interface down to a depth of -50.4 ft., MLLW, i.e., to the full design depth of -49.4 ft. plus one foot overdepth. Surface core sections at location Nos. 13, 14 and 15 will be taken by diver-operated core sampling to a depth of 4-feet. Sediment bore characteristics and core section designations are summarized in Table I.

In addition, PSDDA recommends that in high-ranked areas, where the potential exists for leaving subsurface sediments exposed which are more contaminated than the present surface sediments, one-foot cores beyond overdepth will be collected from and archived at each subsurface boring location. For this project, the archived depth would be from -50.4 ft. to -51.4 ft. Each archived sample will be placed in its own jar and stored at -20^{o}C for up to six months after sample collection. These samples will be available for future reference should it become necessary to characterize sediments to be exposed after dredging. Archived samples will be labelled "Z" followed by the boring number.

INSERT FIGURE 4 HERE

INSERT FIGURE 5 HERE

INSERT FIGURE 6 HERE

INSERT FIGURE 7 HERE

TABLE I:

USN PSNS PIER D DREDGING
SEDIMENT BORE CHARACTERISTICS AND CORE SECTIONS
(depths in feet referenced to MLLW)

Sediment Bore Number	Existing Bottom Depth	Length of Sediment Bores (to nearest ft., dredge to -50.4')	Core Section Designations and Depths
1	-39.5	11	A -39.5 to -43.5 B -43.5 to -47.5 C -47.5 to -50.4
2	-37.6	13	A -37.6 to -41.6 B -41.6 to -45.6 C -45.6 to -49.6 D -49.6 to -50.4
3	-40.1	10	A -40.1 to -44.1 B -44.1 to -48.1 C -48.1 to -50.4
4	-42.0	8	A -42.0 to -46.0 B -46.0 to -50.0 C -50.0 to -50.4
5	-40.8	10	A -40.8 to -44.8 B -44.8 to -48.8 C -48.8 to -50.4
6	-38.0	12	A -38.0 to -42.0 B -42.0 to -46.0 C -46.0 to -50.0 D -50.0 to -50.4
7	-37.0	13	A -37.0 to -41.0 B -41.0 to -45.0 C -45.0 to -49.0 D -49.0 to -50.4
8	-40.0	10	A -40.0 to -44.0 B -44.0 to -48.0 C -48.0 to -50.4
9	-41.5	9	A -41.5 to -45.5 B -45.5 to -49.5 C -49.5 to -50.4
10	-41.4	9	A -41.4 to -45.4 B -45.4 to -49.4 C -49.4 to -50.4
11	-38.8	12	A -38.8 to -42.8 B -42.8 to -46.8 C -46.8 to -50.4
12	-40-1	10	A -40.1 to -44.1 B -44.1 to -48.1 C -48.1 to -50.4
13	-41.0	4	A -41.0 to -45.0
14	-41.1	4	A -41.1 to -45.1

15	-41.8	4	A -41.8 to -45.8

16	-39.8	11	A -39.8 to -43.8 B -43.8 to -47.8 C -47.8 to -50.4
17	-40.0	10	A -40.0 to -44.0 B -44.0 to -48.0 C -48.0 to -50.4
18	-41.1	9	A -41.1 to -45.1 B -45.1 to -49.1 C -49.1 to -50.4
19	-40.8	10	A -40.8 to -44.8 B -44.8 to -48.8 C -48.8 to -50.4
20	-41.7	9	A -41.7 to -45.7 B -45.7 to -49.7 C -49.7 to -50.4
21	-42.0	8	A -42.0 to -46.0 B -46.0 to -50.0 C -50.0 to -50.4
22	-42.0	8	A -42.0 to -46.0 B -46.0 to -50.0 C -50.0 to -50.4
23	-42.0	8	A -42.0 to -46.0 B -46.0 to -50.0 C -50.0 to -50.4

TABLE II:

PIER D SAMPLE COMPOSITING SCHEME

A. SURFACE SEDIMENTS (top 4 ft. of dredge prism)

DMMU AND SAMPLE IDENTIFICATION		DMMU Volume Represented (cubic yards)
DMMU (Grid Unit No.)	**SAMPLE (Core Section)**	
S1	1A	3900
S2	2A	3900
S3	3A	3700
S4	4A	3900
S5	5A	3500
S6	6A	4000
S7	7A	4000
S8	8A	3900
S9	9A	3900
S10	10A	3800
S11	11A	3500
S12	12A	4000
S13	13A	4000
S14	14A	4000
S15	15A	4000
S16	16A	4000
S17	17A	4000
C1	18A & 19A	3800
C2	20A & 21A	3900
C3	22A & 23A	3900

B. SUBSURFACE SEDIMENTS (remainder of dredge prism)

Composite Sample I.D. No.	Samples Composited (by Core section)	DMMU Volume Represented (approx. Cy)
C4	1B, 1C, 2B, 2C, 2D	11,600
C5	3B, 3C, 4B, 4C, 5B, 5C	13,000
C6	6B, 6C, 6D, 7B, 7C, 7D	12,300
C7	8B, 8C, 9B, 9C, 10B, 10C	12,800
C8	11B, 11C, 12B, 12C	9,300
C9	16B, 16C, 17B, 17C	11,100
C10	18B, 18C, 19B, 19C, 20B, 20C	12,400

C11	21B, 21C, 22B, 22C, 23B, 23C	11,300

4.4 Field Sampling Schedule. The field sampling schedule is constrained by the shortest sample holding time (seven days). To safely meet the holding times for composited samples, the field samples will be composited and delivered for laboratory testing within three days of sampling the first core section within each composite. Sampling will generally proceed by completing all coring within a given subsurface composite (up to three sampling locations) before proceeding to bore locations for the next composite. Based on a review of the limited available sediment data and expected logistic considerations, it is projected that up to three full depth sediment bores can be completed per sampling day. The entire core-sampling program is expected to be completed within 10 working days.

Initiation of core sampling will be preceded by cleanup and other preparation of sample coring and handling equipment in the GeoMetrics laboratory, acquisition of appropriate EPA-approved decontaminated sample containers from the analytic laboratories, on-site establishment of positioning references and tide gage by the surveyor, and mobilization of the drill barge to the site.

4.5 Field Operations and Equipment. The field crew and equipment will be mobilized from GeoMetrics's Tacoma Office.

The field crew will make sure all equipment is in good working order prior to collection of cores. Program plans will be developed and final arrangements made for logistics and field operations. The drill barge will mobilize from Bainbridge Island to Bremerton.

4.5.1 Drill Barge. The drill barge to be employed for the coring program will be provided by GeoTechnica, Inc., of Des Moines, Washington. The barge is a 70.9 foot by 24.4 foot self-contained coring and sampling vessel with a moon-pool opening for drill deployment and a four-point anchor winch system. The vessel has about 1500 square feet of working deck space and adequate power and electronics to work self-contained. A tender tug and a power skiff will also be available full time to provide logistical and anchoring support.

4.5.2 Navigation and Positioning. The station location will be referenced to the drill casing during sampling, and will be accomplished by the range-azimuth method. Distances will be measured from known references using an EDM (electronic distance measurement), and horizontal angles from established points and baseline(s) will be measured using a surveying theodolite. Elevations will be referenced to local MLLW (NOAA) and corrected using the tide gage. Horizontal coordinates will be referenced to Washington Coordinate System for proper North or South Zones NAD 83 (North American Datum 1983). Horizontal coordinates will be converted and identified as latitude and longitude (NAD 83) to the nearest 0.1 second.

