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Seattle District

WASHINGTON STATE DEPARTMENT OF ECOLOGY

# PSDDA BIENNIAL REPORT

## Dredged Material Management Years 1992/1993

Puget Sound
Dredged Disposal Analysis
Program

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# Puget Sound
# Dredged Disposal Analysis

## Biennial Report

Dredged Material Management Years 1992/1993


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## TABLE OF CONTENTS


LIST OF TABLES . . . . . ii

LIST OF FIGURES . . . . . iii

LIST OF ACRONYMS . . . . . iv

EXECUTIVE SUMMARY . . . . . 1

INTRODUCTION . . . . . 3

CHAPTER 1 - PSDDA EVALUATION ACTIVITIES . . . . . 1-1

A. INTRODUCTION . . . . . 1-1
B. DY92/93 PROJECTS . . . . . 1-7
C. SUMMARY AND ASSESSMENT OF DY92/93 DATA . . . . . 1-25
D. FIVE-YEAR PSDDA PROGRAM RETROSPECTIVE . . . . . 1-39

CHAPTER 2 - DISPOSAL SITE USE AND MONITORING . . . . . 2-1

A. DISPOSAL ACTIVITY AND SITE USE . . . . . 2-1
B. DISPOSAL SITE MONITORING . . . . . 2-8

CHAPTER 3 - PSDDA PROGRAM REVIEW . . . . . 3-1

CLARIFICATION PAPERS . . . . . 3-3
STATUS REPORTS . . . . . 3-25
ISSUE PAPERS . . . . . 3-43

APPENDIX A - PROJECT-SPECIFIC NARRATIVE . . . . . A-1

APPENDIX B - PSDDA EVALUATION GUIDELINES . . . . . B-1

APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES . . . . . C-1

## LIST OF TABLES


| | | Page |
|---|---|---|
| Table 1-1 | DY92/93 PSDDA Evaluation Activities | 1-2 |
| Table 1-2 | DY92/93 Project Ranking | 1-10 |
| Table 1-3 | DY92/93 Projects - Approved Sampling Plans | 1-12 |
| Table 1-4 | DY92/93 Project Sampling | 1-14 |
| Table 1-5 | DY92/93 Biological Testing Data | 1-16 |
| Table 1-6 | DY92/93 Suitability Determinations | 1-18 |
| Table 1-7 | PSDDA Chemical Testing Summary | 1-26 |
| Table 1-8 | Multiple Exceedances of PSDDA Guideline Values | 1-28 |
| Table 1-9 | DY92/93 Bioassay "Hits" | 1-29 |
| Table 2-1 | Volume of Dredged Material Disposed at PSDDA Sites-DY92 | 2-1 |
| Table 2-2 | Summary of DY92 PSDDA Disposal Projects | 2-3 |
| Table 2-3 | Volume of Dredged Material Disposed at PSDDA Sites-DY93 | 2-4 |
| Table 2-4 | Summary of DY93 PSDDA Disposal Projects | 2-6 |
| Table 2-5 | 1993 PSDDA Site Monitoring Bioassay Results, Bellingham Bay | 2-17 |
| Table 2-6 | Cumulative Disposal Volumes, DY89-93 | 2-18 |
| Table 2-7 | PSDDA Disposal Site Monitoring Surveys | 2-20 |

## LIST OF FIGURES


| | | Page |
|---|---|---|
| Figure 1-1 | DY92/93 Project Locations | 1-4 |
| Figure 1-2 | Average Cost per Dredged Material Management Unit | 1-20 |
| Figure 1-3 | Total Project Sampling and Testing Costs | 1-21 |
| Figure 1-4 | Average Project Sampling and Testing Costs (by rank) | 1-22 |
| Figure 1-5 | Processing Time | 1-33 |
| Figure 1-6 | Cost Analysis - Project Size Versus Unit Cost | 1-36 |
| Figure 1-7 | Rank Versus Unit Testing Costs | 1-37 |
| Figure 1-8 | Chemistry Unit Cost | 1-38 |
| Figure 1-9 | Bioassay Suite Unit Cost Analysis | 1-38 |
| Figure 1-10 | PSDDA Program Retrospective | 1-40 |
| Figure 2-1 | Dredging Year 1992 Disposal Volumes | 2-2 |
| Figure 2-2 | Dredging Year 1993 Disposal Volumes | 2-5 |
| Figure 2-3 | Elliott Bay PSDDA Disposal Site | 2-10 |
| Figure 2-4 | Comparative Copper and Lead Concentrations, 1988-1992 | 2-11 |
| Figure 2-5 | On-site Chemical Concentrations, 1988-1992 | 2-13 |
| Figure 2-6 | Bellingham Bay PSDDA Disposal Site | 2-16 |
| Figure 2-7 | Cumulative Disposal Volumes, 1989-1993 | 2-19 |
| Figure 3-1 | Sediment Larval Seawater Control Performance | 3-22 |
| Figure 3-2 | Sediment Larval Reference and Test Sediment Performance | 3-23 |
| Figure 3-3 | Reference and Test Sediment Standard Deviation Distribution | 3-24 |

## LIST OF ACRONYMS

| | |
|---|---|
| AET | Apparent Effects Threshold |
| ARM | Annual Review Meeting |
| BT | Bioaccumulation Trigger |
| COC | Chemical of Concern |
| CWA | Clean Water Act |
| CY | Cubic Yard |
| DAIS | Dredged Analysis Information System |
| DFW | Department of Fisheries and Wildlife |
| DMEAR | Dredged Material Evaluation Application Report |
| DMMO | Dredged Material Management Office |
| DMMU | Dredged Material Management Unit |
| DNR | Department of Natural Resources |
| DY | Dredging Year |
| EPA | Environmental Protection Agency |
| EPTA | Evaluation Procedures Technical Appendix |
| FC | Full Characterization |
| GIS | Geographic Information System |
| HPA | Hydraulic Project Approval |
| HPAH | High-molecular-weight PAH |
| LPAH | Low-molecular-weight PAH |
| ML | Maximum Level |
| MPAR | Management Plan Assessment Report |
| MPR | Management Plan Report |
| NOAA | National Oceanic and Atmospheric Administration |
| NRDA | Natural Resource Damage Assessment |
| O&M | Operations and Maintenance |
| PAH | Polynuclear Aromatic Hydrocarbon |
| PC | Partial Characterization |
| PCBs | Polychlorinated Biphenyls |
| PPB | Parts Per Billion |
| PPM | Parts Per Million |
| PSDDA | Puget Sound Dredged Disposal Analysis |
| PSEP | Puget Sound Estuary Program |
| PSVTS | Puget Sound Vessel Traffic Service |
| QA/QC | Quality Assurance/Quality Control |
| SAP | Sampling and Analysis Plan |
| SMS | Sediment Management Standards |
| SL | Screening Level |
| TOC | Total Organic Carbon |
| USACE | U.S. Army Corps of Engineers |

## EXECUTIVE SUMMARY

This first PSDDA Biennial Report consolidates the same types of information contained in the three reports previously prepared by the PSDDA agencies on an annual basis. The report covers the application of PSDDA sediment evaluation procedures to dredging projects, summarizes disposal activities and site monitoring, and discusses program modifications and status reports for the 1992 and 1993 dredging years (DY 1992/1993, June 16, 1991 -- June 15, 1993).

There was a marked increase in the number and complexity of dredging projects proposed during DY 1992/1993. This increased complexity was primarily caused by projects involving a) extensive port development in contaminated areas, and b) simultaneous sampling and testing of sediment under PSDDA, federal (CERCLA) and/or state cleanup programs (Sediment Management Standards, Chapter 173-204 WAC). These project areas were often spatially heterogeneous with respect to levels of sediment contamination, located near sources of contaminants, or exposed to local chemicals of concern. In a few cases, the beneficial reuse of material tested under PSDDA contributed to project complexity. The agencies met these challenges by effectively pooling their resources and continuing the close coordination characteristic of the PSDDA program.

The results of chemical testing of sediment samples during DY 1992/1993 showed fewer instances where laboratories could not achieve analytical detection limits at or below PSDDA screening levels (SL). This problem, which surfaced during early years of implementation, was alleviated in part because certain SL values had been raised by the PSDDA agencies during DY 1990-1991. The 10-day amphipod bioassay continued to perform well, while the sediment larval bioassay protocols and interpretation guidelines required minor adjustments. A chronic sublethal bioassay using the juvenile polychaete *Neanthes arenaceodentata* was adopted for use; the 10-day mortality endpoint used in DY 1992 was replaced by the 20-day biomass endpoint beginning in DY 1993. The saline extract Microtox test was still in use but undergoing critical review. It is noteworthy that the overall costs of sampling and chemical/biological testing ($0.67/cubic yard) for DY 1992/1993 remained similar to previous dredging years.

A total of 643,000 cubic yards (CY) of dredged material was placed at six disposal sites during DY 1992/1993. Three of these, the Anderson/Ketron Island, Bellingham Bay and Port Townsend sites, had not previously been used. The Elliott Bay disposal site received enough material (242,000 cy) to trigger full monitoring in spring 1992, following a partial monitoring in 1990. The full monitoring data showed that the dredged material was accurately placed and resulted in no unacceptable biological effects on or outside of the site. There was evidence of minor bay-wide changes in sediment quality (increased copper, for example) which were unrelated to PSDDA disposal activities. In addition, the first post-disposal monitoring of the Bellingham Bay site was conducted in spring 1993. The physical mapping of the site and the perimeter chemistry results from this partial monitoring effort indicated that the dredged material was deposited on site and that the site management biological effects condition was met.

DY 1992/1993 witnessed a continued decline in DNR's dredge fund, the source of funds for monitoring the PSDDA disposal sites. Revenues from disposal fees were unpredictable because of delays in actual dredging and disposal. For much the same reason, it remained difficult to accurately predict the costs of future monitoring events.

This report also describes project processing and the progress made by the PSDDA agencies to improve sediment data management, revise guideline values and anticipate new challenges to the program.

Data management capabilities at both the Corps and Ecology were enhanced. For example, the Corps expanded its DAIS database to accommodate sediment vertical profile camera data, benthic infaunal abundance and bioaccumulation data. It also linked DAIS more effectively to geographic information system displays. The update of PSDDA guideline values neared completion in DY 1993. Some changes to ML and SL values will likely be recommended at the 1995 ARM, after adequate review by the PSDDA Regulatory Work Group and the public.

Although not described in this report, PSDDA agencies began a long-term process to examine larger interdisciplinary issues which loom on the horizon of sediment management in the Puget Sound. These included discussions of issues such as:

1. the need for a strategy to site, fund, construct and assign future liability for a multi-user confined site(s) for disposal of contaminated dredged material

2. defining what constitutes "beneficial uses" of dredged material and devising the optimal coordinated strategy to identify beneficial use opportunities

3. the need for a coordinated, interagency strategy to cleanup contaminated sediments, addressing such impediments to cleanup as the difficulty in assigning liability and inadequate funds

4. how to plan, locate and manage mitigated or restored aquatic habitats within the landscape of commerce and dredging activity

5. the need for comprehensive bay-wide management plans which include, for example, source control, management of dredged materials and cleanup of contaminated sediments

Recommendations from the management of the PSDDA agencies on these issues are forthcoming and may be presented at the 1994 ARM.

# PSDDA BIENNIAL REPORT
# DREDGING YEARS 1992/1993

This report summarizes the application of the PSDDA sediment evaluation guidelines to dredging projects during Dredging Years (DY) 1992 and 1993. It also describes the disposal of tested material at the eight PSDDA open-water disposal sites in Puget Sound during that period. Minor clarifications of the evaluation procedures, status reports on work undertaken by the agencies, and papers discussing major issues are also presented in preparation for the sixth annual review meeting (ARM). The format of this report has changed from prior years to consolidate, under one cover, the reporting requirements of the Corps, DNR and Ecology pursuant to the PSDDA Phase I and II Management Plan Reports (MPR). This report includes information previously reported in the Dredged Material Evaluation Application Report (DMEAR) and in the Management Plan Assessment Report (MPAR). The intention was to streamline the reporting process and provide readers with all important information in one report.

This report covers the period June 16, 1991 to June 15, 1993 and is divided into three chapters. Chapter 1 reviews PSDDA project evaluation activities for DY 92/93. Chapter 2 describes PSDDA disposal operations and the associated disposal site monitoring activities which occurred in DY 92/93. Chapter 3 presents program issue papers, clarifications and status reports of on-going activities.

# CHAPTER 1

# PSDDA EVALUATION ACTIVITIES

## A. INTRODUCTION

This chapter summarizes the application of PSDDA evaluation guidelines for Dredging Years 1992 and 1993. Tables related to project-specific ranking, sampling, testing, suitability determinations and costs are presented in the first part of the chapter. The second half of the chapter presents an overall assessment of these activities and data. Where projects involved unusual circumstances or the application of best professional judgement by the agencies, more detailed descriptions are provided in Appendix A.

During DY92/93, there were forty-two projects at some stage of the PSDDA process. Table 1-1 provides a complete summary of these activities. Activities which occurred in other dredging years are indicated by parentheses.

Of the projects listed in Table 1-1, seventeen had final suitability determinations made, or applications withdrawn, by June 15, 1992 and are considered DY92 projects for the purpose of this chapter. Another fourteen projects had suitability determinations or partial characterization ranking determinations completed, or had their permit applications withdrawn by June 15, 1993. These are considered DY93 projects. DY92 and DY93 project locations can be seen in Figures 1-1a and 1-1b respectively.

The additional projects shown for DY94 and beyond either had initial ranking determinations made or sampling plans approved prior to June 15, 1993 but did not receive suitability determinations prior to June 15, 1993. These projects are presented here to provide a complete summary of all DY92/93 activities but will not be considered further in this report.

TABLE 1-1. DY92/93 PSDDA EVALUATION ACTIVITIES

| PROJECT | Project Volume (CY) | Ranking Determination | Sampling Plan Approval | Suitability Determination |
|---|---|---|---|---|
| *Dredging Year 1992:* | | | | |
| Day Island Yacht Club | 9,000 | (91)[1] | 92 | 92 |
| Port of Everett-10th Street Boat Ramp | 12,340 | (91) | 92 | 92 |
| Port of Everett-12th Street Channel | 80,400 | 92 | 92 | 92 |
| LaConner Boat Works | 4,200 | 92 | N/A | 92 |
| LOTT Olympia Treatment Plant Outfall | 7,975 | (91) | 92 | 92 |
| Morton Marine | 4,000 | 92 | 92 | 92 |
| City of Renton-Cedar River Delta | 111,800 | 92 | 92 | 92 |
| Port of Seattle-American Presidents Line | 8,000 | 92 | 92 | 92 |
| Port of Seattle-Terminal 5 | 12,000 | (91) | (91) | 92 |
| South Park Marina | 8,000 | (89) | 92 | 92 |
| Port of Tacoma Blair Waterway | 594,000 | (91) | (91) | 92 |
| USACE/Port of Bellingham Waterways | 303,125 | (91) | 92 | 92 |
| USACE Duwamish, DY 92 | 196,089 | (91) | 92 | 92 |
| US Navy Bangor TRF Dock (North) | 10,300 | 92 | 92 | 92 |
| US Navy Bangor TRF Dock (South) | 9,500 | 92 | 92 | AW |
| US Navy Bremerton Pier D (Round 1) | 171,400 | (91) | (91) | 92 |
| US Navy Keyport KB Dock | 4,500 | 92 | 92 | 92 |
| *Dredging Year 1993:* | | | | |
| Boyer Alaska Barge Line | 4,000 | 92 | 92 | AW |
| Port of Everett-South Terminal PC | 610,000 | N/A | 92 | 93[2] |
| King County Sammamish River | 16,800 | 93 | 93 | 93 |
| LaConner Marina | 112,000 | 93 | 93 | 93 |
| Lone Star Northwest-West Terminal | 3,900 | 92 | 92 | 93 |
| Pratt/Todd Private Moorage | 700 | 93 | N/A | 93 |
| Port of Seattle-Southwest Harbor PC | 169,000 | N/A | 92 | 93[2] |
| Port of Seattle-Terminal 91 | 11,000 | 92 | 92 | 93 |

| PROJECT | Project Volume (CY) | Ranking Determination | Sampling Plan Approval | Suitability Determination |
|---|---|---|---|---|
| *Dredging Year 1993 (continued):* | | | | |
| Port of Seattle-Terminal 115 | 3,000 | 93 | 93 | 93 |
| Shell Oil Company | 21,800 | 92 | 92 | 93 |
| USACE Duwamish DY93 | 60,000 | 93 | N/A | 93 |
| USACE Everett Downstream PC | 462,243 | 93 | 93 | 93[2] |
| USACE Everett Downstream FC | 462,243 | 93 | 93 | 93 |
| US Navy Homeport-Element II | 428,000 | (90) | (91) | 93 |
| *Dredging Year 1994 and beyond:* | | | | |
| City of Bremerton Outfall | 2,600 | 93 | 93 | (94) |
| Port of Brownsville Marina | 10,000 | 93 | 93 | (94) |
| Port of Everett-Piers 1 and 3 | 51,000 | (94) | (94) | |
| Port of Everett-South Terminal FC | 183,000 | 93 | (94) | |
| Hylebos Waterway Remediation | TBD | 93 | | |
| Indian Cove Moorage | 8,000 | 93 | 93 | (94) |
| Konoike-Pacific Terminals | 10,500 | 93 | 93 | |
| Lonestar Northwest-Hylebos | 7,000 | (94) | (94) | |
| METRO Emergency Bypass | 8,100 | 93 | 93 | AW |
| Port of Seattle-Terminal 30 | 33,4000 | 93 | (94) | (94) |
| Sinclair Inlet Marina | 1,900 | 92 | (94) | (94) |
| Thea Foss Waterway Remediation | TBD | (94) | | |
| US Navy Bremerton-Pier D (Round 2) | 105,100 | (91) | (94) | |
| US Navy Everett-Norton Terminal | 115,000 | 93 | 93 | (94) |