Diver collected core sample locations will be determined underwater using taped distance from the sampling point to at least two fixed (known) reference points.

These systems are expected to document sampling locations to +/- 3 meters accuracy to allow the dredge to discretely remove different DMMUs (Phase I EPTA, Sect. 4.4.1, 1988).

4.5.3 Sample Collection Techniques. Samples will be collected using a barge-mounted, hollow-stem auger drilling rig equipped with a Gregory sampler. The hydraulically operated barge coring system acquires marine sediment cores up to two feet long in shallow water. The Gregory sampler uses compressed nitrogen to push the sampling tube into the sediments. Shelby tubes will be used for sampling and will be made of stainless steel. Tubes are 2.0 ft. long with 3-inch-outside diameters and were selected based on the type of sediments expected at the project site. The thin wall of the Shelby tube is suited for soft silts and sands, since they can be pushed or driven into the material with limited disturbance. Thicker-walled samplers used in denser soils increase the lateral displacement of the material in the sampling area; sample recovery may be reduced and inflow of the material into the casing (heaving) may be increased. Heaving will be controlled by maintaining positive pressure in the drill head.

Casing will be installed from the deck surface to the mud line. The first sample will be collected from zero to two feet of depth. The casing will then be advanced to the bottom of the sample depth and the next two-foot sample will be taken. These two subsamples will be labelled "A1" and "A2" on the boring logs. The subsamples will be composited in the GeoMetrics lab and labeled "S" (for single-station, single-stratum), as stated previously for surface samples.

This method of sampling, retrieval and casing advancement at two foot intervals will be utilized until the total sample depth (-51.4 feet) is reached. The recovered subsurface core-segments will be labeled in alphabetical order starting with "B". There will be two cores for each letter, except in those cases where the deepest core is two feet long or less. Laboratory compositing will follow the scheme presented in Table II. Compositing will be performed in GeoMetrics' Tacoma facility.

For the three diver-collected surface cores beneath the carrier Bon Homme Richard, (Nos. 13, 14 and 15), a four foot long sediment sampling tube assembly will be hand-inserted by the divers.

4.6 Sample Collection and Handling Procedures. All sampling tubes and cutter heads will be thoroughly cleaned prior to use according to the following procedure:

- Hot Water Rinse
- Wash with brush and Alconox soap
- Double Rinse with distilled water
- Rinse with nitric acid
- Rinse with deionized water
- Rinse with methanol

After cleaning, all core tubes will be foil wrapped and capped to limit the risk of contamination. Caps will only be removed as the tubes are loaded onto the sampling device. Once the cap has been removed, a final wash as defined above will be performed at the cutter head just prior to deployment. For the diver-collected surface cores, the protective cutter head cap and wrapper will be removed underwater upon inserting the core tube. Sufficient extra sampling tubes will be available on-site to allow for uninterrupted operations should a sampling tube become contaminated. The rule of "potential for contaminants" will be used such that any sampling tube suspected of contamination will be rejected and recycled on shore for use later in the program.

As samples are taken, logs and field notes of all core samples will be maintained and correlated to the sampling location map. Included in this log will be the following:

- Elevation of each boring station sampled as measured from mean lower low water (MLLW NAD83). This will be accomplished using a lead line to determine depth at the sampling location referenced to an on-site tide gage set to MLLW.

- Date and time of collection of each sediment bore sample.

- Names of field supervisor and person(s) collecting and logging in the sample.

- Weather conditions.

- The sample station number as derived from Table I and Figures 4 and 5, and individual designation numbers assigned for each individual core section.

- Length and depth intervals of each core section and recovery for each sediment sample as measured from MLLW.

- Qualitative notation of apparent resistance of sediment column to coring.

- Any deviation from the approved sampling plan.

During deployment and retrieval of the coring device, care will be taken to ensure that the cutter head or end of the core tube does not come into contact with the vessel. Once on deck, the cutter head will be inspected and a physical description of the material at the mouth of the core will be entered into the core log. The cutter head will be removed and a cap will be placed over the end of the tube and secured firmly in place with duct tape. The core will then be removed from the sampler and the other end of the core will be capped and taped. A label identifying the core will be securely attached to the outside of the core and wrapped with transparent tape to prevent loss or damage of the label. The core sections will be stored on their sides on Blue Ice in coolers. Three 12-cubic-foot coolers will be on board, with enough capacity to handle 40 2-foot core sections. The cores will be sealed tightly enough to prevent leakage.

4.7 Sample Transport and Chain-of-Custody Procedures. At the end of each day the cores will be transferred to GeoMetrics compositing facility. Chain-of-custody procedures will commence onboard the sampling barge and will track delivery of each of the cores to the GeoMetrics laboratory. Specific procedures are as follows:

- Samples will be packaged and shipped in accordance with U.S. Department of Transportation regulations as specified in 49 CFR 173.6 and 49 CFR 173.24.

- The coolers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the cooler and GeoMetrics' office name and address) to enable positive identification.

- A sealed envelope containing chain-of-custody forms will be enclosed in a plastic bag and taped to the inside lid of the cooler.

- Signed and dated chain-of-custody seals will be placed on all coolers prior to shipping.

Upon transfer of sample possession to the compositing laboratory, the chain-of-custody form will be signed by the persons transferring custody of the coolers. Upon receipt of samples at the laboratory, the shipping container seal will be broken and the condition of the samples will be recorded by the receiver. Chain-of-custody forms will be used to track the compositing of individual core samples.

4.8 Sample Compositing and Subsampling.

4.8.1 Decontamination. Prior to each day's use, sediment compositing equipment in the soils laboratory (including stainless steel mixing bowls, extrusion tray, sampling spoons and core splitter) will be scrubbed with sponges and/or nylon scrubbers in a solution of laboratory grade non-phosphate based soap and potable water. Following initial scrubbing, all soap and dirt will be removed by successive rinses of distilled water, rinsed with nitric acid, deionized water and methanol. Volatiles sampling utensils will not receive the nitric acid or methanol rinse.

All hand work (using the core extrusion dowel and core splitter, and stainless steel spoons for extracting the sample from the split cores, mixing the samples and filling sample containers) will be conducted with disposable latex gloves which will be rinsed with distilled water before and after handling each individual sample, as appropriate, to prevent sample contamination. Gloves will be disposed of between composites to prevent cross contamination between the DMMUs.

4.8.2 Extrusion. For each individual laboratory sample, the core sections comprising that sample will have their sealed caps removed one-by-one for extrusion. The sediment from each sample tube will be extruded onto a stainless steel tray using a foil-covered wooden dowel. The sample will be disturbed as little as possible when extruding. The foil covering on the dowel will be replaced between composites. Upon extrusion, the core will be split with a decontaminated stainless steel wire core splitter.

4.8.3 Volatiles and Sulfides Subsampling. Volatile and sulfides subsamples will be removed immediately upon extrusion and splitting, and prior to compositing (volatiles and sulfides could be lost while compositing), from one randomly chosen core representing each composite. For example, for a composite consisting of 6 core samples, one of the 6 would be chosen (using a random numbers table) for volatiles and sulfides subsampling prior to any other processing. Volatiles and sulfides subsamples will be taken simultaneously from the representative sampling core section by two laboratory staff members. Subsamples will be taken along the entire length of the representative core section, from sediment which has not had contact with the core lining.

(Samples will not be taken from "Z" cores as these are to be archived for possible analysis at some later time, at which time volatiles and sulfides would not be required to be analyzed.)

Two separate 4-ounce containers will be completely filled with sample sediment for volatiles. No headspace will be allowed to remain in either container. Two samples are collected to ensure that an acceptable sample with no headspace is submitted to the laboratory for analysis. The containers, screw caps, and cap septa (silicone vapor barriers) will be washed with detergent, rinsed once with tap water, rinsed at least twice with distilled water, and dried at >105 C. A solvent rinse will not be used because it may interfere with the analysis.

To avoid leaving headspace in the containers, sample containers can be filled in one of two ways. If there is adequate water in the sediment, the vial will be filled to overflowing so that a convex meniscus forms at the top. Once sealed, the bottle will be inverted to verify the seal by demonstrating the absence of air bubbles. If there is little or no water in the sediment, jars will be filled as tightly as possible, eliminating obvious air pockets. With the cap liner's PTFE side down, the cap will be carefully placed on the opening of the vial, displacing any excess material.

For sulfides sampling, 8 mls of 2N zinc acetate will be placed in a 4-ounce sampling jar. The sulfides sample (approximately 50 g) will be placed in the jar, covered, and shaken vigorously to completely expose the sediment to the zinc acetate.

The volatiles and sulfides sampling jars will be clearly labeled with the project name, sample/composite identification, type of analysis to be performed, date and time, and initials of person(s) preparing the sample, and referenced by entry into the log book. The sulfides sampling jars will indicate that zinc acetate has been added as a preservative.

Table III contains those cores, randomly selected, which will be used to collect representative sediment for volatiles and sulfides sampling.

TABLE III:

RANDOM CORES FOR VOLATILES AND SULFIDES SUBSAMPLING

DMMU AND RANDOM CORE IDENTIFICATION	
DMMU	**RANDOM CORE SECTION**
S1	1A1
S2	2A1
S3	3A2
S4	4A1
S5	5A2
S6	6A2
S7	7A1
S8	8A2
S9	9A2
S10	10A2
S11	11A1
S12	12A2
S13	13A1
S14	14A1
S15	15A2
S16	16A1
S17	17A1
C1	19A1
C2	20A1
C3	23A1
C4	2C1
C5	3B2
C6	7D1
C7	9B1
C8	12C1
C9	16B2
C10	20B2
C11	23B1

4.8.4 Core Logging. After volatiles and sulfides subsampling, each discrete core section will then be color photographed. A sediment description of each core sample will be recorded on the core log for the following parameters as appropriate and present:

- Sample recovery
- Physical soil description in accordance with the Unified Soil Classification System (includes soil type, density/consistency of soil, color)
- Odor (e.g., hydrogen sulfide, petroleum)
- Visual stratifications and lenses
- Vegetation
- Debris
- Biological Activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms)
- Presence of oil sheen
- Any other distinguishing characteristics or features

4.8.5 Compositing and Other Subsampling. Samples will then be composited by GeoMetrics in accordance with the compositing plan shown in Table II and PSDDA protocols. For subsurface composite samples, equal volumes of sediment will be removed from each core section comprising a composite. Sediments representing each composite sample will be placed in a stainless steel bowl and mixed using stainless steel mixing spoons. The composited sediment in the stainless steel bowl will be mixed until homogenous and will continue to be stirred while individual samples are taken of the homogenate. This will ensure that the mixture remains homogenous and that settling of coarse-grained sediments does not occur.

At least six liters of homogenized sample will be prepared to provide adequate volume for physical, chemical and biological laboratory analyses. Bioassays require approximately 4 liters while chemical testing requires approximately 1 liter of sediment. Both chemistry and bioassay samples will be taken from the same homogenate. Portions of each composite sample will be placed in appropriate containers obtained from the chemical and biological laboratories. See Table IV for container and sample size information. For "Z" cores, a 250 ml glass jar will be filled and frozen for possible future analysis.

Approximately 19 additional liters of sediment would be required for bioaccumulation testing. This additional volume will not be collected at this time. If a BT is exceeded, and the Navy decides to pursue biological testing, additional sediment will be collected prior to bioaccumulation testing. The Navy balanced the costs involved with collecting large volumes of additional

sediments for each DMMU immediately, versus the costs of a resampling effort, and decided on the latter strategy.

TABLE IV:

SAMPLE STORAGE CRITERIA

Sample Type	Holding Time	Sample Size[a]	Temperature[c]	Container	Archive[b]
Particle Size	6 Months	100-200g (150 ml)	4°C	1-liter Glass (combined)	
Total Solids	14 Days	125g (100 ml)	4°C		X
Total Volatile Solids	14 Days	125 g (100 ml)	4°C		
Total Organic Carbon	14 Days	125 g (100 ml)	4°C		
Ammonia	7 Days	25 g (20 ml)	4°C		
Metals (except Mercury)	6 Months	50 g (40 ml)	4°C		
Semivolatiles, Pesticides and PCBs	14 Days until extraction 1 Year until extraction 40 Days after extraction	150 g (120 ml)	4°C -18°C 4°C		
Total Sulfides	7 Days	50 g (40 ml)	4°C[d]	125 ml Plastic	
Mercury	28 Days	5 g (4 ml)	-18°C	125 ml Glass	
Volatile Organics	14 Days	100 g (2-40 ml jars)	4°C	2-40 ml Glass	
Bioassay	8 Weeks	4 L	4°C	6-1 liter Glass	
Bioaccumulation	8 Weeks	19[e]	4°C	8-1 liter Glass	

a. Recommended minimum field sample sizes for one laboratory analysis. Actual volumes to be collected have been increased to provide a margin of error and allow for retests.

b. For every DMMU, a 250 ml container is filled and frozen to run any or all of the analyses indicated.

c. During transport to the lab, samples will be stored on blue ice. The mercury and archived samples will be frozen immediately upon receipt at the lab.

d. The sulfides sample will be preserved with 5 ml of 2 Normal zinc acetate per 30 g of sediment.

e. Depends on which two species are used. *Macoma* test requires about 8 L/treatment, *Nereis* test requires about 10 L/treatment, and *Arenicola* test requires about 1 L/treatment.

After placement, each sample will have chain-of-custody labels attached and will be stored at approximately 4°C until withdrawn for analysis. Each sample reserved for bioassays will be stored at 4°C in a nitrogen atmosphere, i.e., nitrogen gas in the container headspace, for up to 56 days pending inititation of any required biological testing. Each sample container will be clearly labeled with the project name, sample/composite identification, type of analysis to be performed, date and time, and initials of person(s) preparing the sample, and referenced by entry into the log book.

4.9 Sample Transport and Chain-of-Custody Procedures. All containerized sediment samples will be transported to the analytical laboratory after compositing is completed. Specific sample shipping procedures will be as follows:

- Each cooler or container containing the sediment samples for analysis will be delivered to the laboratory within 24 hours of being sealed.

- Samples will be packaged and shipped in accordance with U.S. Department of Transportation regulations as specified in 49 CFR 173.6 and 49 CFR 173.24.

- Individual sample containers will be packed to prevent breakage and transported in a sealed ice chest or other suitable container.

- The shipping containers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the container and consultant's office name and address) to enable positive identification.

- Glass jars will be separated in the shipping container by shock absorbent material (e.g., bubble wrap) to prevent breakage.

- Ice will be placed in separate plastic bags and sealed.