[1]Activities noted in parentheses occurred outside DY92/93.
[2]Reranking determination based on partial characterization results
TBD: to be determined
AW: application for open-water disposal withdrawn
N/A: not applicable

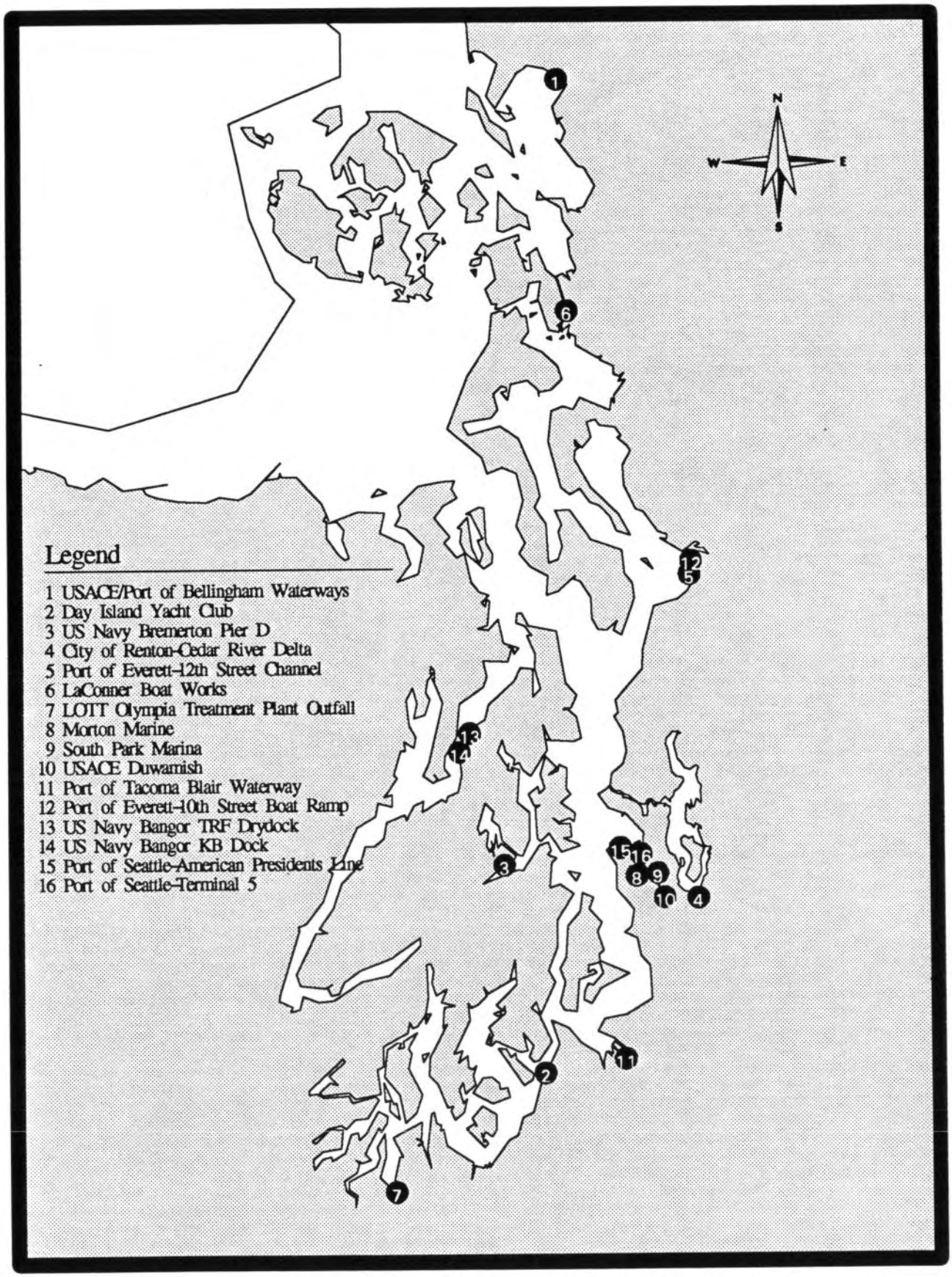



**Figure 1-1a. Dredging Year 1992 Project Locations**

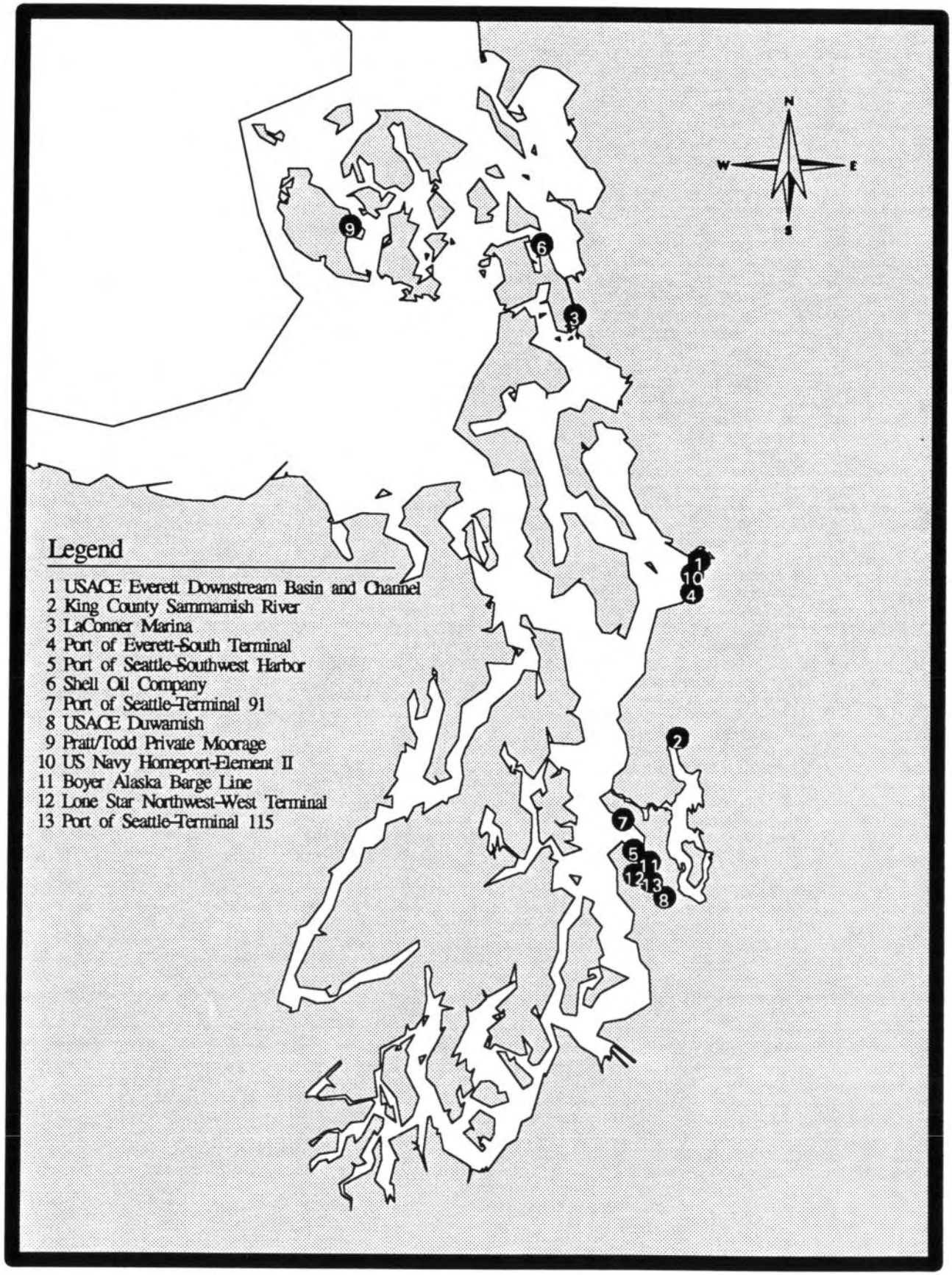



**Figure 1-1b. Dredging Year 1993 Project Locations**

## B. DY92/93 PROJECTS

### Ranking

Sampling and analysis requirements under the PSDDA program are fully explained in the 1988 Phase I Evaluation Procedures Technical Appendix (EPTA) and the 1989 Phase II MPR. Under these guidelines, the initial appraisal of a proposed dredging project requires a careful examination of all existing sediment quality data within the dredging area. An initial area ranking is based on a "reason to believe" that chemicals of concern may or may not be present in the project area. The PSDDA agencies have established ranks for general areas (eg. Elliott Bay) and activities (eg. marinas) based on historical data or awareness of active sources of contamination. In the absence of project-specific data, representatives of the Corps of Engineers, Washington State Departments of Ecology and Natural Resources, and the Environmental Protection Agency apply an initial ranking based on guidance contained in the Phase I and Phase II documents (EPTA: page II-40; Phase II MPR: page A-10).

PSDDA guidelines allow for a reconsideration of the initial ranking if historical data at the site are adequate or the applicant conducts a partial characterization (PC) as described in EPTA (pages II-63 to II-65) to survey sediments in the project area for the PSDDA chemicals of concern (COCs). If the PC chemistry data support a lower ranking (using criteria stipulated in EPTA: pages II-63 to II-65), sampling and analysis requirements for surface and subsurface sediments may be reduced during the full characterization (FC), commensurate with the revised ranking requirements. Chemicals of concern may also be eliminated for analysis during the FC, based on the PC data. Table 1-2 contains the initial and full characterization rankings of all DY92/93 projects. The "initial rank" was taken from the PSDDA Phase II MPR, pages A-10 and A-11. The "full characterization" rank was the rank actually used in the full characterization of project sediments. Of seventeen DY92 projects, two had ranking adjustments made. Of fourteen DY93 projects, two were reranked based on partial characterization data, and a third was reranked upon review of historical data.

### Sampling and Analysis Plans

Approved sampling and analysis plans are required before applicants collect representative sediment samples for either a PC or FC. The applicant or dredging consultant receives guidance in sampling plan development based on the ranking which has been assigned to the proposed project. In close coordination with the Corps of Engineers' Dredged Material Management Office (DMMO), a conceptual dredging plan and representative sampling plan are established. Protocols for station positioning, decontamination, field sampling, compositing, chemical analysis, biological testing, QA/QC and data submittal are all included in the sampling and analysis plan. Once completed, DMMO coordinates review and approval of the plan with representatives of the PSDDA agencies.

Table 1-3 contains data related to sampling plans approved for DY92/93 projects. Application of PSDDA sampling and analysis requirements resulted in the number of field samples and dredged material management units (DMMUs) formulated for each of the projects.

Descriptions of those projects for which no testing was required, or for which best professional judgement was applied, are discussed in the project descriptions in Appendix A.

Sampling

Table 1-4 contains data related to sampling efforts during DY92/93. Two general requirements for PSDDA sampling are to sample to the depth of dredging (including overdepth), and to provide positioning data to a minimum precision of one-tenth of a second ($\pm 2$ meters), latitude and longitude. For the majority of the projects listed in the table, the maximum sediment depths correspond to both the actual length of the deepest boring as well as to the maximum depth of the dredging prism including overdepth. In high-ranked areas there is an additional requirement to provide an archived sample from the one foot of sediment beyond the dredging prism. This additional depth is not reflected in the table. A variety of positioning techniques were used to provide the required precision. Great emphasis is placed on positioning in order to provide high-quality data. Precise positioning is important to provide repeatability in sampling and to provide data which can be utilized in a geographic information system (GIS).

Chemical Testing

Chemical testing was conducted for sixteen projects in DY92 and twelve projects in DY93. During DY92, one project, LaConner Boatworks, did not require testing based on PSDDA no-test guidelines. In DY 93, two projects did not require chemical testing. USACE Duwamish dredging did not require testing based on frequency guidelines, and the Pratt/Todd moorage was not tested based on small project, no-test guidelines. In general, the QA/QC for projects undergoing testing was excellent, and acceptable by the PSDDA agencies for regulatory decision-making. A complete listing of PSDDA sediment guideline value exceedances for DY92/93 projects is included in Appendix C.

Biological Testing

Biological testing data can be found in Table 1-5. For those projects undergoing tiered testing, only those DMMUs which had exceedances of SLs were subject to biological testing. Based on a reason-to-believe that at least one COC would exceed SL, and to save time in the testing process, several project proponents opted for concurrent biological testing. The 20-day *Neanthes* biomass test was instituted at the beginning of DY93, replacing the 10-day *Neanthes* mortality bioassay.

Suitability Determinations

A suitability determination outlines the evaluation procedures used in the characterization of project sediments, summarizes chemical and biological testing data and associated QA/QC issues, and documents the interpretation of testing results. The suitability determination is a technical memorandum, drafted by the Corps' DMMO, and signed by PSDDA representatives from the Corps of Engineers, Environmental Protection Agency, Department of Ecology and Department of Natural Resources. The suitability determination documents the suitability of proposed dredged sediments for open-water disposal at one of the eight PSDDA sites. It does not, however,

constitute final project approval by the agencies. Comprehensive agency comments on the overall project are provided through the regulatory public notice and review process.

Table 1-6 contains information taken from the suitability determinations for each of the projects which completed their PSDDA review during DY92/93. For the sixteen projects receiving suitability determinations in DY92, three had at least one DMMU which was found unsuitable for open-water disposal under PSDDA evaluation guidelines. In DY93, of eleven projects receiving suitability determinations, again three had at least one DMMU that was found unsuitable for open-water disposal.

Cost Data

Figure 1-2 shows the total costs for DY92/93 projects which submitted cost data to the DMMO. Cost data were submitted for twenty-one projects. Cost data were not submitted for one DY92 project (Port of Seattle American Presidents Line) and six DY93 projects (Port of Seattle Terminal 115, Boyer Alaska Barge Line, LaConner Marina, Shell Oil Company, Port of Seattle Southwest Harbor PC, and Port of Everett South Terminal PC). The latter two DY93 projects are still underway, and costs will be analyzed in the next biennial report. Cost data submitted for the Renton Cedar River project do not include costs for freshwater bioassays required by Ecology for Water Quality Certification. Cost data for the Corps of Engineers' navigation channel dredging and the Port of Bellingham's berthing areas in Bellingham Harbor were summarized jointly for this report.

Total project costs were divided by the total number of DMMUs for each project and are shown in Figure 1-3. The average DMMU sampling, chemical analysis, biological analysis and miscellaneous costs are depicted for comparison among projects.

Figure 1-4 shows project costs on a per-cubic-yard basis compared with project-specific testing volumes. The projects are grouped within each assigned area ranking. Three projects had multiple ranking, and the estimated costs within each rank were distributed among ranking subareas on a cost-per-DMMU basis for comparison. For the Port of Tacoma Blair Waterway dredging project, the PSDDA agencies assigned a moderate rank for the surface material (0-4 feet) and a low-moderate rank for the subsurface material (>4 feet). The Corps' Duwamish maintenance dredging project included low-moderate material within the upper-turning basin, and high-ranked material downstream from the basin. The Corps and Port of Bellingham maintenance dredging project included two high-ranked waterways and one moderate-ranked waterway. The project-specific data illustrate how the volume of the project influences the testing cost per cubic yard.