- A sealed envelope containing chain-of-custody forms will be enclosed in a plastic bag and taped to the inside lid of the cooler.

- Signed and dated chain-of-custody seals will be placed on all coolers prior to shipping.

Upon transfer of sample possession to the analytical laboratory, the chain-of-custody form will be signed by the persons transferring custody of the sample container. Upon receipt of samples at the laboratory, the shipping container seal will be broken and the condition of the samples will be recorded by the receiver. Chain-of-custody forms will be used internally in the lab to track sample handling and final disposition.

5.0 LABORATORY PHYSICAL AND CHEMICAL SEDIMENT ANALYSIS

5.1 Laboratory Analyses Protocols. Laboratory testing procedures will be conducted in accordance with the PSDDA Evaluation Procedures Technical Appendix, June 1988; the PSDDA Phase II Management Plan Report, September 1989; and with the PSEP Recommended Protocols. Several details of these procedures are discussed below.

5.1.1 Chain-of-custody. A chain-of-custody record for each set of samples will be maintained throughout all sampling activities and will accompany samples and shipment to the laboratory. Detailed information on chain-of-custody is in Section 4.9.

5.1.2 Limits of Detection. The surface and subsurface composite samples identified in Section 4.2 and Tables IIA and IIB will be analyzed for all the parameters listed in Appendix D and for grain size distribution. The preparation procedures, test methods, method detection limits to be achieved by the analytical laboratory, and PSDDA screening levels are also identified in Appendix D. Detection limits of all chemicals of concern must be below PSDDA screening levels. Failure to achieve this may result in a requirement to reanalyze or perform bioassays. The testing laboratory will be specifically cautioned by the GeoMetrics sampling and analysis director to make certain that it complies with the PSDDA detection limit requirements. All reasonable means, including additional cleanup steps and method modifications, will be used to bring all limits-of-detection below PSDDA SLs. In addition, an aliquot (8 oz) of each sediment sample for analysis will be archived and preserved at -18 C for additional analysis if necessary.

The following scenarios are possible and will be handled appropriately:

1. One or more chemicals-of-concern (COC) have limits of detection exceeding screening levels while all other COCs are quantitated or have limits of detection at or below the screening levels: the requirement to conduct biological testing would be triggered solely by limits of detection. In this case the chemical testing subcontractor will do everything possible to bring limits of detection down to or below the screening levels, including additional cleanup steps, re-extraction, etc. This is the only way to prevent unnecessary biological testing. If problems or questions arise, the chemical testing subcontractor will be directed to contact the Dredged Material Management Office.

2. One or more COCs have limits of detection exceeding screening levels for a lab sample, but below respective bioaccumulation triggers (BT) and maximum levels (ML), and other COCs have quantitated concentrations above screening levels: The need to do bioassays is based on the detected exceedances of SLs and the limits of detection above SL become irrelevant. No further action is necessary.

3. One or more COCs have limits of detection exceeding SL and exceeding BT or ML, and other COCs have quantitated concentrations above screening levels: the need to do bioassays is based on the detected exceedances of SLs but all other limits of detection must be brought below BTs and MLs to avoid the requirement to do bioaccumulation testing or special

biological testing. As in case i) everything possible will be done to lower the limits of detection.

4. One COC is quantitated at a level which exceeds ML by more than 100%, or more than one COC concentration exceeds ML: there is reason to believe that the test sediment is unsuited for open-water disposal without additional chronic sublethal testing data. In the absence of chronic sublethal data, problems with limits of detection for other COCs are irrelevant. No further action is necessary.

In all cases, to avoid potential problems and leave open the option for retesting, sediments or extracts will be kept under proper storage conditions until the chemistry data is deemed acceptable by the PSDDA agencies.

5.1.3 Sediment Conventionals. All conventional parameters will be analyzed. Particle grain size distribution for each composite sample will be determined in accordance with ASTM D 422 (modified). Wet sieve analysis will be used for the sieve sizes U.S. No. 4, 10, 20, 40, 60, 140, 200 and 230. Hydrogen peroxide will not be used in preparations for grain-size analysis. (Hydrogen peroxide breaks down organic aggregates and its use may provide an overestimation of the percent fines found in undisturbed sediment. Incorrect grain size matches could result when reference sediments are collected.) Hydrometer analysis will used for particle sizes finer than the 230 mesh. Water content will be determined using ASTM D 2216. Sediment classification designation will be made in accordance with U.S. Soil Classification System, ASTM D 2487.

5.1.4 Holding Times. The tiered testing option will be implemented for biological testing (see Section 6, Biological Testing). To the maximum extent practicable all chemical results will be provided within 28 days of sampling to allow a timely decision for tiered biological testing. Sediment samples reserved for potential bioassays will be stored under chain-of-custody at GeoMetrics's laboratory.

All samples for physical, chemical and biological testing will be maintained at the testing laboratory at the following temperatures and analyzed prior to the expiration times specified in Table IV.

5.1.5 Quality Assurance/Quality Control. The chemistry QA/QC procedures found in Table V will be followed.

5.2 Laboratory Written Report. A written report will be prepared by the analytical laboratory documenting all the activities associated with sample analyses. As a minimum, the following will be included in the report:

- Results of the laboratory analyses and QA/QC results.

- All protocols used during analyses.

- Chain of custody procedures, including explanation of any deviation from those identified herein.
- Any protocol deviations from the approved sampling plan.
- Location and availability of data.
- QA2 data required by Ecology for the SEDQUAL database.

As appropriate, this sampling plan may be referenced in describing protocols.

TABLE V:

MINIMUM LABORATORY QA/QC

ANALYSIS TYPE	METHOD BLANKS[4]	DUPLI-CATES[4]	CRM[5]	MATRIX SPIKE[4]	SURRO-GATES[1]
Volatile Organics[2,3]	X	X[7]		X	X
Semivolatiles[2,3]	X	X[7]	X[6]	X	X
Pesticides/PCBs[2,3]	X	X[7]	X[6]	X	X
Metals	X	X	X	X	
Ammonia	X	X			
Total Sulfides	X	X			
Total Organic Carbon	X	X	X[7]		
Total Solids		X			
Total Volatile Solids		X			
Particle Size		X			

1. Surrogate spikes required for every sample, including matrix spiked samples, blanks and reference materials

2. Initial calibration required before any samples are analyzed, after each major disruption of equipment, and when ongoing calibration fails to meet criteria.

3. Ongoing calibration required at the beginning of each work shift, every 10-12 samples or every 12 hours (whichever is more frequent), and at the end of each shift

4. Frequency of Analysis (FOA) = one per extraction batch; batches limited to 20 samples

5. Certified Reference Material

6. Sequim Bay Reference (one replicate)

7. Matrix spike duplicate will be run

6.0 BIOLOGICAL TESTING

6.1 Bioassay Laboratory Protocols. The tiered testing approach will be used. Biological testing will be undertaken on any composite sample which has one or more chemicals of concern above the PSDDA screening level (SL) but below the PSDDA maximum level (ML), although a sample with a single ML exceedance which is less than or equal to two times the ML still qualifies for biological testing. If any COC exceeds a bioaccumulation trigger (BT), a decision will be made as to whether or not to pursue biological testing, which would include the standard suite of PSDDA bioassays plus bioaccumulation testing with Macoma. To the maximum extent practicable, chemical results will be provided for bioassay decisions within 28 days of first sample collection. The remaining four week (28 day) period will allow time for bioassay preparation as well as time for retests if necessary.

The DMMO project manager will be kept informed of analytical progress to support bioassay decisions. His active participation and judgement are considered vital to final decisions. Bioassay testing requires that test sediments be matched and run with an appropriate PSDDA-approved reference sediment to factor out sediment grain-size effects on bioassay organisms. The approach to selecting reference sediment samples is outlined below:

- Highest priority by ChemTest will be the sieve analysis portion of grain size determination to identify the proportions of fines (hydrometer analysis for clay size distribution will be conducted later). These early results are expected to support selection of the reference sediment(s).

- Ammonia and sulfides analysis will also be expedited to provide a basis to evaluate the need for aeration in the sediment larval test.

- Sample collection is scheduled to be completed within about 10 days. Regardless, on or before about day 15 all available grain size information will be collated and reviewed by GeoMetrics and BioTesting. Based on this analysis a recommendation on appropriate reference sediment will be made to the DMMO project manager. The DMMO will coordinate the reference sediment selection with the other PSDDA agencies.

- BioTesting will collect the identified reference sediments as soon as possible. The guidance received by DMMO will assist BioTesting in locating a suitably matched reference sediment. Wet-sieving in the field, however, is essential in finding an adequate match. The location of the reference sediment sampling location will be recorded to the nearest 0.1 second.

All sediment samples for potential bioassays will be stored at 4^{o}C, pending completion of chemical analyses and initiation of any required biological testing. All bioassay analyses, including retests, will commence within 56 days after collection of the first core section in the sediment composite to be analyzed. Chain-of-custody procedures will be maintained by the laboratory throughout biological testing.

Bioassay testing will be pre-planned to initiate appropriate testing as soon as possible after the first chemical results become available and the decision is made to conduct bioassays. This includes obtaining test organisms and control and reference sediments in a timely manner. This approach will support the opportunity for any second-round (additional) biological testing within the allowable 56-day holding period if such need arises. As initial chemistry data becomes available, the US Navy project manager and the bioassay laboratory representative will maintain close coordination with the Corps of Engineers DMMO to expedite biological testing decisions.

The acute toxicity and chronic sublethal bioassays prescribed by PSDDA (amphipod, sediment larval, *Neanthes* growth) will be conducted on each sample identified for biological testing. All biological testing will be in strict compliance with Recommended Protocols for Conducting Laboratory Bioassays on Puget Sound Sediments (for USEPA Region 10), 1995, with appropriate modifications as specified by PSDDA in the MPR-Phase II, public workshops and the sediment management annual review process. General biological testing procedures and specific procedures for each sediment bioassay are summarized below:

6.2 General Biological Testing Procedures.

6.2.1 Negative Controls. Negative control sediments are used in the amphipod and *Neanthes* bioassays to check laboratory performance. Negative control sediments are clean sediments in which the test organism normally lives and which are expected to produce low mortality. Control sediments will be collected from West Beach of Whidbey Island for both the amphipod and *Neanthes* bioassays.

The sediment larval test utilizes a negative seawater control rather than a control sediment. The seawater control will be collected from approximately 20 meters of water off West Beach.

The amphipod, sediment larval and *Neanthes* tests all have performance standards for negative controls, which are identified in Section 6.3.

6.2.2 Reference Sediment. PSDDA prescribes the use of bioassay reference sediments for test comparison and interpretations which closely match the grain size characteristics of the dredged materials test sediments. The reference sediment is used to block for physical effects of the test sediment.

All bioassays have performance standards for reference sediments (see Section 6.3). Failure to meet these standards may result in the requirement to retest.

All reference sediments will be analyzed for total solids, total volatile solids, total organic carbon, bulk ammonia, bulk sulfides and grain-size.

6.2.3 Replication. Five laboratory replicates of test sediments, reference sediments and negative controls will be run for each bioassay.

6.2.4 Positive Controls. A positive control will be run for each bioassay. Positive controls are chemicals known to be toxic to the test organism and which provide an indication of the sensitivity of the particular organisms used in a bioassay. Cadmium chloride will be used for the amphipod, sediment larval and *Neanthes* bioassays.

6.2.5 Water Quality Monitoring. Water quality monitoring will be conducted for the amphipod, sediment larval and *Neanthes* bioassays. This consists of daily measurements of salinity, temperature, pH and dissolved oxygen for the amphipod and sediment larval tests. These measurements will be made every three days for the *Neanthes* bioassay. Ammonia and sulfides will be determined at test initiation and termination for all three tests. Monitoring will be conducted for all test and reference sediments and negative controls (including seawater controls). Parameter measurements must be within the limits specified for each bioassay. Measurements for each treatment will be made on a separate chemistry beaker set up to be identical to the other replicates within the treatment group, including the addition of test organisms.

6.3 Bioassay-specific Procedures.

6.3.1 Amphipod Bioassay. This test involves exposing the amphipod *Rhepoxynius abronius* to test sediment for ten (10) days and counting the surviving animals at the end of the exposure period. Daily emergence data and the number of amphipods failing to rebury at the end of the test will be recorded as well. The control sediment has a performance standard of 10 percent mortality. The reference sediment has a performance standard of 20 percent mortality greater than control.

6.3.2 Sediment Larval Bioassay. This test monitors larval development of a suitable echinoderm species (either *Stronglyocentrotus purpuratus* or *Dendraster excentricus*) in the presence of test sediment. The test is run until the appropriate stage of development is achieved in a sacrificial seawater control (PSDDA MPR-Phase II, pp. 5-20). At the end of the test, larvae from each test sediment exposure are examined to quantify abnormality and mortality.

The seawater control has a performance standard of 30 percent combined mortality and abnormality. The reference sediment has a performance standard of 35 percent combined mortality and abnormality normalized to seawater control.

Initial counts will be made for a minimum of five 10-ml aliquots. Final counts for seawater control, reference sediment and test sediment will be made on 10-ml aliquots.

The sediment larval bioassay has a variable endpoint (not necessarily 48 hours) which is determined by the developmental stage of organisms in a sacrificial seawater control (PSDDA MPR Phase II, page 5-20).

Ammonia and sulfides toxicity may interfere with test results for this bioassay. Aeration will be conducted throughout the test to minimize these effects.

6.3.3 *Neanthes* Growth Test. This test utilizes the polychaete *Neanthes arenaceodentata*, in a 20-day growth test. The growth rate of organisms exposed to test sediments is compared to the growth rate of organisms exposed to a reference sediment. *Neanthes* will be obtained from Dr. Don Reish in Long Beach, California. Neanthes worms from Don Reish's lab may take 2 or 3 weeks to culture and deliver and will be ordered regardless of the outcome of the chemical characterization.

The control sediment has a performance standard of 10 percent mortality. The reference sediment has a performance standard of 80 percent of the control growth rate. The control growth guideline is 0.72 mg/ind/day.

6.4 Interpretation. Test interpretations consist of endpoint comparisons to controls and reference on an absolute percentage basis as well as statistical comparison to reference. Test interpretation will follow the guidelines established in the PSDDA Management Plan Report-Phase II (page 5-17) for the amphipod, and sediment larval bioassays, and the minutes of the

dredging year 1991 annual review meeting for the *Neanthes* bioassay, as modified by subsequent annual review proceedings and workshops.

6.5 Bioassay Retest. Any bioassay retests must be fully coordinated with, and approved by, the PSDDA agencies. The DMMO should be contacted to handle this coordination.