TABLE 1-2a. DY92 PROJECT RANKING

| PROJECT | LOCATION | WATERBODY | INITIAL RANK | FULL CHARACTERIZATION RANK |
|---|---|---|---|---|
| Day Island Yacht Club | Tacoma | Day Island Waterway | M | M |
| Port of Everett-10th Street Boat Ramp | Everett | Port Gardner | M | M |
| Port of Everett-12th Street Channel | Everett | Port Gardner | M | M |
| LaConner Boat Works | LaConner | Swinomish Channel | L | L |
| LOTT Olympia Treatment Plant Outfall | Olympia | Budd Inlet | H | H |
| Morton Marine | Seattle | Duwamish | H | H |
| City of Renton-Cedar River Delta | Renton | Lake Washington | M | M |
| Port of Seattle-American Presidents Line | Seattle | West Waterway | H | H |
| Port of Seattle Terminal 5 | Seattle | West Waterway | H | H |
| South Park Marina | Seattle | Duwamish River | H | H |
| Port of Tacoma Blair Waterway | Tacoma | Blair Waterway | H | M/LM |
| USACE/Port of Bellingham Waterways | Bellingham | Bellingham Bay | H | H/M |
| USACE Duwamish | Seattle | Duwamish River | H/LM | H/LM |
| US Navy Bangor TRF Dock (North) | Bangor | Hood Canal | M | M |
| US Navy Bangor TRF Dock (South) | Bangor | Hood Canal | M | M |
| US Navy Bremerton Pier D (Round 1) | Bremerton | Sinclair Inlet | H | H |
| US Navy Bangor KB Dock | Keyport | Hood Canal | M | M |

TABLE 1-2b. DY93 PROJECT RANKING

| PROJECT | LOCATION | WATERBODY | INITIAL RANK | FULL CHARACTERIZATION RANK |
|---|---|---|---|---|
| Boyer Alaska Barge Line | Seattle | Duwamish River | H | H |
| Port of Everett-South Terminal PC | Everett | Port Gardner | H | N/A |
| King County Sammamish River | Kenmore | Lake Washington | H | H |
| LaConner Marina | LaConner | Swinomish Channel | M | M |
| Lone Star Northwest-West Terminal | Seattle | Duwamish River | H | H |
| Pratt/Todd Private Moorage | Friday Harbor | Friday Harbor | M | N/A |
| Port of Seattle-Southwest Harbor PC | Seattle | West Waterway | H | N/A |
| Port of Seattle-Terminal 91 | Seattle | Elliott Bay | H | H |
| Port of Seattle-Terminal 115 | Seattle | West Waterway | H | H |
| Shell Oil Company | Anacortes | Guemes Channel | M | M |
| USACE Duwamish | Seattle | Duwamish River | LM | LM |
| USACE Everett Downstream PC | Everett | Snohomish River | M | N/A |
| USACE Everett Downstream FC | Everett | Snohomish River | M | LM |
| US Navy Homeport - Element II | Everett | Port Gardner | M | LM |

Abbreviations:

L = Low
LM = Low-Moderate
M = Moderate
H = High
N/A = Not Applicable

TABLE 1-3a. DY92 PROJECTS - APPROVED SAMPLING PLANS

| PROJECT | Rank | Total Volume (CY) | Surface Volume (CY) | Number of Surface Samples | Number of Surface DMMUs | Subsurface Volume (CY) | Number of Subsurface Samples | Number of Subsurface DMMUs |
|---|---|---|---|---|---|---|---|---|
| Day Island Yacht Club | M | 9,000 | 9,000 | 5 | 1 | 0 | 0 | 0 |
| Port of Everett 10th St | M | 12,340 | 12,340 | 6 | 2 | 0 | 0 | 0 |
| Port of Everett 12th St | M | 80,400 | 37,100 | 11 | 5 | 43,300 | 16 | 3 |
| LaConner Boat Works | L | 4,200 | N/A | N/A | N/A | N/A | N/A | N/A |
| LOTT Olympia Outfall | H | 7,975 | 5,355 | 3 | 2 | 2,620 | 1 | 1 |
| Morton Marine | H | 4,000 | 4,000 | 2 | 1 | 0 | 0 | 0 |
| Renton-Cedar River | M | 111,800 | 67,950 | 10 | 3 | 43,850 | 10 | 2 |
| Port of Seattle-APL | H | 8,000 | 4,000 | 2 | 1 | 4,000 | 2 | 1 |
| Port of Seattle-T5 | H | 12,000 | 12,000 | 6 | 3 | 0 | 0 | 0 |
| South Park Marina | H | 8,000 | 8,000 | 4 | 2 | 0 | 0 | 0 |
| Port of Tacoma Blair | M/LM | 594,000 | 345,500 | 65 | 22 | 248,500 | 31 | 5 |
| Bellingham Waterways | H/LM | 303,125 | 211,599 | 57 | 27 | 91,526 | 37 | 6 |
| USACE Duwamish | H/LM | 196,089 | 139,808 | 29 | 24 | 56,281 | 8 | 1 |
| Navy Bangor TRF (N) | M | 10,300 | 5,100 | 2 | 1 | 5,200 | 2 | 1 |
| Navy Bangor TRF (S) | M | 9,500 | 4,900 | 2 | 1 | 4,600 | 2 | 1 |
| Navy Bremerton Pier D | H | 171,400 | 77,600 | 23 | 20 | 93,800 | 30 | 8 |
| Navy Keyport KB Dock | M | 7,400 | 4,400 | 2 | 1 | 3,000 | 2 | 1 |
| Total: | | 1,549,529 | 948,652 | 229 | 116 | 596,677 | 141 | 30 |

TABLE 1-3b. DY93 PROJECTS - APPROVED SAMPLING PLANS

| PROJECT | Rank | Total Volume (CY) | Surface Volume (CY) | Number of Surface Samples | Number of Surface DMMUs | Subsurface Volume (CY) | Number of Subsurface Samples | Number of Subsurface DMMUs |
|---|---|---|---|---|---|---|---|---|
| Boyer Alaska Barge Line | H | 4,000 | 4,000 | 4 | 1 | 0 | 0 | 0 |
| POE South Terminal PC | H | 610,000 | 166,000 | 14 | N/A | 444,000 | 4 | N/A |
| KC Sammamish River | H | 16,800 | 16,800 | 4 | 4 | 0 | 0 | 0 |
| LaConner Marina | M | 70,900 | 70,900 | 19 | 5 | 0 | 0 | 0 |
| Lone Star-West Terminal | H | 3,900 | 3,900 | 2 | 1 | 0 | 0 | 0 |
| Pratt/Todd Moorage | M | 700 | N/A | N/A | N/A | N/A | N/A | N/A |
| POS-SW Harbor PC | H | 163,400 | 38,900 | 2 | N/A | 124,500 | 4 | N/A |
| POS-Terminal 91 | H | 11,000 | 11,000 | 3 | 3 | 0 | 0 | 0 |
| POS-Terminal 115 | H | 3,000 | 3,000 | 5 | 2 | 0 | 0 | 0 |
| Shell Oil Company | M | 26,636 | 18,647 | 5 | 2 | 7,989 | 2 | 1 |
| USACE Duwamish | LM | 60,000 | N/A | N/A | N/A | N/A | N/A | N/A |
| USACE Everett PC | M | 462,243 | 187,000 | 5 | N/A | 275,243 | 0 | N/A |
| USACE Everett FC | LM | 462,243 | 187,000 | 28 | 7 | 275,243 | 36 | 5 |
| Homeport-Element II | LM | 428,000 | 88,000 | 11 | 3 | 340,000 | 47 | 9 |
| Total[1] | | 1,087,179 | 403,247 | 81 | 28 | 623,232 | 85 | 15 |

[1]PC data not included in total

TABLE 1-4a. DY92 PROJECT SAMPLING

| PROJECT | GRAIN SIZE (PERCENTAGES) | | | | SAMPLING EQUIPMENT | MAXIMUM SEDIMENT DEPTH (FT) | MEAN SEDIMENT DEPTH (FT) |
|---|---|---|---|---|---|---|---|
| | GRAVEL >2 mm | SAND .063-2 mm | SILT .004-.063 mm | CLAY <.004 mm | | | |
| Day Island Yacht Club | 20 | 50 | 25 | 5 | Impact corer-dropped weights | 3.0 | 2.4 |
| Port of Everett-10th Street | 0-1 | 25-47 | 39-57 | 10-14 | Vibracore | 9.0 | 6.7 |
| Port of Everett-12th Street | 0-4 | 9-62 | 30-76 | 8-25 | Impact corer-hydraulic hammer | 15 | 10.4 |
| LOTT Olympia Outfall | 3-21 | 34-72 | 8-37 | 15-18 | Hollow-stem auger (round 1)<br>Diver-operated corer (round 2) | 12 | 8 |
| Morton Marine | 0-3 | 66-69 | 25-28 | 5-6 | Impact corer-dropped weights | 4 | 4 |
| Renton-Cedar River | 1-57 | 37-93 | 4-15 | 0-2 | Impact corer-mechanical hammer | 8 | 5.7 |
| Port of Seattle-APL | 1 | 67-92 | 5-25 | 2-8 | Impact corer-hydraulic hammer | 8.0 | 7.8 |
| Port of Seattle-Terminal 5 | 3-5 | 83-87 | 5-10 | 2-6 | Impact corer-hydraulic hammer | 8 | 5.8 |
| South Park Marina | 0-1 | 30-35 | 56-61 | 8-11 | Impact corer-dropped weights | 4 | 4 |
| Port of Tacoma Blair | 0-3 | 26-89 | 9-59 | 1-17 | Impact corer-hydraulic hammer | 12 | 7.8 |
| Bellingham Waterways | 0-68 | 3-79 | 6-90 | 2-31 | Vibracore | 12 | 4 |
| USACE Duwamish | 0-1 | 17-62 | 31-67 | 7-29 | Vibracore | 14 | 6.2 |
| Navy Bangor TRF (N) | 22-42 | 43-49 | 12-24 | 2-5 | Auger/split-spoon sampler | 10 | 6.5 |
| Navy Pier D (Round 1) | 0-41 | 9-85 | 11-68 | 3-28 | Auger/Gregory sampler<br>Split spoon sampler<br>Diver push core/grab sampler | 13 | 10 |
| Navy Keyport KB Dock | 6-29 | 66-82 | 2-8 | 3-4 | Impact corer-hydraulic hammer | 8 | 7.3 |

TABLE 1-4b. DY93 PROJECT SAMPLING

| PROJECT | GRAIN SIZE (PERCENTAGES) | | | | SAMPLING EQUIPMENT | MAXIMUM SEDIMENT DEPTH (FT) | MEAN SEDIMENT DEPTH (FT) |
|---|---|---|---|---|---|---|---|
| | GRAVEL >2 mm | SAND .063-2 mm | SILT .004-.063 mm | CLAY <.004 mm | | | |
| POE South Terminal PC | 0-34[1] | 33-94 | 2-35 | 0-18 | Impact corer-hydraulic hammer | 16.0 | 6.5 |
| KC Sammamish River | 1-2 | 76-88 | 10-23 | 0-2 | Impact corer-hydraulic hammer | 5.4 | 4.8 |
| LaConner Marina | 0-2 | 7-26 | 65-78 | 8-10 | Impact corer-dropped weights | 4 | 3.5 |
| Lone Star West Terminal | 1-3 | 10-12 | 52-76 | 12-37 | Diver-operated auger | 5 | 4.5 |
| POS-SW Harbor PC | 0-2 | 33-85 | 13-64 | 0-13 | Auger/gus sampler | 12 | 6 |
| POS-Terminal 91 | 33 | 48 | 17 | 1 | Impact corer-hydraulic hammer | 7.5 | 7.5 |
| POS-Terminal 115 | 0-11 | 45-48 | 42-49 | 2-4 | Impact corer-hydraulic hammer | 5.9 | 4.7 |
| Shell Oil Company | 1-22 | 35-58 | 18-44 | 12-18 | Auger/gus sampler | 10 | 3.7 |
| USACE Everett PC | 0-3 | 56-98 | 2-35 | 0-8 | Vibracore | 4 | 4 |
| USACE Everett FC | 0-3 | 40-88 | 9-56 | 0-12 | Vibracore | 16 | 11.8 |
| Homeport-Element II | 0-2 | 22-51 | 37-64 | 1-12 | Impact corer/auger | 30 | 30 |

[1]Much of the >2mm fraction was wood waste.

TABLE 1-5a. DY92 BIOLOGICAL TESTING DATA

| PROJECT | Number of Biological Analyses | Number of Analyses Failing Bioassays | Number Undergoing Concurrent Testing | Number Undergoing Tiered Testing | Bioassays Conducted (✓ = Yes) | | | | Sediment Larval Species | Control Sediment Location | Reference Sediment Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Amphipod (1) | Sediment Larval | Microtox (2) | Juvenile Infaunal (3) | | | |
| Day Island YC | 1 | 0 | 0 | 1 | ✓ | ✓ | ✓ | ✓ (M) | *D. excentricus* | West Beach | Carr Inlet |
| POE 10th Street | 1 | 0 | 0 | 1 | ✓ | ✓ | ✓ | ✓ (M) | *D. excentricus* | West Beach | Carr Inlet |
| POE 12th Street | 6 | 0 | 0 | 6 | ✓ | ✓ | ✓ | ✓ (M) | *D. excentricus* | West Beach | Carr Inlet |
| LOTT (Round 1) | 3 | 0 | 3 | 0 | ✓ | — | — | — | — | West Beach | Samish Bay |
| LOTT (Round 2) | 1 | 0 | 0 | 1 | ✓ | ✓ | ✓ | ✓ (M) | *D. excentricus* | West Beach | Carr Inlet |
| Morton Marine | 1 | 0 | 1 | 0 | ✓ | ✓ | ✓ | ✓ (M) | *D. excentricus* | West Beach | Carr Inlet |
| POS-APL | 2 | 0 | 2 | 0 | ✓ | ✓ | ✓ | ✓ (M) | *D. excentricus* | West Beach | Carr Inlet |
| POS-Terminal 5 | 3 | 0 | 3 | 0 | ✓ | ✓ | ✓ | ✓ (M) | *D. excentricus* | West Beach | West Beach |
| South Park Marina | 2 | 0 | 2 | 0 | ✓ | ✓ | ✓ | ✓ (M) | *D. excentricus* | West Beach | Carr Inlet |
| Blair Waterway | 27 | 0 | 27 | 0 | ✓ | ✓ | ✓ | ✓ (M) | *D. excentricus* | West Beach | Jetty Island |
| Bellingham Waterways | 20 | 5 ND<br>9 D | 0 | 20 | ✓ | ✓ | ✓ | ✓ (M) | *D. excentricus* | West Beach | Sequim Bay<br>Samish Bay<br>Jetty Island |
| USACE Duwamish | 16 | 0 | 0 | 16 | ✓ | ✓ | ✓ | ✓ (M) | *D. excentricus* | West Beach | Carr/Samish |
| US Navy-Pier D | 28 | 16 ND | 28 | 0 | ✓ | ✓ | ✓ | ✓ (M) | *D. excentricus* | West Beach | Samish Bay |
| Total | 111 | 21 ND | 66 | 45 | | | | | | | |

(1) *Rhepoxynius abronius*
(2) *Photobacterium phosphoreum*
(3) *Neanthes arenaceodentata*

D = Dispersive guidelines
ND = Non-Dispersive guidelines

M = 10-day mortality test
B = 20-day biomass test

TABLE 1-5b. DY93 BIOLOGICAL TESTING DATA

| PROJECT | Number of Biological Analyses | Number of Analyses Failing Bioassays | Number Undergoing Concurrent Testing | Number Undergoing Tiered Testing | Bioassays Conducted (✓ = Yes) | | | | Sediment Larval Species | Control Sediment Location | Reference Sediment Location |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Amphipod (1) | Sediment Larval | Microtox (2) | Juvenile Infaunal (3) | | | |
| Sammamish River | 1 | 0 | 0 | 1 | ✓. | ✓ | ✓ | ✓ (B) | *D. excentricus* | West Beach | West Beach |
| LS West Terminal | 1 | 0 | 0 | 1 | ✓ | ✓ | ✓ | ✓ (M) | *D. excentricus* | West Beach | Holmes Har. |
| POS-T91 | 3 | 2 ND | 3 | 0 | ✓ | ✓ | ✓ | ✓ (M) | *S. purpuratus* | West Beach | Carr Inlet |
| POS-T115 | 2 | 0 | 2 | 0 | ✓ | ✓ | ✓ | ✓ (B) | *D. excentricus* | West Beach | Carr Inlet |
| USACE Everett | 3 | 0 | 0 | 3 | ✓ | ✓ | ✓ | ✓ (B) | *D. excentricus* | West Beach | WB/Carr |
| Homeport II | 4 | 1 ND | 0 | 4 | ✓ | ✓ | ✓ | ✓(M) | *D. excentricus* | West Beach | Jetty Island |
| Total | 14 | 3 ND | 5 | 9 | | | | | | | |

(1) *Rhepoxynius abronius*
(2) *Photobacterium phosphoreum*
(3) *Neanthes arenaceodentata*

D = Dispersive guidelines
ND = Non-Dispersive guidelines

M = 10-day mortality test
B = 20-day biomass test

TABLE 1-6a. DY92 SUITABILITY DETERMINATIONS

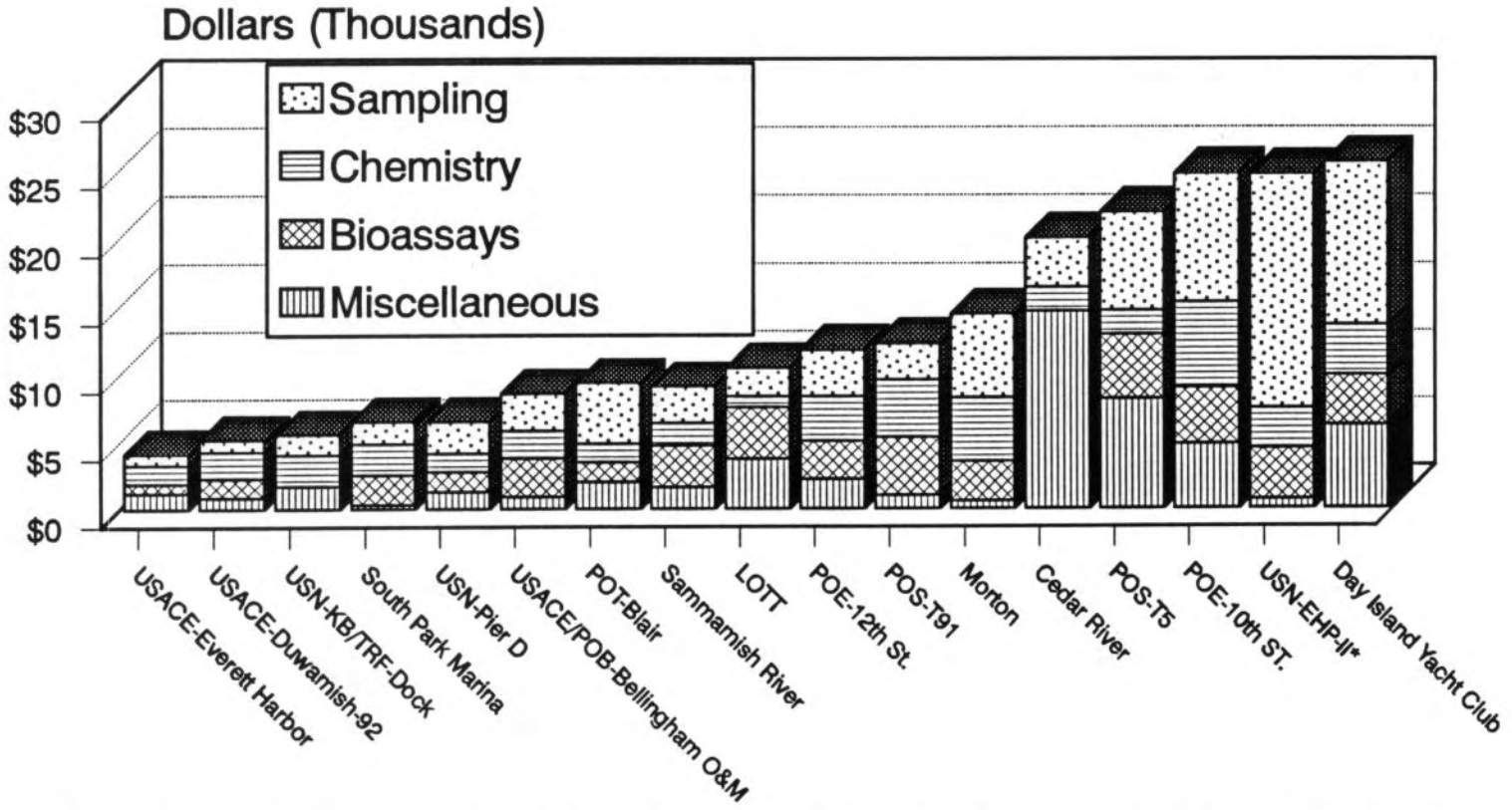
| PROJECT | Rank | Total Volume | Number of Chemical Analyses | Number of Biological Analyses | DMMUs Failing | Volume Failing | DMMUs Passing | Volume Passing | Proposed PSDDA Disposal Site |
|---|---|---|---|---|---|---|---|---|---|
| Day Island Yacht Club | M | 9,000 | 1 | 1 | 0 | 0 | 1 | 9,000 | Ander/Ketron |
| POE-10th Street | M | 12,340 | 2 | 1 | 0 | 0 | 2 | 12,340 | Port Gardner |
| POE-12th Street | M | 80,400 | 8 | 6 | 0 | 0 | 8 | 80,400 | Port Gardner |
| LaConner Boat Works | L | 4,200 | 0 | 0 | 0 | 0 | N/A | 4,200 | Rosario Strait |
| LOTT Olympia Outfall | H | 7,975 | 3 | 1 | 0 | 0 | 3 | 7,975 | Ander/Ketronr. |
| Morton Marine | H | 4,000 | 1 | 1 | 0 | 0 | 1 | 4,000 | Elliott Bay |
| Renton Cedar River | M | 111,800 | 5 | 0 | 0 | 0 | 5 | 115,000 | Elliott Bay |
| POS-APL | H | 8,000 | 2 | 2 | 0 | 0 | 2 | 8,000 | Elliott Bay |
| POS-Terminal 5 | H | 12,000 | 3 | 3 | 0 | 0 | 3 | 12,000 | Elliott Bay |
| South Park Marina | H | 8,000 | 2 | 2 | 0 | 0 | 2 | 8,000 | Elliott Bay |
| Port of Tacoma Blair | M/L | 594,000 | 27 | 27 | 0 | 0 | 27 | 594,000 | Comm. Bay |
| Bellingham Waterways | H/M | 303,125 | 33 | 20 | 10 ND<br>14 D | 66,035 ND<br>99,872 D | 23 ND<br>19 D | 237,090 ND<br>203,253 D | Bell. Bay<br>Rosario Strait |
| USACE Duwamish | H/L | 196,089 | 24 | 16 | 4 | 15,672 ND | 20 | 180,417 | Elliott Bay |
| USN TRF Dock (North) | M | 10,300 | 2 | 0 | 0 | 0 | 2 | 10,300 | P. Townsend |
| USN Bremerton Pier D | H | 171,400 | 28 | 28 | 18 | 102,000 ND | 10 | 69,400 | Elliott Bay |
| USN Keyport KB Dock | M | 4,500 | 2 | 0 | 0 | 0 | 2 | 4,500 | P. Townsend |
| Total | | 1,537,129 | 143 | 108 | 32 ND | 183,707 ND | 111 ND | 1,356,622 ND | |

TABLE 1-6b. DY93 SUITABILITY DETERMINATIONS

| PROJECT | Rank | Total Volume | Number of Chemical Analyses | Number of Biological Analyses | DMMUs Failing | Volume Failing | DMMUs Passing | Volume Passing | Proposed PSDDA Disposal Site |
|---|---|---|---|---|---|---|---|---|---|
| Boyer Alaska Barge Line | H | 4,000 | 1 | --[1] | 1 | 4,000 | 0 | 0 | None |
| KC Sammamish River | H | 16,800 | 4 | 1 | 0 | 0 | 4 | 16,800 | Elliott Bay |
| LaConner Marina | M | 70,900 | 5 | 0 | 0 | 0 | 5 | 70,900 | Rosario Strait |
| Lone Star-West Terminal | H | 3,900 | 1 | 1 | 0 | 0 | 1 | 3,900 | Elliott Bay |
| Pratt/Todd Moorage | M | 700 | N/A | N/A | N/A | N/A | N/A | 700 | Rosario Strait |
| POS-Terminal 91 | H | 11,000 | 3 | 3 | 3 | 11,000 | 0 | 0 | None |
| POS-Terminal 115 | H | 3,000 | 2 | 2 | 0 | 0 | 2 | 8,000 | Elliott Bay |
| Shell Oil Company | M | 26,636 | 3 | 0 | 0 | 0 | 3 | 26,636 | Rosario Strait |
| USACE Duwamish | LM | 60,000 | N/A | N/A | N/A | N/A | N/A | 25,000 | Elliott Bay |
| USACE Everett FC | LM | 462,243 | 12 | 3 | 0 | 0 | 12 | 462,243 | Port Gardner |
| USN Homeport-II | LM | 428,000 | 12 | 4 | 1 | 6,296 | 11 | 421,704 | Port Gardner |
| Total: | | 1,087,179 | 43 | 14 | 5 | 21,296 | 38 | 1,035,883 | |

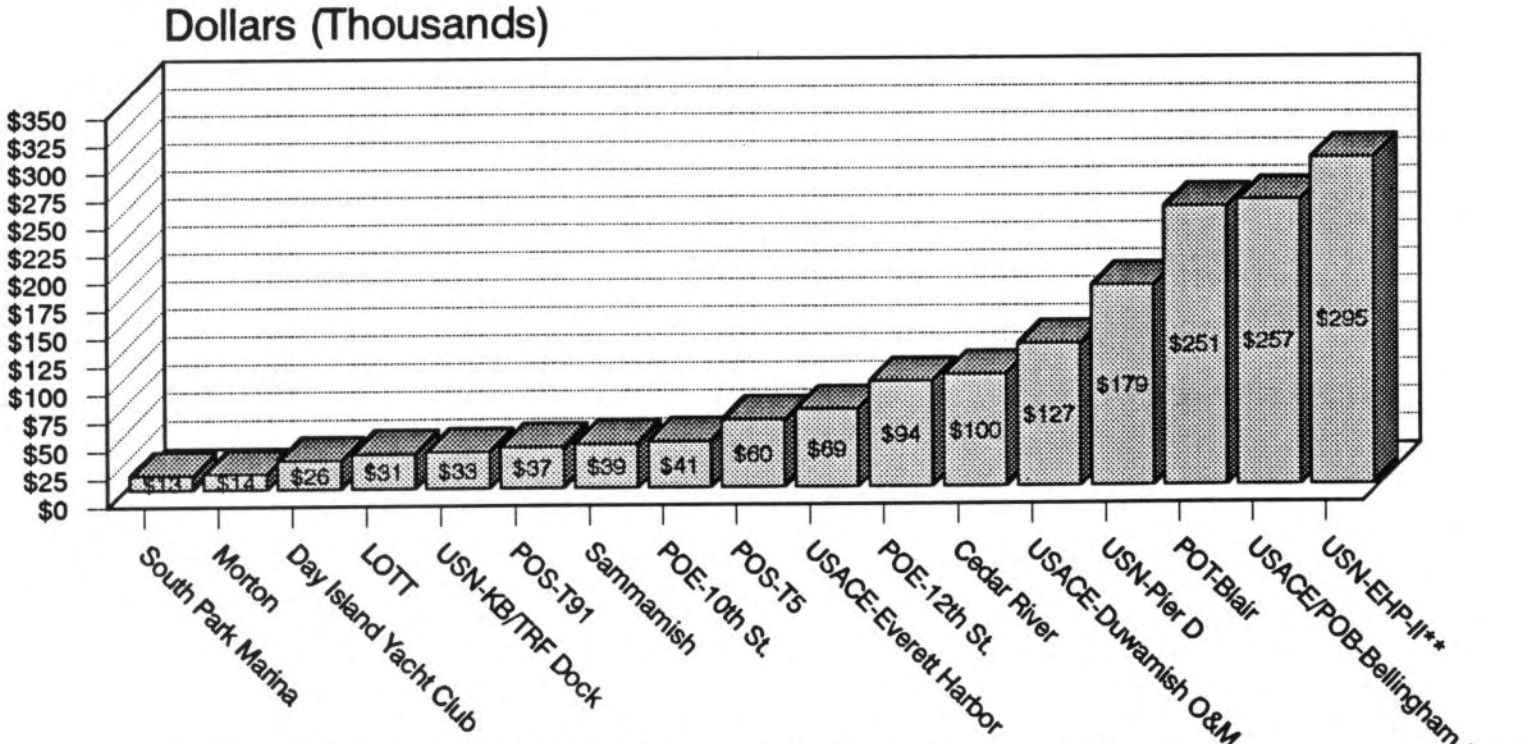
[1]Bioassay data not submitted.

# FIGURE 1-2. Average Cost per Dredged Material Management Unit




* reflects additional supplemental sampling/testing costs outside normal PSDDA process, including dioxin analyses.

# FIGURE 1-3. Total Project Sampling/Testing Costs*

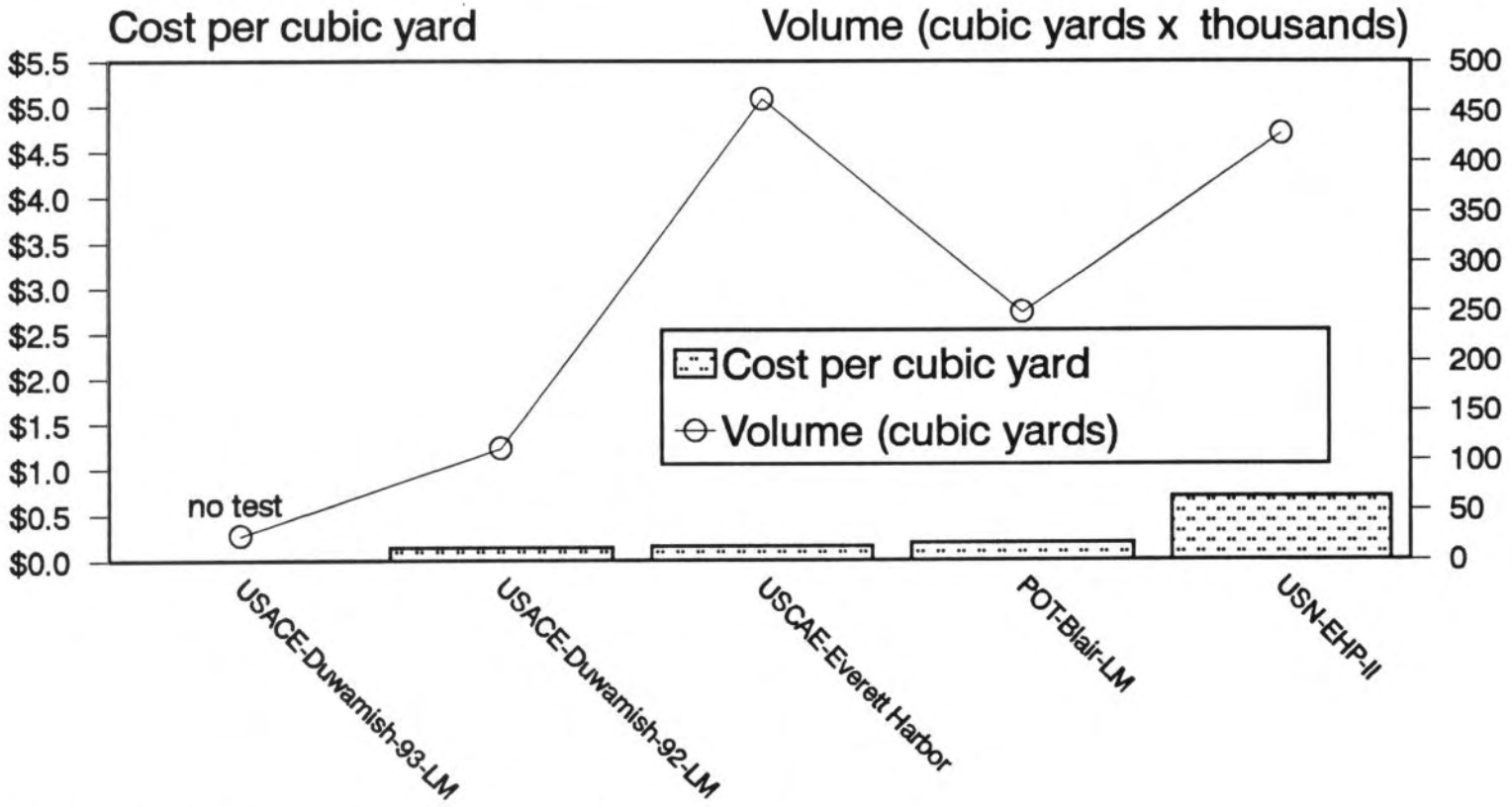



* only depicts projects submitting data, where testing was required.

** reflects additional supplemental sampling/testing costs outside normal PSDDA process.

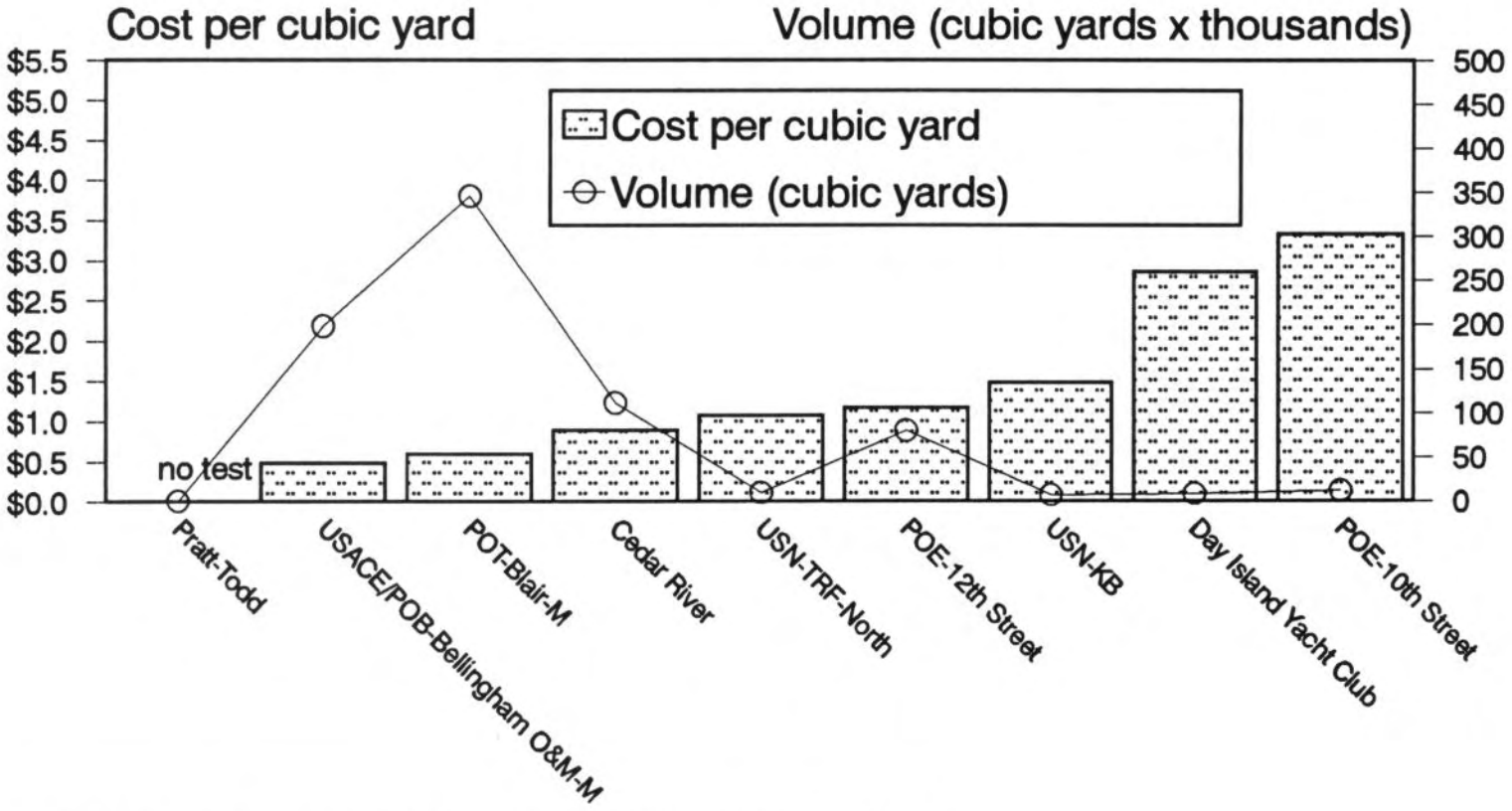
# FIGURE 1-4a. Average Project Sampling/Testing Costs