6.6 Laboratory Written Report. A written report will be prepared by the biological laboratory documenting all the activities associated with sample analyses. As a minimum, the following will be included in the report:

- Results of the laboratory bioassay analyses and QA/QC results, reported both in hard copy and in the Corps' DAIS data format. Raw data will be legible or typed. Illegible data may result in the need for a retest if the PSDDA agencies cannot interpret the data as a result. See Appendix E for the complete set of submittals.

- All protocols used during analyses, including explanation of any deviation from the Recommended Protocols and the approved sampling plan.

- Chain of custody procedures, including explanation of any deviation from the identified protocols.

- Location and availability of data, laboratory notebooks and chain-of-custody forms.

As appropriate, this sampling plan may be referenced in describing protocols.

7.0 REPORTING

7.1 QA Report. The project quality assurance representative will prepare a quality assurance report based upon activities involved with the field sampling and review of the laboratory analytical data. The laboratory QA/QC reports will be incorporated by reference. This report will identify any field and laboratory activities that deviated from the approved sampling plan and the referenced protocols and will make a statement regarding the overall validity of the data collected. The QA/QC report will be incorporated into the Final Report.

7.2 Final Report. A written report shall be prepared by GeoMetrics documenting all activities associated with collection, compositing, transportation of samples, and chemical and biological analysis of samples. The chemical and biological reports will be included as appendices. As a minimum, the following will be included in the Final Report:

- Type of sampling equipment used.
- Protocols used during sampling and testing and an explanation of any deviations from the sampling plan protocols.
- Descriptions of each sample accompanied by photographs adequate to provide a visual representation of the sediments.
- Methods used to locate the sampling positions within an accuracy of ± 2m.
- Locations where the sediment samples were collected. Locations will be reported in latitude and longitude to the nearest tenth of a second.
- A plan view of the project showing the actual sampling location.
- Chain-of-custody procedures used, and explanation of any deviations from the sampling plan procedures.
- Description of sampling and compositing procedures.
- Final QA report for Section 7.1 above.
- Data results. In addition, all field and laboratory analyses results and associated QA data will be submitted on floppy diskettes using the Corps of Engineers' Dredged Analysis Information System format.
- QA2 data required by the Department of Ecology for data validation prior to entering data in their Sediment Quality database. These data are listed in Appendix D.
- Sampling and analysis cost data will be submitted upon project completion on forms provided by the Dredged Material Management Office.

APPENDIX A

Data Summary

PILOT SEDIMENT CHARACTERIZATION RESULTS

PIER D, AUGUST, 1989

(From GeoMetrics, Inc. Report, 9/26/89)

APPENDIX B

SECTION 10/404 DRAFT PERMIT APPLICATION

PIER D

PLACE DEPT. OF ARMY LETTER HERE
PLACE PUGET SOUND NAVAL SHIPYARD LETTER HERE
PLACE APPLICATION FOR DEPT OF ARMY PERMIT HERE
PLACE APPLICATION FOR DEPT OF ARMY PERMIT - Page 2 HERE
PLACE VICINITY MAP HERE
PLACE SECTION A-A HERE
PLACE SECTION B-B HERE
PLACE SECTION C-C HERE

APPENDIX C

PSDDA PARAMETERS AND METHODS

APPENDIX C

PSDDA PARAMETERS

(Testing Parameter, Preparation Method, Analytical Method, Sediment Method Detection Limit (MDL), PSDDA Screening Levels (SL), Maximum Levels (ML) and Bioaccumulation Levels (BT))

PARAMETER	PREP METHOD (recommended)	ANALYSIS METHOD (recommended)	SEDIMENT MDL (1)	PSDDA(1) SL	BT	ML
CONVENTIONALS:						
Total Solids (%)	---	Pg.17 (2)	0.1	---	---	---
Total Volatile Solids(%)	---	Pg.20 (2)	0.1	---	---	---
Total Organic Carbon (%)	---	Pg.23 (2, 3)	0.1	---	---	---
Total Sulfides (mg/kg)	---	Pg.32 (2)	1	---	---	---
Ammonia (mg/kg)	---	Plumb 1981 (4)	1	---	---	---
Grain Size	---	Modified ASTM with Hydrometer	---	---	---	---
METALS (ppm):						
Antimony	APNDX D (5)	GFAA (6)	2.5	150	150	200
Arsenic	APNDX D (5)	GFAA (6)	2.5	57	507.1	700
Cadmium	APNDX D (5)	GFAA (6)	0.3	5.1	---	14
Chromium	APNDX D (5)	GFAA (6)	0.3	---	---	---
Copper	APNDX D (5)	ICP (7)	15.0	390	---	1,300
Lead	APNDX D (5)	ICP (7)	0.5	450	---	1,200
Mercury	MER (8)	7471 (8)	0.02	0.41	1.5	2.3
Nickel	APNDX D (5)	ICP (7)	2.5	140	370	370
Silver	APNDX D (5)	GFAA (6)	0.2	6.1	6.1	8.4
Zinc	APNDX D (5)	ICP (7)	15.0	410	---	3,800
ORGANOMETALLIC COMPOUNDS (ug/L):						
Tributyltin (interstitial water)	NMFS	Krone	0.01	---	0.15	---
ORGANICS (ppb):						
LPAH						
Naphthalene	3550 (9)	8270 (10)	20	2,100	---	2,400
Acenaphthylene	3550 (9)	8270 (10)	20	560	---	1,300
Acenaphthene	3550 (9)	8270 (10)	20	500	---	2,000
Fluorene	3550 (9)	8270 (10)	20	540	---	3,600
Phenanthrene	3550 (9)	8270 (10)	20	1,500	---	21,000

Anthracene	3550 (9)	8270 (10)	20	960	---	13,000
2-Methylnaphthalene	3550 (9)	8270 (10)	20	670	---	1,900
Total LPAH				5,200	---	29,000
HPAH						
Fluoranthene	3550 (9)	8270 (10)	20	1,700	4,600	30,000
Pyrene	3550 (9)	8270 (10)	20	2,600	---	16,000
Benzo(a)anthracene	3550 (9)	8270 (10)	20	1,300	---	5,100
Chrysene	3550 (9)	8270 (10)	20	1,400	---	21,000
Benzofluoranthenes	3550 (9)	8270 (10)	20	3,200	---	9,900
Benzo(a)pyrene	3550 (9)	8270 (10)	20	1,600	3,600	3,600
Indeno(1,2,3-c,d)pyrene	3550 (9)	8270 (10)	20	600	---	4,400
Dibenzo(a,h)anthracene	3550 (9)	8270 (10)	20	230	---	1,900
Benzo(g,h,i)perylene	3550 (9)	8270 (10)	20	670	---	3,200
Total HPAH				12,000	---	69,000
CHLORINATED HYDROCARBONS						
1,3-Dichlorobenzene	P&T (12)	8240 (11)	3.2	170	1,241	---
1,4-Dichlorobenzene	P&T (12)	8240 (11)	3.2	110	120	120
1,2-Dichlorobenzene	P&T (12)	8240 (11)	3.2	35	37	110
1,2,4-Trichlorobenzene	3550 (9)	8270 (10)	6	31	---	64
Hexachlorobenzene (HCB)	3550 (9)	8270 (10)	12	22	168	230
PHTHALATES						
Dimethyl phthalate	3550 (9)	8270 (10)	20	1,400	1,400	---
Diethyl phthalate	3550 (9)	8270 (10)	20	1,200	---	---
Di-n-butyl phthalate	3550 (9)	8270 (10)	20	5,100	10,220	---
Butyl benzyl phthalate	3550 (9)	8270 (10)	20	970	---	---
Bis(2-ethylhexyl)phthalate	3550 (9)	8270 (10)	20	8,300	13,870	---
Di-n-octyl phthalate	3550 (9)	8270 (10)	20	6,200	---	---
PHENOLS						
Phenol	3550 (9)	8270 (10)	20	420	876	1,200
2 Methylphenol	3550 (9)	8270 (10)	6	63	---	77
4 Methylphenol	3550 (9)	8270 (10)	20	670	---	3,600
2,4-Dimethylphenol	3550 (9)	8270 (10)	6	29	---	210
Pentachlorophenol	3550 (9)	8270 (10)	61	400	504	690
MISCELLANEOUS EXTRACTABLES						
Benzyl alcohol	3550 (9)	8270 (10)	6	57	---	870
Benzoic acid	3550 (9)	8270 (10)	100	650	---	760
Dibenzofuran	3550 (9)	8270 (10)	20	540	---	1,700
Hexachloroethane	3550 (9)	8270 (10)	20	1,400	10,220	14,000
Hexachlorobutadiene	3550 (9)	8270 (10)	20	29	212	270