## Low-Moderate Ranked Projects




weighted average = $0.33/cy for DY92/93

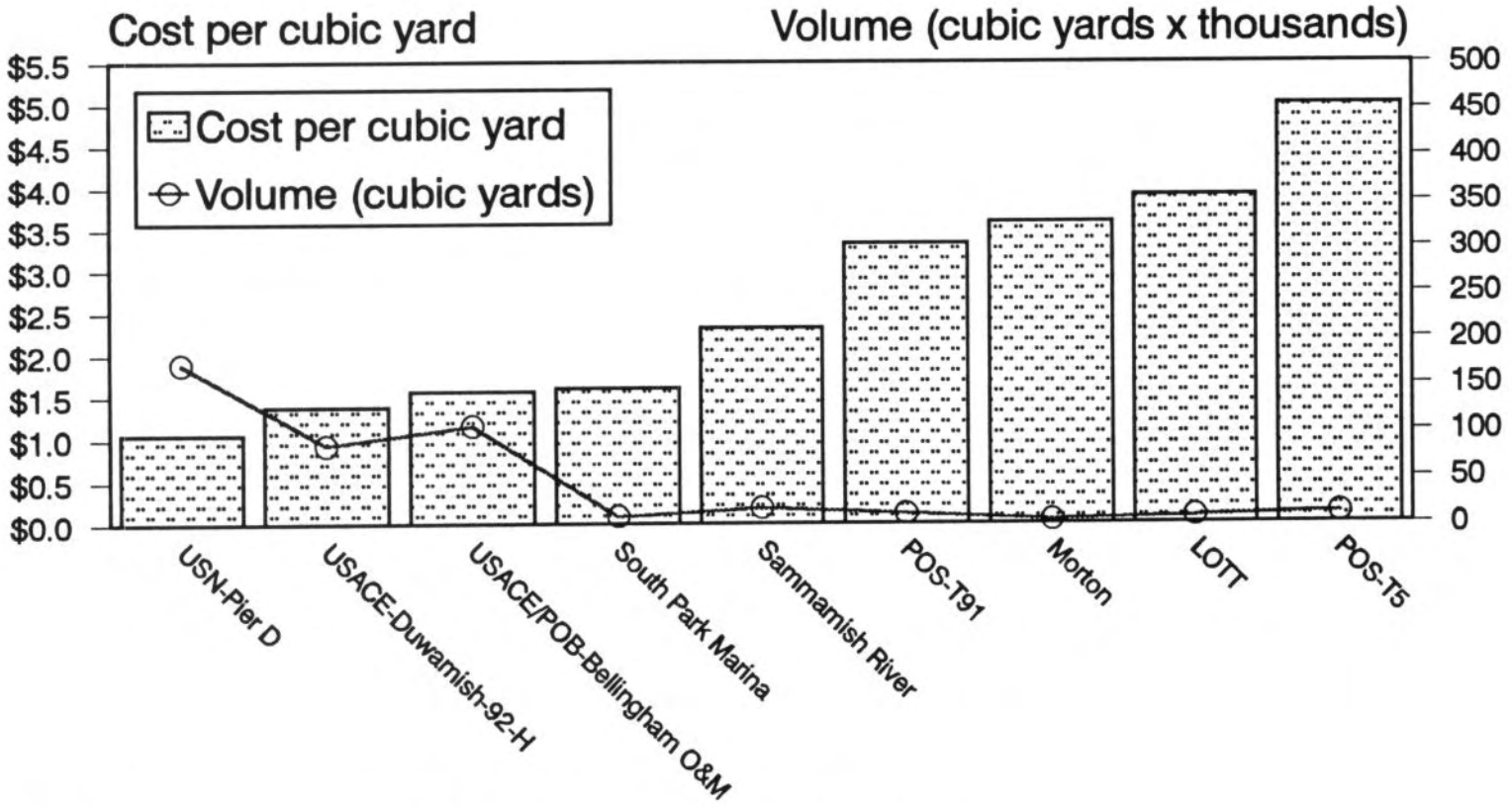
# Figure 1-4b. Average Project Sampling/Testing Costs Moderate Ranked Projects




weighted average = $0.75/cy for DY92/93 Projects

# Figure 1-4c. Average Project Sampling/Testing Costs

## High Ranked Projects




weighted average = $1.54/cy for DY92/93 Projects

## C. SUMMARY AND ASSESSMENT OF DY92/93 DATA

### Summary of Testing Results

Chemical Testing. Table 1-7 summarizes the chemical testing results from DY92 and DY93. A total of 54 of the 58 PSDDA COCs had their screening levels exceeded for at least one project. These included both detected exceedances (40 COCs) and detection limit exceedances (38 COCs). Five COCs had detected concentrations above the BT, while 16 COCs were detected above the ML. Table 1-8 highlights those chemicals which had detected concentrations exceeding SL, BT and ML most often. Also included are those chemicals for which the detection limit exceeded SL the most often.

From Table 1-8 it can be seen that the chemicals most often detected above SL, BT and ML included two metals, nine individual PAHs, total LPAH, total HPAH, dibenzofuran, total DDT and total PCBs. The chemicals for which detection limits most often exceeded SL included the chlorobenzenes, phenols and miscellaneous extractables. These detection limit exceedances were generally inconsequential and none of them triggered, on their own, the need to conduct biological testing. In 1991, the PSDDA agencies had revised six of the screening levels which had been creating the majority of the detection limit problems prior to that time. The DY92/93 data indicate that detection limits are no longer problematic.

### Dioxin Testing in Port Gardner

EPA published a report in 1991 that presented data concerning the concentration of dioxins and furans in crab tissue taken from several areas in Puget Sound. Some of the highest concentrations occurred in Port Gardner, prompting the PSDDA agencies to require dioxin/furan testing for projects in that area. Dioxins and furans were quantitated at four sites along the Everett waterfront: 10th Street Boat Ramp, 12th Street Barge Channel, Port of Everett South Terminal, US Navy Everett Homeport-Element II.

The most toxic of these chemicals (2,3,7,8-TCDD) was not detected in the majority of the sediments. Where it was detected, the concentration ranged from 0.18 to 0.67 parts per trillion (pptr). Summing the toxic equivalent concentrations (TEC) for the individual congeners of dioxin and furan, each with its own laboratory based toxicity equivalent factor (TEF), provides a way to qualitatively assess toxicity for mammals based on observed tissue concentrations. This procedure is used to assess food-ingested dioxin assimilation, and therefore has limited applicability to sediment, because it does not consider the relative bioavailability of the individual congeners. For purposes of comparison only, the TECs for all but one of these project sediments ranged from 0.36 to 11.33 pptr. (At South Terminal, sawdust-laden sediment in the immediate vicinity of a former pulp mill exhibited a TEC of 22.95 pptr. However, 2,3,7,8-TCDD was undetected at this same location. This material was found unsuitable for open-water disposal). Based on these generally low concentrations, the PSDDA agencies suspended the requirement for dioxin and furan testing in the vicinity of these projects.

TABLE 1-7. DY92/93 CHEMICAL TESTING SUMMARY

| CHEMICAL OF CONCERN | # of DMMU D>SL | # of Projects D>SL | # of DMMU D>BT | # of Projects D>BT | # of DMMU D>ML | # of Projects D>ML | # of DMMU U>SL | # of Projects U>SL | # of DMMU U>BT | # of Projects U>BT | # of DMMU U>ML | # of Projects U>ML |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METALS | | | | | | | | | | | | |
| Antimony | 2 | 2 | | | | | | | | | | |
| Arsenic | 2 | 2 | | | | | | | | | | |
| Cadmium (1) | 43 | 6 | | | | | | | | | | |
| Copper (1) | 22 | 6 | | | | | | | | | | |
| Lead (1) | 31 | 9 | | | | | | | | | | |
| Mercury | 48 | 7 | 7 | 3 | 3 | 3 | | | | | | |
| Silver | 6 | 2 | | | | | | | | | | |
| Zinc (1) | 23 | 6 | | | | | | | | | | |
| LPAH | | | | | | | | | | | | |
| 2-Methylnaphthalene (1) | 12 | 6 | | | 3 | 3 | 3 | 1 | | | | |
| Acenaphthene (1) | 20 | 10 | | | 5 | 3 | | | | | 1 | 1 |
| Acenaphthylene (1) | 12 | 5 | | | | | 3 | 3 | | | | |
| Anthracene (1) | 18 | 8 | | | 5 | 3 | 1 | 1 | | | | |
| Fluorene (1) | 18 | 9 | | | 5 | 3 | 1 | 1 | | | | |
| Naphthalene (1) | 15 | 6 | | | 3 | 3 | 1 | 1 | | | | |
| Phenanthrene (1) | 20 | 9 | | | 2 | 2 | | | | | | |
| Total LPAH (1) | 25 | 11 | | | 4 | 3 | 1 | 1 | | | | |
| HPAH | | | | | | | | | | | | |
| Benzo(a)anthracene (1) | 14 | 7 | | | 1 | 1 | | | | | | |
| Benzo(a)pyrene | 5 | 3 | | | | | | | | | | |
| Benzo(g,h,i)perylene (1) | 3 | 1 | | | | | 1 | 1 | | | | |
| Benzofluoranthenes (1) | 19 | 8 | | | | | | | | | | |
| Chrysene (1) | 12 | 6 | | | | | | | | | | |
| Dibenzo(a,h)anthracene (1) | 4 | 2 | | | | | 2 | 1 | | | | |
| Fluoranthene | 15 | 7 | 4 | 3 | 3 | 3 | | | | | | |
| Indeno(1,2,3-c,d)pyrene (1) | 41 | 13 | | | | | 1 | 1 | | | | |
| Pyrene (1) | 41 | 12 | | | 2 | 1 | | | | | | |
| Total HPAH (1) | 41 | 12 | | | 1 | 1 | | | | | | |
| CHLORINATED HYDROCARBON | | | | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | 1 | 1 | | | | | 24 | 6 | | | 6 | 3 |
| 1,2-Dichlorobenzene | | | | | | | 13 | 3 | 7 | 3 | | |
| 1,3-Dichlorobenzene (2) | | | | | | | 2 | 2 | 1 | 1 | | |
| 1,4-Dichlorobenzene | | | | | | | 10 | 3 | 1 | 2 | 1 | 1 |
| Hexachlorobenzene | | | | | | | 17 | 4 | 2 | 1 | 2 | 1 |

D=Detected U=Undetected SL=Screening Level BT=Bioaccumulation Trigger ML=Maximum Level

(1)=No BT exists (2)=No ML exists (3)=No BT or ML exists

TABLE 1.7 (CONTINUED) - DY92/93 CHEMICAL TESTING SUMMARY

| CHEMICAL OF CONCERN | # of DMMU D>SL | # of Projects D>SL | # of DMMU D>BT | # of Projects D>BT | # of DMMU D>ML | # of Projects D>ML | # of DMMU U>SL | # of Projects U>SL | # of DMMU U>BT | # of Projects U>BT | # of DMMU U>ML | # of Projects U>ML |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PHTHALATES | | | | | | | | | | | | |
| Butyl Benzyl Phthalate (3) | | | | | | | 1 | 1 | | | | |
| Di-n-butyl Phthalate (2) | 1 | 1 | | | | | | | | | | |
| Diethyl Phthalate (3) | | | | | | | 4 | 2 | | | | |
| Dimethyl Phthalate (2) | | | | | | | 2 | 1 | | | | |
| PHENOLS | | | | | | | | | | | | |
| 2 Methylphenol (1) | 5 | 2 | | | 5 | 2 | 11 | 3 | | | | |
| 2,4-Dimethyl phenol (1) | 8 | 3 | | | 6 | 2 | 9 | 2 | | | | |
| 4 Methylphenol (1) | 19 | 7 | | | 4 | 2 | 2 | 1 | | | | |
| Pentachlorophenol | 4 | 2 | | | | | 26 | 5 | 3 | 2 | 1 | 1 |
| Phenol | 3 | 2 | | | | | 3 | 2 | 1 | 1 | 1 | 1 |
| MISCELLANEOUS EXTRACTABL | | | | | | | | | | | | |
| Benzoic Acid (1) | | | | | | | 9 | 3 | | | 5 | 2 |
| Benzyl Alcohol (1) | 1 | 1 | | | | | 11 | 3 | | | 7 | 2 |
| Dibenzofuran (1) | 21 | 9 | | | 3 | 3 | 1 | 1 | | | 1 | 1 |
| Hexachlorobutadiene | | | | | | | 48 | 7 | 3 | 2 | 1 | 1 |
| N-Nitrosodiphenylamine | | | | | | | 12 | 4 | 2 | 2 | 2 | 2 |
| VOLATILE ORGANICS | | | | | | | | | | | | |
| Ethylbenzene | | | | | | | 10 | 2 | 8 | 1 | 7 | 1 |
| Tetrachloroethene | | | | | | | 10 | 2 | 7 | 1 | 6 | 1 |
| Total Xylene (1) | 3 | 3 | | | | | 10 | 2 | | | 7 | 1 |
| Trichloroethene | | | | | | | 7 | 1 | 4 | 1 | 2 | 1 |
| PESTICIDES AND PCBs | | | | | | | | | | | | |
| Aldrin (2) | 3 | 1 | | | | | 2 | 1 | | | | |
| Chlordane (2) | | | | | | | 15 | 3 | | | | |
| Dieldrin (2) | 4 | 1 | 1 | 1 | | | 2 | 2 | | | | |
| Heptachlor (2) | 4 | 1 | | | | | 5 | 2 | | | | |
| Lindane (2) | 1 | 1 | | | | | 1 | 1 | | | | |
| Total DDT | 47 | 7 | 8 | 2 | 6 | 2 | 5 | 2 | | | | |
| Total PCBs | 37 | 8 | 6 | 2 | 1 | 1 | 15 | 2 | | | | |

D=Detected U=Undetected SL=Screening Level BT=Bioaccumulation Trigger ML=Maximum Level

(1)=No BT exists (2)=No ML exists (3)=No BT or ML exists

TABLE 1-8. MULTIPLE EXCEEDANCES OF PSDDA GUIDELINE VALUES

| CHEMICAL | CHEMICALS EXCEEDING SL IN AT LEAST ONE-THIRD OF THE PROJECTS | CHEMICALS EXCEEDING BT IN AT LEAST TWO PROJECTS | CHEMICALS EXCEEDING ML IN AT LEAST THREE PROJECTS | CHEMICALS WITH DETECTION LIMITS EXCEEDING SL IN AT LEAST THREE PROJECTS |
|---|---|---|---|---|
| Lead | X | | | |
| Mercury | | X | X | |
| 2-Methylnaphthalene | | | X | |
| Acenaphthene | X | | X | |
| Acenaphthylene | | | | X |
| Anthracene | | | X | |
| Fluorene | X | | X | |
| Naphthalene | | | X | |
| Phenanthrene | X | | | |
| Total LPAH | X | | X | |
| Fluoranthene | | X | X | |
| Indeno(1,2,3-c,d)pyrene | X | | | |
| Pyrene | X | | | |
| Total HPAH | X | | | |
| 1,2,4-Trichlorobenzene | | | | X |
| 1,2-Dichlorobenzene | | | | X |
| 1,4-Dichlorobenzene | | | | X |
| Hexachlorobenzene | | | | X |
| 2 Methylphenol | | | | X |
| Pentachlorophenol | | | | X |
| Benzoic Acid | | | | X |
| Benzyl alcohol | | | | X |
| Dibenzofuran | X | | X | |
| Hexachlorobutadiene | | | | X |
| N-Nitrosodiphenylamine | | | | X |
| Chlordane | | | | X |
| Total DDT | | X | | |
| Total PCBs | | X | | |

Biological Testing. Biological testing was conducted for eighteen of the twenty-six projects which underwent chemical testing during DY92/93. Table 1-9 shows the number of times each of the four bioassays was conducted and the number of hits for each. The *Neanthes* 20-day biomass test was instituted at the beginning of DY93 and was conducted for only three of the projects in DY92/93. The *Neanthes* 10-day mortality test was run for the other projects.

TABLE 1-9 - DY92/93 BIOASSAY "HITS"[1]

| BIOASSAY | Number of DMMUs Tested | Number of Hits Under the "Two-Hit Rule" | Number of Hits Under the "Single-Hit Rule" |
|---|---|---|---|
| Amphipod | 115 | 18 | 14 |
| Sediment Larval | 112 | 20 | 2 |
| *Neanthes* Mortality | 106 | 0 | 3 |
| *Neanthes* Biomass | 6 | 0 | 0 |
| Microtox | 112 | 1 | --- |

[1]Nondispersive interpretation

As can be seen from this tabulation, there were very few hits for either of the *Neanthes* bioassays or the Microtox test. The amphipod test exhibited the most hits, but 21 of the total 32 hits for this bioassay were seen in one project, Pier D. The sediment larval test exhibited hits in eight different projects while the amphipod test exhibited hits in five projects.

As was the case in previous dredging years, most sediments exhibited blank-corrected light enhancement in the saline Microtox test. Protocol problems occurred for four projects in which the dilution series was run with two replicates at the highest concentration instead of the required five. However, there were no hits for the amphipod, sediment larval or juvenile infaunal mortality tests for any of these projects. Therefore, the lack of five replicates at the highest concentration for the Microtox test was inconsequential because the Microtox test cannot fail a DMMU in and of itself. Additionally, the two replicates which were done at the highest concentration showed either negligible light diminution or light enhancement. It was deemed unlikely, had the additional three replicates been done at the highest concentration, that significant light diminution would have been exhibited.

Reference area performance continued to be a common problem, especially for the sediment larval test and, to a lesser degree, the amphipod test. Reference sediment performance failures resulted in the need to retest several projects or set aside results of the test. Interim revised performance standards for the sediment larval test are proposed in Chapter 3. These revised standards are designed to reduce the number of retests required in the future.

Regulatory Processing

PSDDA sampling and testing is undertaken as one of the requirements for receiving a permit under Section 404 of the Clean Water Act. There is a sequence of steps in the regulatory process which dredging proponents must take before obtaining these permits. These are as follows:

(1) Submit application for permit.

(2) Prepare sampling and analysis plan for characterization of proposed dredged material.

(3) Receive approval of sampling and analysis plan from PSDDA agencies.

(4) Perform sampling and chemical/biological analysis.

(5) Submit testing results.

(6) Receive suitability determination for open-water disposal from PSDDA agencies.

(7) Complete application details required to issue public notice.

(8) Issue public notice, undergo 30-day public comment period.

(9) Public interest review and permit decision.

The average time requirements for these steps are included in Figures 1-5a and 1-5b, which were constructed using data from DY92/93 dredging projects.

Permit Application. An application for a Corps of Engineers' Section 10/404 permit for dredging and dredged material disposal must be submitted before any PSDDA processing may take place. An application number and Regulatory Branch Project Manager are assigned at this time and the Dredged Material Management Office begins review of information relevant to the proposed dredging.

Sampling and Analysis Plan (SAP) Development. In Figures 1-5a and 1-5b, 165 days was the average time required for SAP development. This number includes the entire time from submittal of the permit application to submittal of the final SAP. In some cases (5 cases in DY 92/93), a preliminary SAP is submitted for review by the PSDDA agencies and a revised SAP is requested of the applicant. This time has been included in the "Sampling and Analysis Plan Development" phase of the process. The mean time for preliminary SAP review for these five projects was 15 days, with an average of 55 days required for SAP revision by the applicant. Because a revised sampling plan is only required when the preliminary SAP has major flaws, and

because the time taken by the applicant to revise the SAP is highly variable (2-160 days), this time was not included in the "PSDDA Process" time on Figure 1-5b.

During DY91, through an iterative process involving several projects, dredging consultants and the PSDDA agencies, a prototype sampling and analysis plan was developed. This prototype is available from the DMMO in both hard copy and electronic format. The availability of this prototype reduced the amount of time required for sampling plan development and reduced the number of times sampling plans were returned for revision. During DY91, five sampling and analysis plans were returned for revision. During DY92 and DY93, the combined total number of sampling plans returned for revision was five.

Sampling Plan Approval. Once a complete sampling plan has been submitted, the DMMO coordinates review of the SAP with the other PSDDA agencies: the Environmental Protection Agency and the State of Washington Departments of Natural Resources and Ecology. An approval letter is sent which includes PSDDA agency comments and recommended modifications of the SAP. Once these comments and modifications have been acknowledged by the applicant, via telephone or letter, sampling and analysis may proceed. It is the goal of the Dredged Material Management Office to complete the review of SAPs within three weeks. During DY 92/93 the average time from the submittal of the final SAP for a project to SAP approval was 17 days. When the preliminary SAPs are included, the average time for review of a SAP was 16 days.

Sampling and Analysis. During this phase, field sampling and chemical/biological analysis are completed following the protocols established in the approved SAP. Data is compiled and submitted in a hard copy report. This data is entered into the Dredged Analysis Information System by the DMMO. Sampling and characterization consume a substantial portion of the PSDDA Process time budget, averaging 130 days during DY92/93. There was a high degree of variability in this phase, with projects ranging from 64 to 368 days. Factors influencing the time required for this phase include weather, laboratory capacity and turn-around, QA problems arising during chemical and biological testing, and report compilation time. During DY92/DY93 the average time between completion of the suitability determination and the issuance of the public notice was 119 days.

Data Review. Once a full set of chemical/biological testing data is submitted along with the sampling report, the DMMO conducts a data review with the other PSDDA agencies. The result of this review is the signing, by PSDDA agency representatives, of a Memorandum for Record documenting the determination reached on the suitability/unsuitability of each of the dredged material management units defined in the approved SAP. The goal of the DMMO is to complete this review within three weeks of data submittal. In DY92/93, the average time required was 11 days.

Completed Permit Application, Public Notice, and Permit Decision. When the suitability determination has been made, the DMMO informs the Regulatory Branch project manager and preparations are made to issue a public notice. At the time of the original application, construction details may not have been known for the project. Alternatively, construction plans may be altered

due to the suitability determination. In these cases, new drawings may be required of the applicant along with other information pertinent to the preparation of the Public Notice on a project.

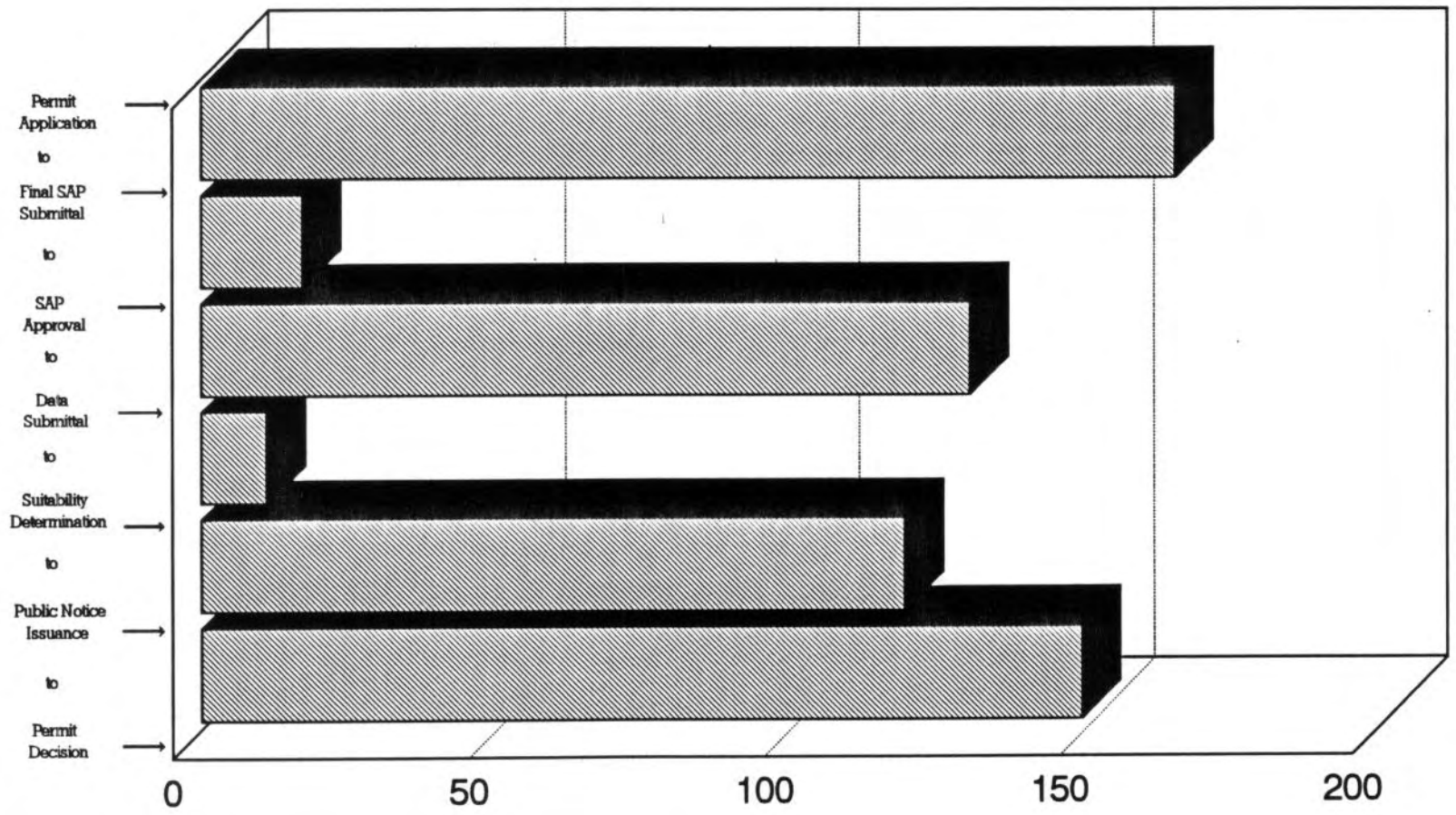
Often the local shorelines process runs concurrently with PSDDA testing. The decision may be made to wait to go out to public notice until the local shoreline jurisdiction has issued a permit. In this case there may be a time lapse between the suitability determination and the public notice. Controversial projects are usually processed concurrently. During DY92/DY93 the average time between completion of the suitability determination and the issuance of the public notice was 119 days.

By regulation, the Regulatory Branch must issue a public notice within fifteen days of the completion of the permit application. A PSDDA project typically undergoes a 30-day public comment period. Comments received during this period are considered during a public interest review.

A Section 404(b)(1) evaluation is performed after the 30-day comment period closure. The Corps Project Manager prepares a permit decision upon completion of the public interest review. This stage of the process may be very time consuming. Dredging and PSDDA processing are often only parts of complex projects. Other elements may be involved, such as wetland fills or eelgrass bed impacts. Resolution of controversial issues such as these may consume additional time after a suitability determination has been made. To improve regulatory response time, the Washington Department of Ecology recommends that applicants seek a hydraulic project approval (HPA) from the Department of Fisheries, and resolve other problems earlier in the permit process. Pre-application meetings could serve to improve turn-around times and could be held earlier in the process. This stage, from the date of the public notice, took an average of 149 days per project, ranging from 48 to 353 days. Four projects from these dredging years have yet to receive their permits, and are not included in this average.

PSDDA Processing Time. PSDDA processing time, as depicted in Figure 1-5b, includes final sampling and analysis plan review and approval, field sampling and analysis, data review and suitability determination. This took an average of 157 days in DY92/93, with the majority of that time taken up by sampling, testing, and data report preparation. Sampling and analysis plan preparation, although a part of the PSDDA process, was not included because of the variability in time which can elapse between permit application and sampling and analysis plan submittal. This is largely outside the control of the PSDDA agencies.

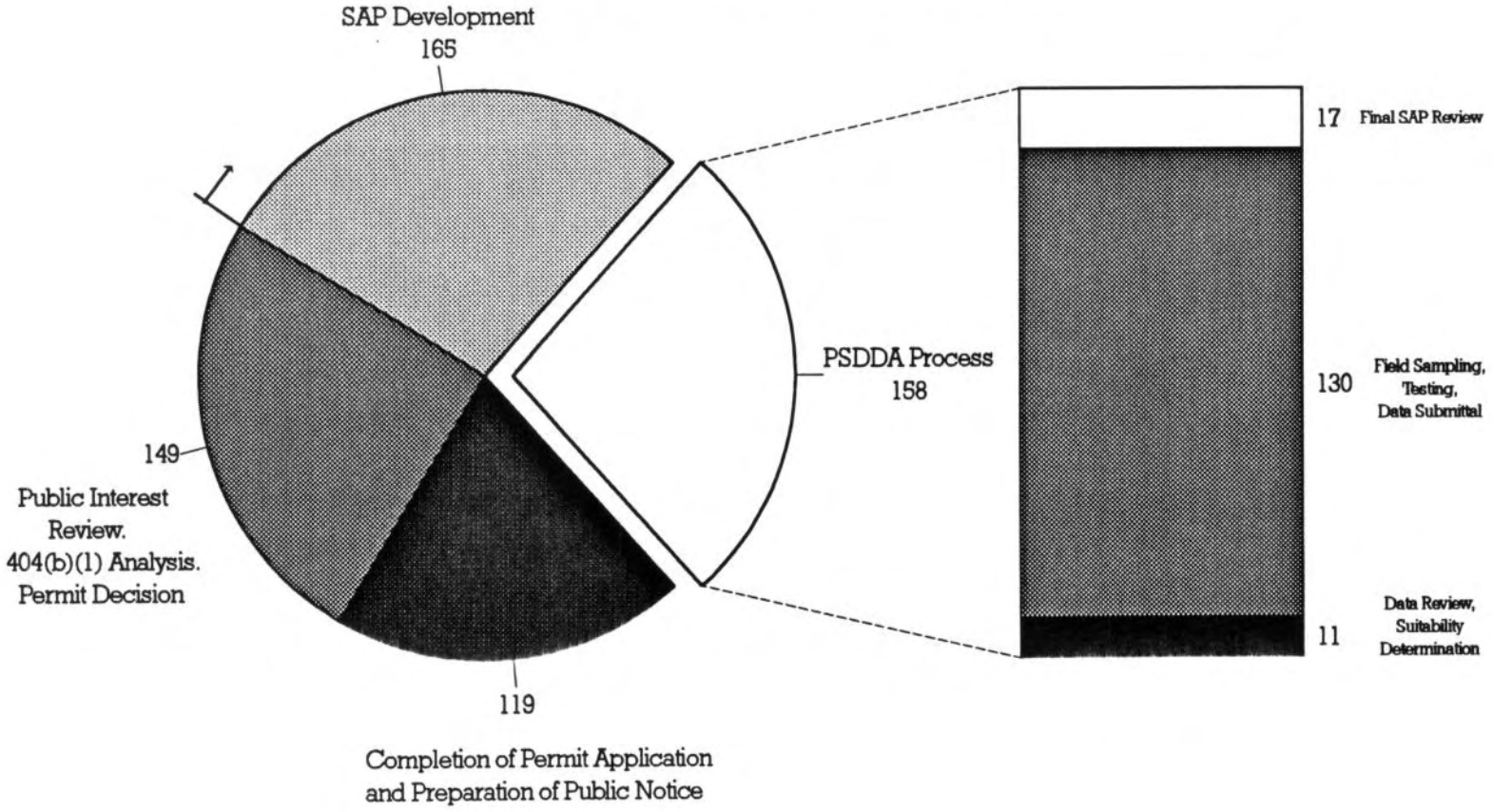
Time Elapsing for Each Regulatory Stage:




# FIGURE 1-5a. Regulatory Processing Time

**Means for DY92/DY93 Projects**

# FIGURE 1-5b. PSDDA PROCESSING TIME
## Means for DY92/DY93 Projects



Cost Analysis

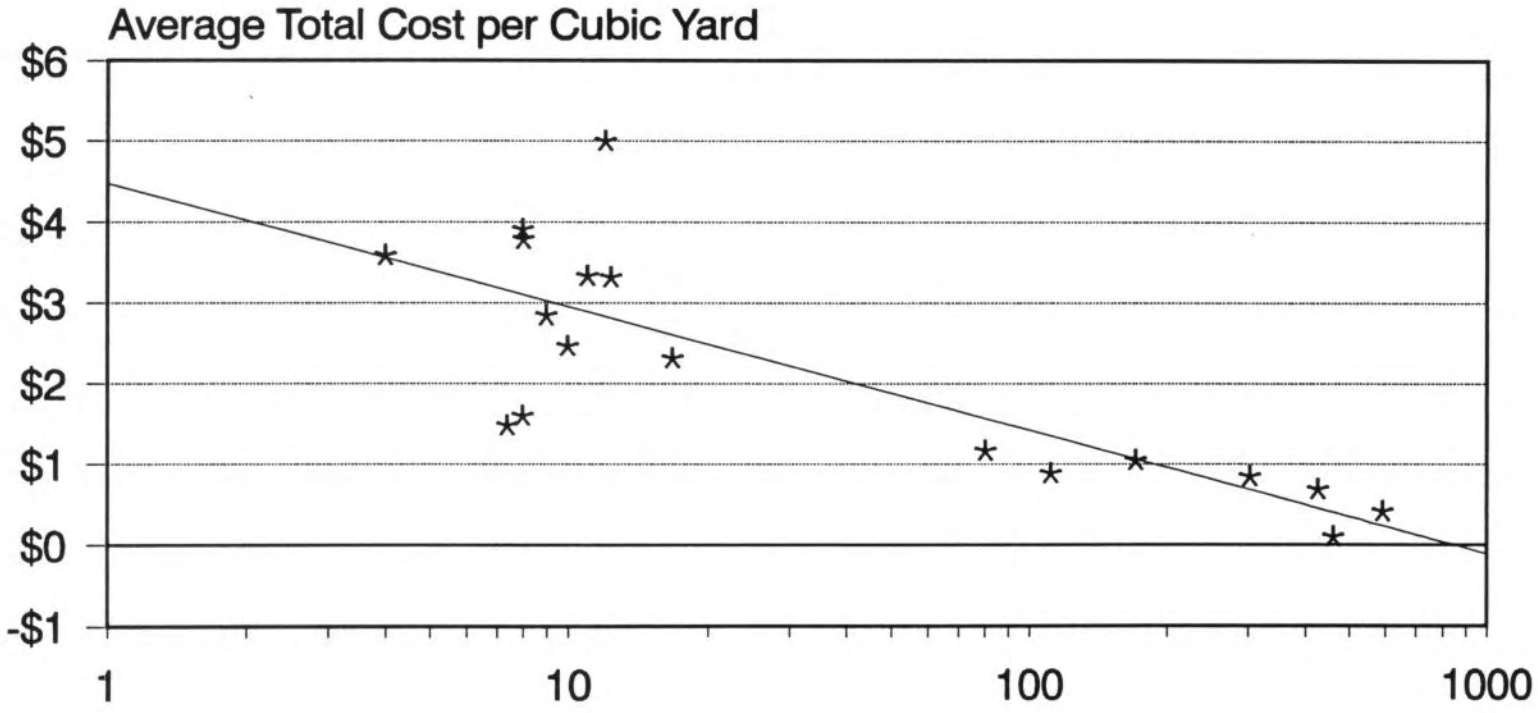
Total Costs. Total sampling and testing costs are generally related to the size and rank of the project. Larger projects have lower unit costs than smaller projects due to economy of scale. Area rank influences costs by requiring larger numbers of analyses (DMMU) for high-ranked projects relative to lower-ranked projects (see Figure 1-4). Figure 1-6 shows the relationship of average total cost per cubic yard to the total volume tested for all DY 92/93 projects submitting data. The regression of these two variables resulted in a significant ($p < 0.001$) correlation and the regression equation noted in Figure 1-6, which can be used to estimate testing costs given the project size. Figure 1-7 relates the average cost per cubic yard to the rank. Both figures verify the general relationships expected and compare favorably with previous analyses reported for DY89-91. Total cumulative PSDDA sampling and testing costs reported for DY92/93 were $1,664,363. These costs include sampling plan development, field sampling, chemical and biological testing, reporting, and other miscellaneous costs. The total volume of proposed dredged material handled under PSDDA evaluation guidelines was 2,588,975 cubic yards (2,485,275 cubic yards excluding projects not reporting testing costs). This included three projects where no testing was required. The average weighted unit cost for all DY92/93 projects was $0.67 per cubic yard, and reflected an increase in the number of moderate and high-ranked projects. The 1992/1993 average unit cost is comparable to those for dredging years 1991($0.38/CY), 1990 ($0.49/CY), and 1989 ($0.34/CY).

Sampling Costs. The costs associated with each of the constituent activities shown in Figure 1-2 (sampling, chemistry, biological testing, miscellaneous) varied widely. Sampling costs, in particular, exhibited high variability and no discernible patterns. An analysis of sampling costs relative to maximum and mean sampling depth failed to find any discernible pattern, although these do influence project sampling costs. The total number of samples was significantly correlated with total sampling costs.

Testing Costs. Chemical testing costs are generally the most straightforward and readily discernible costs. Analytical laboratories performing PSDDA analyses will provide quotes on unit costs. Average unit chemical testing costs (including QA/QC) are depicted in Figure 1-8 as a function of the number of analyses. The scatter plot shows that as the number of analyses increases beyond three, the unit costs drop sharply and steadily decrease for the most part to a low of around $1500 per analysis. Projects with one or two analyses are especially costly, as the QA/QC costs cannot be distributed over several samples. Three projects depicted in Figure 1-8 (Port of Everett 10th Street, Port of Everett 12th Street, and U.S. Navy Homeport Element II) incurred additional chemical costs for dioxin, which significantly increased the unit analysis costs.

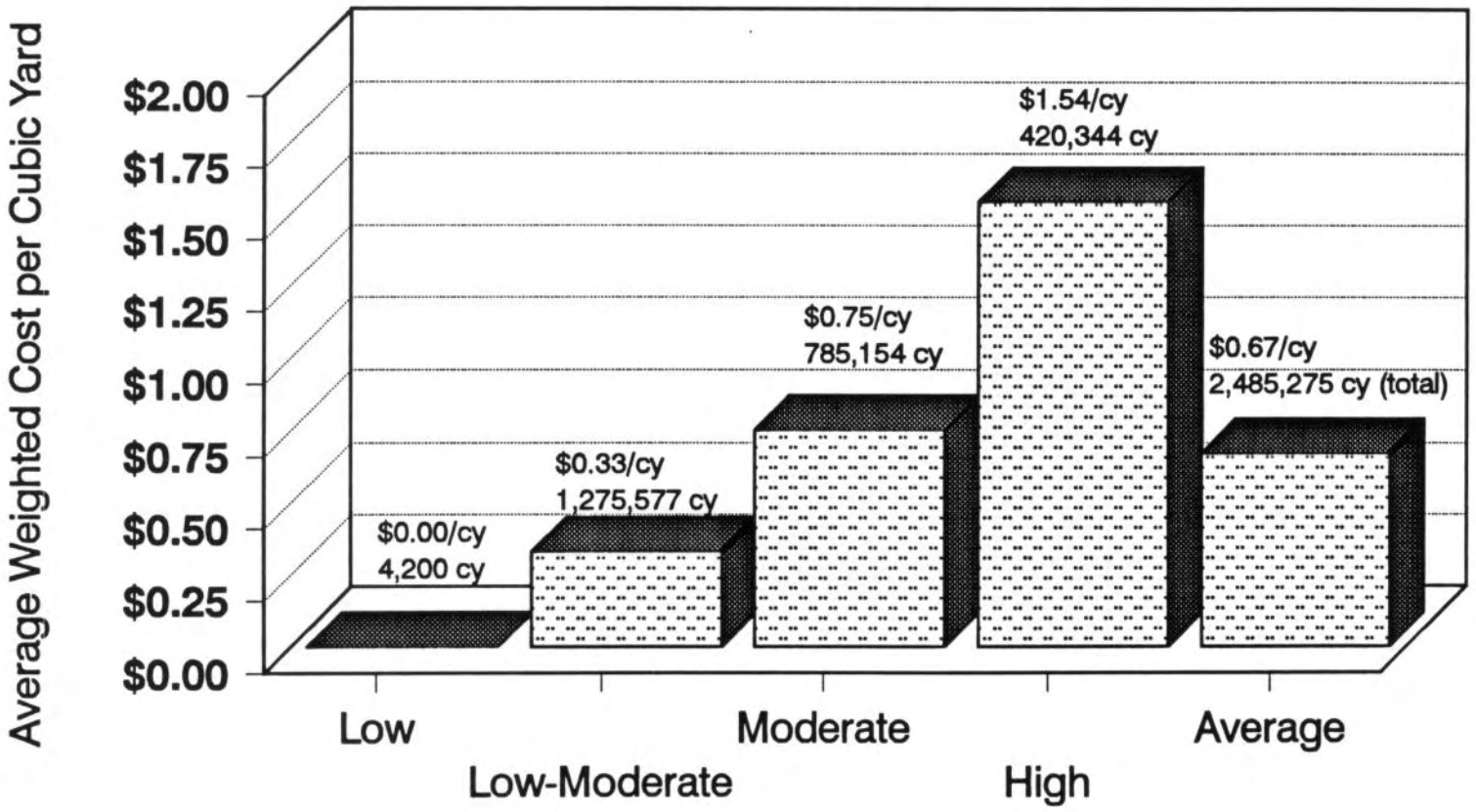
Unit costs for bioassays related well to the total number of analyses, as shown in Figure 1-9. There was a tremendous range in unit costs for projects with only one analysis, whereas the variability in unit costs dropped sharply with additional analyses. Some smaller projects were able to reduce bioassay testing costs by coordinating testing with larger projects, and sharing reference, negative control and positive control data and testing costs.

# FIGURE 1-6. Cost Analysis
## Project Size versus Unit Cost

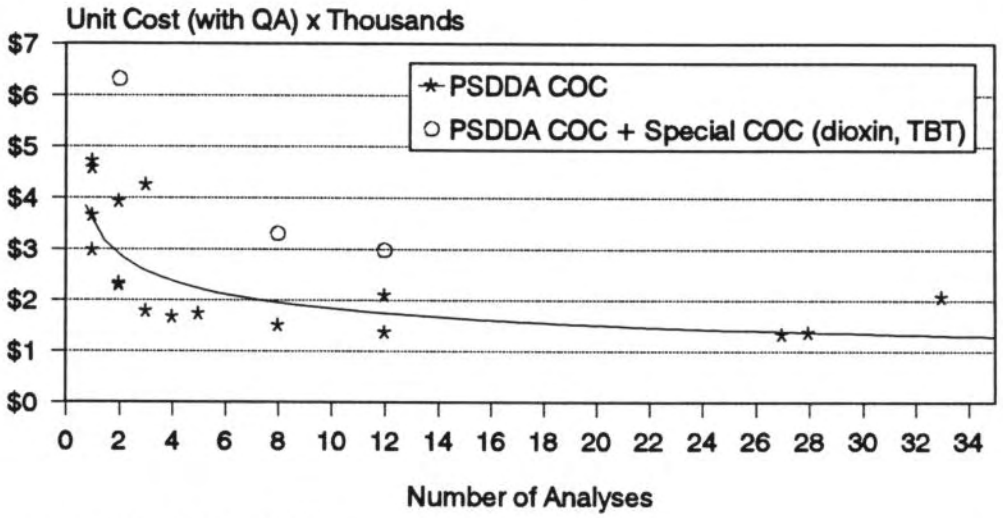



r=-0.72 (n=18, p<0.001); y = 9.063 - 0.664(log x)

# FIGURE 1-7. Rank versus Unit Testing Cost Dredging Years 1992 and 1993

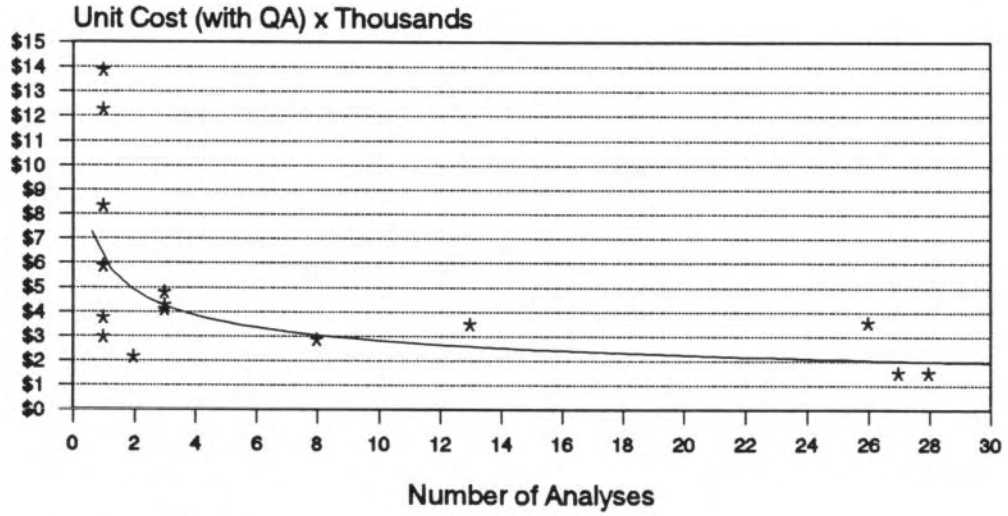


# FIGURE 1-8. Chemistry Unit Cost




r = -0.54 (n=17, p<0.05)

# FIGURE 1-9. Bioassay Suite Unit Cost Analysis




r = -0.49 (n=15, p>0.05)

## D. FIVE-YEAR PROGRAM RETROSPECTIVE

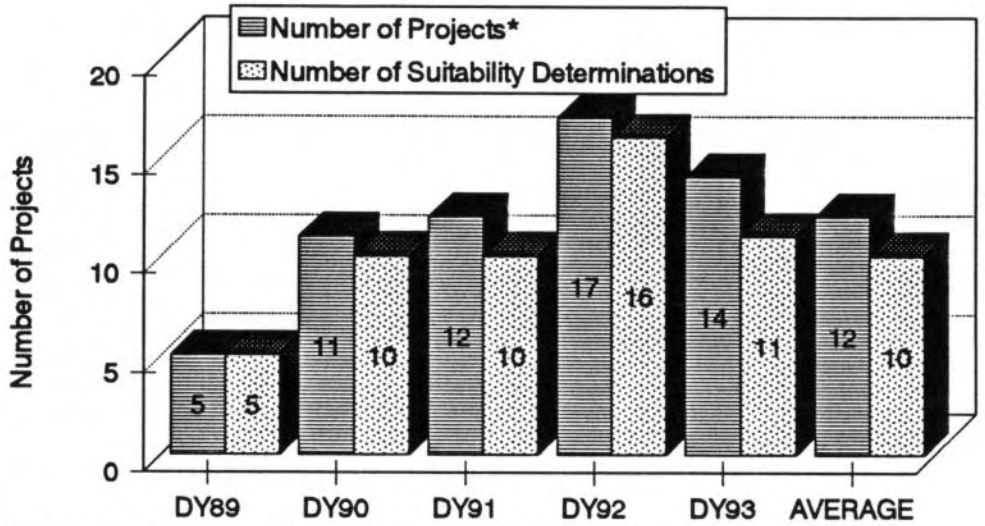
The number of projects undergoing PSDDA evaluations within each of the five dredging years is depicted in Figure 1-10a, and has averaged 12 projects per year. "Projects" include, in this case, partial characterizations as well as full characterizations. Also depicted are the number of suitability determinations completed, which has averaged 10 per year. The difference between the two reflects, in part, the PCs discussed above. It also reflects a few projects where, following PSDDA characterization, the project proponent elected not to pursue PSDDA disposal. These projects were either not dredged, or, if dredged, the material was placed at an Ecology-approved upland disposal site. In some of these cases, the data were not submitted to the PSDDA agencies for review, and no suitability determination was completed.

Figure 1-10b illustrates the number of DMMUs undergoing chemical and biological testing during each year. It shows that there was a large increase during DY92 in DMMUs tested. The increase in testing volume coupled with more projects being located in high ranked and moderate ranked areas during DY92 resulted in more DMMUs. The number of chemistry DMMUs undergoing effects-based bioassay testing varied considerably among dredging years with a high of seventy-seven percent of DY92 DMMUs and a low of thirty-three percent of DY93 DMMUs undergoing biological testing. Approximately sixty-four percent of DMMUs undergoing chemical testing have also been subjected to bioassay testing over the past five years.

Figure 1-10c depicts the total volume of proposed dredged material undergoing PSDDA characterization and the volume found suitable by dredging year. In general, most of the material tested was found suitable for disposal at a PSDDA site, averaging ninety-six percent over the five dredging years. During DY90 the U.S. Navy Homeport Project (Element I) in Everett accounted for approximately 1,000,000 CY of the total volume tested. A total of 293,503 CY of material has been found unsuitable for PSDDA disposal during the past five years.

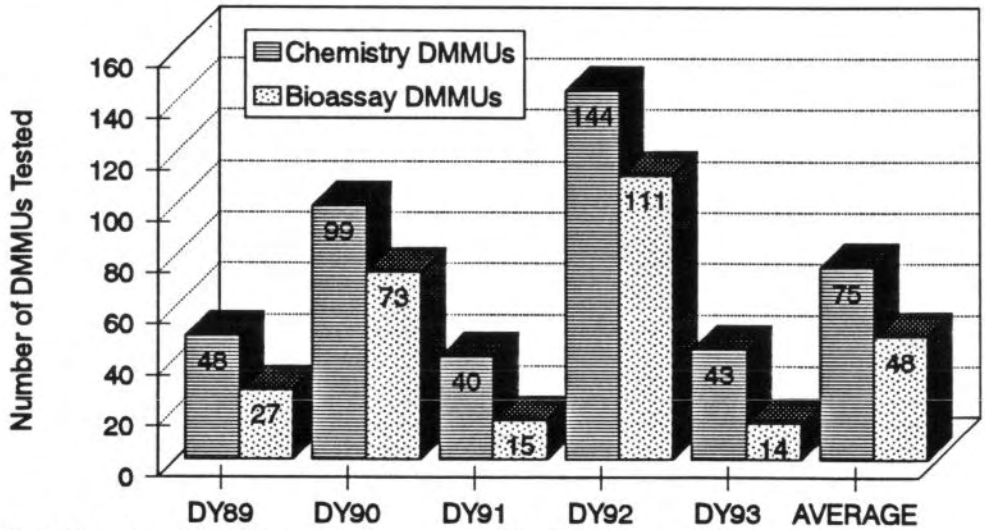
Sampling and testing costs averaged $0.49/CY over the five dredging years (Figure 1-10d). Sampling and testing costs appear to have remained fairly uniform except during DY92, where they averaged $0.78/CY. The higher costs reflect the increase in sampling and testing required for higher ranked projects. The average DMMU volume was 10,761 CY for DY92 compared with 20,089 CY for DY91, which illustrates the shift in area rank between these two dredging years.