N-Nitrosodiphenylamine	3550 (9)	8270 (10)	12	28	130	130
VOLATILE ORGANICS						
Trichloroethene	P&T (12)	8240 (11)	3.2	160	1,168	1,600
Tetrachloroethene	P&T (12)	8240 (11)	3.2	57	102	210
Ethylbenzene	P&T (12)	8240 (11)	3.2	10	27	50
Total Xylene	P&T (12)	8240 (11)	3.2	40	---	160
PESTICIDES						
Total DDT	---	---	---	6.9	50	69
p,p'-DDE	3540 (13)	8080 (13)	2.3	---	---	---
p,p'-DDD	3540 (13)	8080 (13)	3.3	---	---	---
p,p'-DDT	3540 (13)	8080 (13)	6.7	---	---	---
Aldrin	3540 (13)	8080 (13)	1.7	10	37	---
Chlordane	3540 (13)	8080 (13)	1.7	10	37	---
Dieldrin	3540 (13)	8080 (13)	2.3	10	37	---
Heptachlor	3540 (13)	8080 (13)	1.7	10	37	---
Lindane	3540 (13)	8080 (13)	1.7	10	---	---
Total PCBs	3540 (13)	8080 (13)	67	130	38*	3,100

* Total PCBs BT value in ppm carbon-normalized.

1. Dry Weight Basis.

2. Recommended Protocols for Measuring Conventional Sediment Variables in Puget Sound, Puget Sound Estuary Program, 1997.

3. Recommended Methods for Measuring TOC in Sediments, Kathryn Bragdon-Cook, Clarification Paper, Puget Sound Dredged Disposal Analysis Annual Review, May, 1993.

4. Procedures For Handling and Chemical Analysis of Sediment and Water Samples, Russell H. Plumb, Jr., EPA/Corps of Engineers, May, 1981.

5. Recommended Protocols for Measuring Metals in Puget Sound Water, Sediment and Tissue Samples, Puget Sound Estuary Program, 1997.

6. Graphite Furnace Atomic Absorption (GFAA) Spectrometry - SW-846, Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA 1986.

7. Inductively Coupled Plasma (ICP) Emission Spectrometry - SW-846, Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA 1986.

8. Mercury Digestion and Cold Vapor Atomic Absorption (CVAA) Spectrometry - Method 747I, SW-846, Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA 1986.

9. Sonication Extraction of Sample Solids - Method 3550 (Modified), SW-846, Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA 1986. Method is modified to add matrix spikes before the dehydration step rather than after the dehydration step.

10. GCMS Capillary Column - Method 8270, SW-846, Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA 1986.

11. GCMS Analysis - Method 8240, Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA 1986.

12. Purge and Trap Extraction and GCMS Analysis - Method 8240, Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA 1986.

13. Soxhlet Extraction and Method 8080, Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA 1986.

APPENDIX D

QA2 DATA REQUIREMENTS

CHEMICAL VARIABLES

ORGANIC COMPOUNDS

The following documentation is needed for organic compounds:

- A cover letter referencing or describing the procedure used and discussing any analytical problems
- Reconstructed ion chromatograms for GC/MS analyses for each sample
- Mass spectra of detected target compounds (GC/MS) for each sample and associated library spectra
- GC/ECD and/or GC/flame ionization detection chromatograms for each sample
- Raw data quantification reports for each sample
- A calibration data summary reporting calibration range used [and decafluorotriphenylphosphine (DFTPP) and bromofluorobenzene (BFB) spectra and quantification report for GC/MS analyses]
- Final dilution volumes, sample size, wet-to-dry ratios, and instrument detection limit
- Analyte concentrations with reporting units identified (to two significant figures unless otherwise justified)
- Quantification of all analytes in method blanks (ng/sample)
- Method blanks associated with each sample
- Recovery assessments and a replicate sample summary (laboratories should report all surrogate spike recovery data for each sample; a statement of the range of recoveries should be included in reports using these data)
- Data qualification codes and their definitions.

METALS

For metals, the data report package for analyses of each sample should include the following:

- Tabulated results in units as specified for each matrix in the analytical protocols, validated and signed in original by the laboratory manager
- Any data qualifications and explanation for any variance from the analytical protocols
- Results for all of the QA/QC checks initiated by the laboratory
- Tabulation of instrument and method detection limits.

All contract laboratories are required to submit metals results that are supported by sufficient backup data and quality assurance results to enable independent QA reviewers to conclusively determine the quality of the data. The laboratories should be able to supply legible photocopies of original data sheets with sufficient information to unequivocally identify:

- Calibration results
- Calibration and preparation blanks
- Samples and dilutions
- Duplicates and spikes
- Any anomalies in instrument performance or unusual instrumental adjustments.

BIOASSAYS

Amphipod Mortality Test

The following data should be reported by all laboratories performing this bioassay:

- Daily water quality measurements during testing (e.g., dissolved oxygen, temperature, salinity, pH) (plus ammonia & sulfides at test initiation and termination)
- Daily emergence for each beaker and the 10-day mean and standard deviation for each treatment
- 10-day survival in each beaker and the mean and standard deviation for each treatment
- Interstitial salinity values of test sediments

- 96-hour LC_{50} values with reference toxicants.

- Any problems that may have influenced data quality.

Neanthes Growth Test

The following data should be reported by all laboratories performing this bioassay:

- Water quality measurements at test initiation and termination and every three days during testing (e.g., dissolved oxygen, temperature, salinity, pH) (plus ammonia & sulfides at test initiation and termination)

- 20-day survival in each beaker and the mean and standard deviation for each treatment.

- Initial biomass

- Final biomass (20-day) for test, reference and control treatments.

- 96-hour LC_{50} values with reference toxicants.

Any problems that may have influenced data quality.

Echinoderm Larval Test (Solid Phase)

The following data should be reported by all laboratories performing this bioassay:

- Daily water quality measurements (e.g., dissolved oxygen, temperature, salinity, pH) (plus ammonia + sulfides at test initiation & termination)

- Individual replicate and mean and standard deviation data for larval survival at test termination.

- Individual replicate and mean and standard deviation data for larval abnormalities at test termination

- 48-hour LC_{50} and EC_{50} values with reference toxicants.

- Any problems that may have influenced data quality.

APPENDIX E

PROJECT COST DATA SHEET

PROJECT SAMPLING AND TESTING COST SUMMARY (Required fields shaded)		
Project Name:		
Total Project Volume Tested (cubic yards)		
SAMPLING COSTS: (includes: bathymetric survey, SAP development, sample positioning, project sediment sampling costs, reference/control sediment sampling costs)		$
CHEMICAL TESTING COSTS: (PSDDA or Grays Harbor-Willapa Bay DMMP chemicals of concern)		
Number of DMMU analyzed		
Conventionals (unit cost)		$
Metals (unit cost)		$
Organics (unit cost)		$
Special Chemicals (if any, specify which chemicals, e.g., TBT, Dioxin)		$
Total Chemical Testing Costs (includes cumulative chemical testing costs, chemistry report, QA/QC report including QA2 data)		$
BIOLOGICAL TESTING COSTS:		
Number of DMMU analyzed		
Amphipod (specify species and unit cost)		$
Sediment Larval (specify species and unit cost)		$
Neanthes Growth (unit cost)		$
Microtox (unit cost)		$
Bioaccumulation test (2 species) (specify species, unit cost)		$
		$
Total Biological Testing Costs (includes total bioassay testing cost, QA/QC costs, bioaccumulation costs if any)		$
MISCELLANEOUS COSTS: (includes any costs not covered such as administrative overhead, final report Cost)		**$**
GRAND TOTAL COSTS: (summary of sampling + testing costs + miscellaneous costs)		$

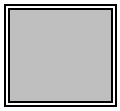
APPENDIX F

DATA REQUIREMENTS FOR DAIS

DAIS DATA CHECKLIST

Sample Locations and Compositing				
	Test Sediment	Reference Sediment	Control Sediment	Seawater Control
Latitude and Longitude (to nearest 0.1 second)				
NAD 1927 or 1983				
USGS Benchmark ID				
Station name (e.g. Carr Inlet)				
Water depth (corrected to MLLW)				
Drawing showing sampling locations and ID numbers				
Compositing scheme (sampling locations/depths for composites)				
Sampling method				
Sampling dates				
Estimated volume of dredged material represented by each DMMU				
Positioning method				
Sediment Conventionals				
Preparation and analysis methods				
Sediment conventional data and QA/QC qualifiers				
QA qualifier code definitions				
Triplicate data for each sediment conventional for each batch				
Units (dry weight except total solids)				
Method blank data (sulfides, ammonia, TOC)				
Method blank units (dry weight)				
Analysis dates (sediment conventionals, blanks, TOC CRM)				
TOC CRM ID				
TOC CRM analysis data				
TOC CRM target values				
Grain Size Analysis				
Fine grain analysis method				
Analysis dates				
Triplicate for each batch				
Grain size data (complete sieve and phi size distribution)				

Chemicals of Concern Analysis Data				
	Metals	Semivol.	Pest./ PCBs	Volatiles
Extraction/digestion method				
Extraction/digestion dates (test sediment, blanks, matrix spike, reference material)				
Analysis method				
data and QA qualifier included for:				
test sediments				
reference materials including 95% confidence interval (each batch)				
method blanks (each batch)				
matrix spikes (each batch)				
matrix spike added (dry weight basis)				
replicates (each batch)				
Units (dry weight)				
Method blank units (dry weight)				
QA/QC qualifier definitions				
Surrogate recovery for test sediment, blank, matrix spike, ref. material				
Analysis dates (test sediment, blanks, matrix spike, reference material)				



Shaded areas indicate required data

BIOASSAYS

Amphipod Mortality and Emergence				
	Each Batch	Test Sediment	Reference Sediment	Control Sediment
Species Name				
Mortality and Emergence:				
Start date				
Daily emergence (for 10 days)				
Survival at end of test				
Number failing to rebury at end of test				
Positive Control:				
Toxicant used				
Toxicant concentrations				
Exposure time				
LC50				
LC50 method of calculation				
Start date				
Survival data				
Water Quality Measurement Methods:				
Dissolved oxygen				
Ammonia				
Interstitial salinity				
Sulfide				
Water salinity				
Water Quality:				
Temperature (day 0 through day 10)				
pH (day 0 through day 10)				
Dissolved oxygen (day 0 through day 10)				
Water salinity (day 0 through day 10)				
Sulfide (day 0, day 10)				
Ammonia (day 0, day 10)				
Interstitial water salinity (day 0)				

Juvenile Infaunal Mortality				
	Each Batch	Test Sediment	Reference Sediment	Control Sediment
Species Name				
Mortality:				
Start date				
Survival at end of test				
Positive Control:				
Toxicant used				
Toxicant concentrations				
Exposure time				
LC50				
LC50 method of calculation				
Start date				
Survival data				
Water Quality Measurement Methods:				
Dissolved oxygen				
Ammonia				
Interstitial salinity				
Sulfide				
Water salinity				
Water Quality:				
Temperature (day 0 through day 10)				
pH (day 0 through day 10)				
Dissolved oxygen (day 0 through day 10)				
Water salinity (day 0 through day 10)				
Sulfide (day 0, day 10)				
Ammonia (day 0, day 10)				
Interstitial water salinity (day 0)				

Neanthes 20-day Growth Test				
	Each Batch	Test Sediment	Reference Sediment	Control Sediment
Starting age (in days post-emergence)				
Food type				
Quantity (mg/beaker/interval)				
Feeding interval (hours)				
Biomass and Mortality:				
Start date				
Initial counts and weights (mg dry weight)				
Number of survivors and final weights (mg dry weight)				
Positive Control:				
Toxicant used				
Toxicant concentration				
Exposure time				
LC50				
LC50 method of calculation				
Start date				
Survival data				
Water Quality Measurement Methods				
Dissolved oxygen				
Ammonia				
Interstitial salinity				
Sulfide				
Water salinity				
Water Quality:				
Temperature (days 0, 3, 6, 9, 12, 15, 18, 20)				
pH (days 0, 3, 6, 9, 12, 15, 18, 20)				
Dissolved oxygen (days 0, 3, 6, 9, 12, 15, 18, 20)				
Water salinity (days 0, 3, 6, 9, 12, 15, 18, 20)				
Interstitial salinity (day 0)				
Sulfide (initial and final)				
Ammonia (initial and final)				

Sediment Larval Mortality and Abnormality				
	Each Batch	Test Sediment	Reference Sediment	Seawater Control
Species Name				
Bioassay Parameters				
Inoculation time (hours)				
Exposure time (hours)				
Stocking beaker density (#/ml)				
Stocking aliquot size (ml)				
Aeration (yes/no)				
Mortality and Abnormality:				
Start date				
Initial count (minimum of five 10-ml aliquots)				
Final Count:				
Aliquot size (ml)				
Number normal per aliquot				
Number abnormal per aliquot				
Water Quality Measurement Methods:				
Dissolved oxygen				
Ammonia				
Sulfide				
Water salinity				
Water Quality:				
Temperature (daily)				
pH (daily)				
Dissolved oxygen (daily)				
Water salinity (daily)				
Sulfide (initial and final)				
Ammonia (initial and final)				
Positive Control:				
Toxicant used				
Toxicant concentrations				
Exposure time				
EC50				
EC50 method of calculation				
Start date				
Normal/abnormal counts				