## Figure 1-10a. PSDDA Program Retrospective: Number of Projects Evaluated under PSDDA



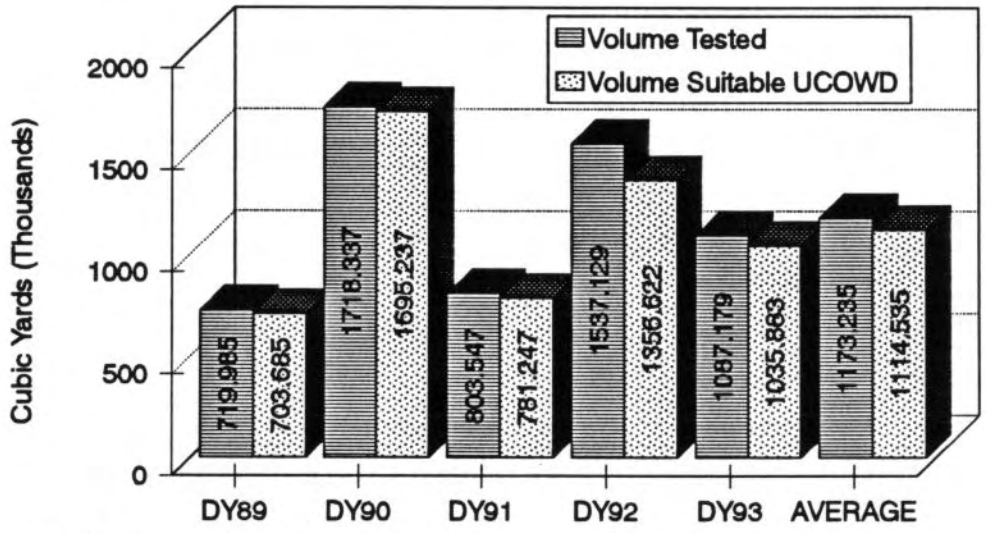

* includes projects undergoing Partial Characterizations

## Figure 1-10b. PSDDA Program Retrospective: Number of Chemistry and Bioassay DMMUs Tested



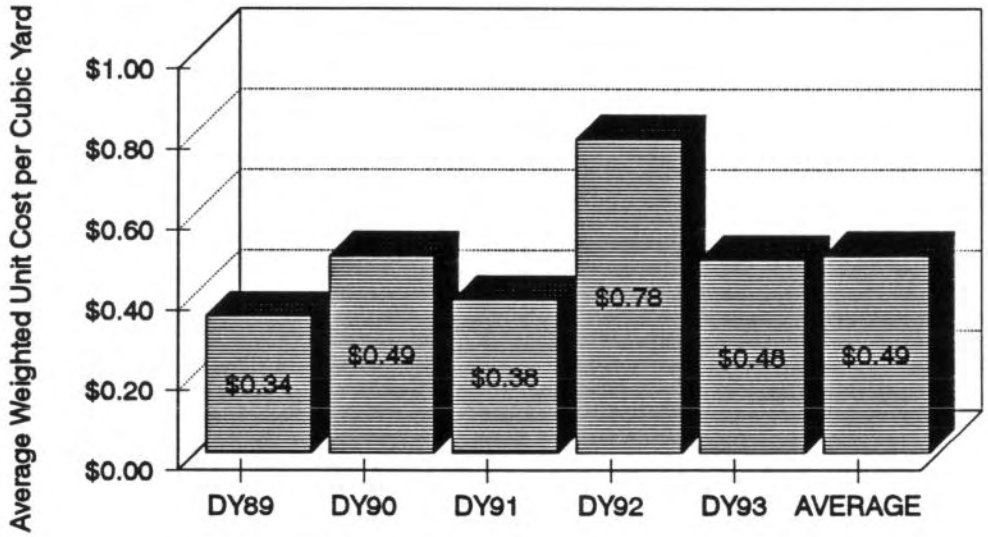

DMMU = Dredged Material Management Unit

## Figure 1-10c. PSDDA Program Retrospective: Total Tested versus Suitable Volume




UCOWD = unconfined open-water disposal

## Figure 1-10d. PSDDA Program Retrospective: Average Sampling and Testing Costs



# CHAPTER 2

# DISPOSAL SITE USE AND MONITORING

## A. DISPOSAL ACTIVITY AND SITE USE

The Washington Department of Natural Resources (DNR) issues land use authorizations (disposal site use permits) to project proponents who wish to dispose of dredged material at PSDDA open-water disposal sites. These authorizations are issued only for sediments which are: 1) suitable for open-water disposal as determined by the PSDDA evaluation process; and 2) associated with dredging projects which have received all required regulatory permits (e.g. CWA 404/401 permits). This section of the report describes PSDDA disposal activity for Dredging Years 1992 and 1993. This information is discussed by year and by individual disposal site.

### Dredging Year 1992

In DY92, a total of 274,091 cubic yards of dredged material were disposed at PSDDA open-water disposal sites (Table 2-1). Two of the eight sites, Elliott Bay and Rosario Strait, were used. The Elliott Bay site received most of the material, 230,241 CY, with the balance, 43,850 CY, going to Rosario Strait (Figure 2-1). Table 2-2 provides the project-by-project breakdown of disposal activity in DY92.

TABLE 2-1. VOLUME OF DREDGED MATERIAL DISPOSED AT PSDDA SITES-DY92

| Disposal Site | # of Projects | Total Volume (CY) |
|---|---|---|
| Elliott Bay | 5 | 230,241 |
| Rosario Strait | 3 | 43,850 |
| All Sites Combined | 8 | 274,091 |

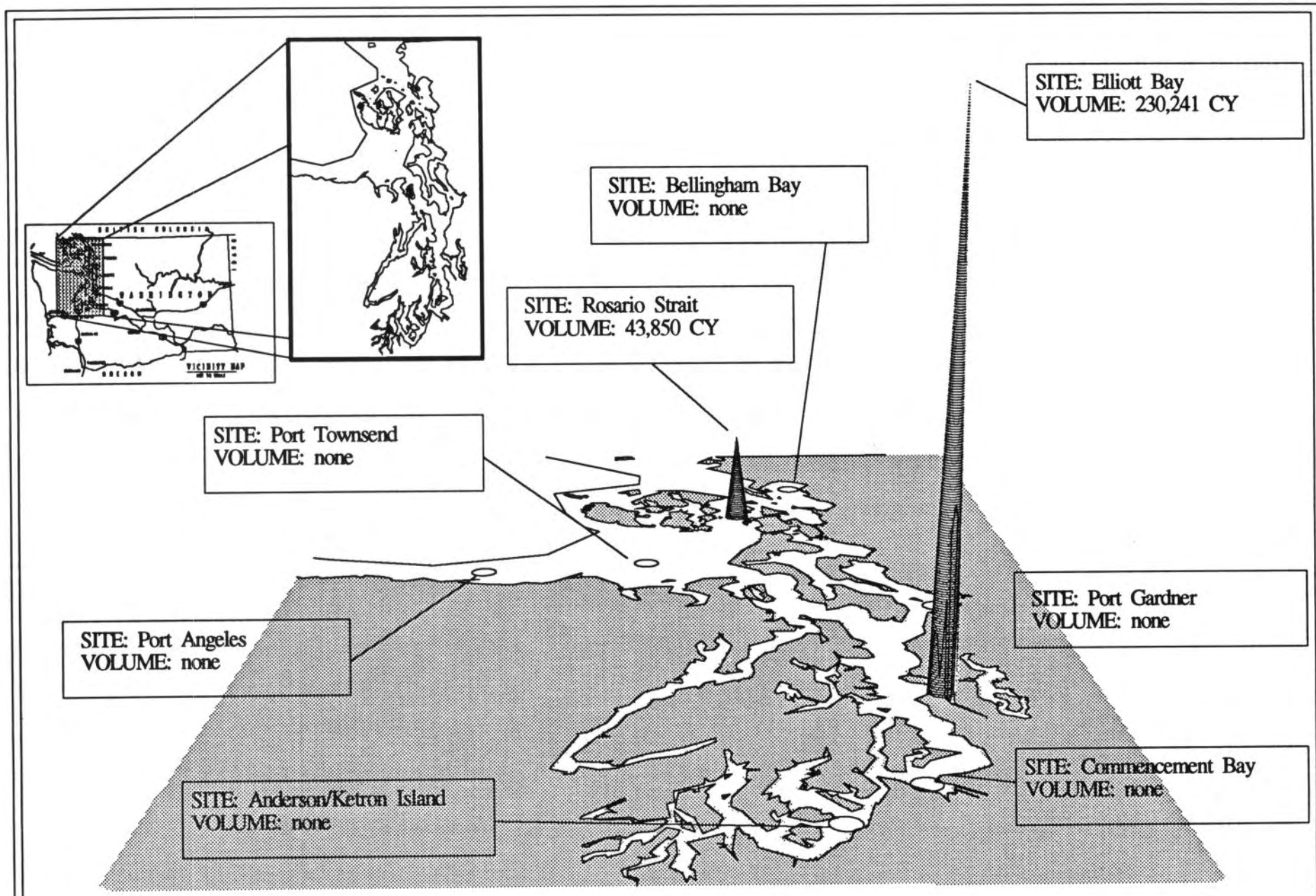



**Figure 2-1. Dredging Year 1992 Disposal Volumes**

TABLE 2-2. SUMMARY OF DY92 PSDDA DISPOSAL PROJECTS

| Site | Proponent | Dredging Contractor | Disposed Volume (CY) | Barge Loads | Off-Site[a] | Disposal Dates |
|---|---|---|---|---|---|---|
| Elliott Bay | Morton Marine | A.H. Powers | 9,600 | 8 | No | 03/03/92 to 03/13/92 |
| Elliott Bay | U.S. Navy Manchester | American Construction | 33,250 | 27 | No | 11/18/91 to 01/17/92 |
| Elliott Bay | Port of Seattle T-5 | A.H. Powers | 3,417 | 3 | No | 12/11/91 to 12/13/91 |
| Elliott Bay | South Park Marina | A.H. Powers | 6,898 | 5 | No | 03/03/92 to 03/09/92 |
| Elliott Bay | USACE Duwamish | Aqua Marine Constructors | 177,076 | 83 | No | 02/06/92 to 03/21/92 |
| Rosario Strait | Port of Skagit County | Culbertson Marine | 7,156 | 8 | No | 07/02/91 to 08/18/91 |
| Rosario Strait | BP Oil Ferndale | Manson Construction | 31,269 | 16 | No | 10/16/91 to 10/23/91 |
| Rosario Strait | Anchor Cove Marina | Meridian Construction | 5,425 | 26 | No | 02/18/92 to 03/17/92 |

a = Offsite indicates disposal outside of disposal site target zone

Dredging Year 1993

In DY93, a total of 368,990 CY of dredged material went to six PSDDA sites (Table 2-3). The Rosario Strait, Port Gardner, Bellingham Bay, Port Townsend, Elliott Bay, and Anderson/Ketron sites were used. The Rosario Strait and Port Gardner sites received the majority of the material; 176,486 and 109,500 cubic yards, respectively. Figure 2-2 illustrates the pattern of site use in DY93. Table 2-4 provides a project-by-project summary of the disposal activity.

TABLE 2-3. VOLUME OF DREDGED MATERIAL DISPOSED AT PSDDA SITES-DY93

| Disposal Site | # of Projects | Total Volume (CY) |
|---|---|---|
| Rosario Strait | 6 | 176,486 |
| Port Gardner | 2 | 109,500 |
| Bellingham Bay | 1 | 32,883 |
| Port Townsend | 1 | 22,642 |
| Elliott Bay | 4 | 17,282 |
| Anderson/Ketron | 2 | 10,197 |
| All Sites Combined | 16 | 368,990 |

Summary of Disposal Activity by Site

**Elliott Bay.** During DY92, the Elliott Bay disposal site received 230,241 cubic yards of material from a total of 5 projects (Table 2-1). All disposal occurred in the disposal site target area. All dredging was accomplished by clamshell dredge except for the South Park project which used a hydraulic dredge. Seventy-seven percent of the dredged material disposed at the Elliott Bay site in DY92 was from the Corps O&M dredging of the Duwamish Channel. Table 2-2 provides information on specific project volumes and site-use dates.

In DY93, a total volume of 17,282 CY from four relatively small projects was disposed of at the Elliott Bay site in DY93. Dredging and disposal was by clamshell/bottom-dump barge and all disposal occurred within the site target area. Project details are included in Table 2-4.

**Rosario Strait.** The Rosario Strait site received 43,850 cubic yards from 3 projects in DY92. Table 2-2 provides project-specific information. All disposal occurred on site. The large BP Oil project spanned DY91 and DY92, while only 31,269 CY were disposed in DY92, 459,125 CY were disposed from this project in DY 91 (MPAR, 1992). The Anchor Cove spanned DY92 and 93 and received a two day extension on the HPA dredging closure. A clamshell dredge was used for the Port of Skagit and BP Oil projects, while Anchor Cove was dredged hydraulically. All disposals were within the disposal site target area.

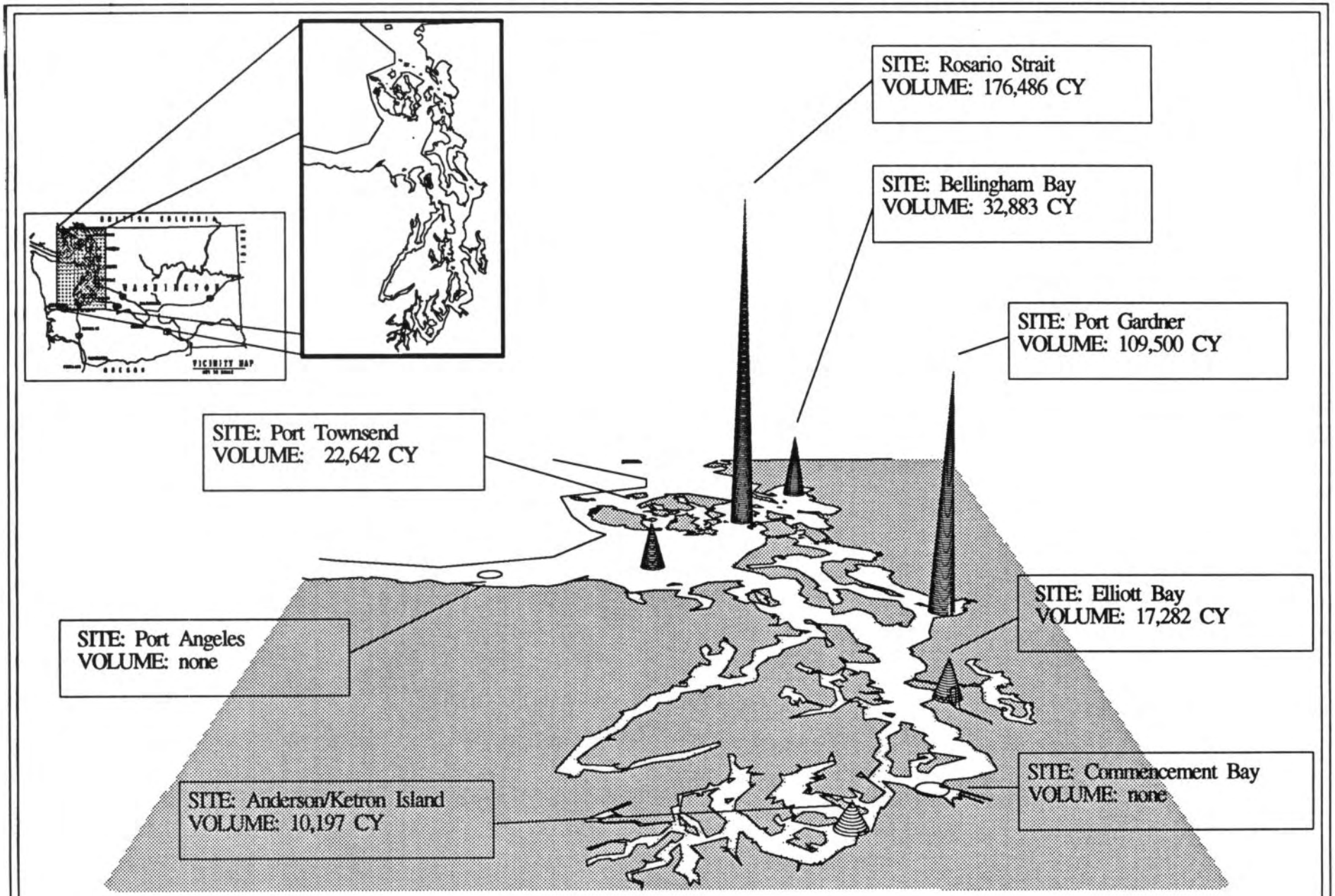



**Figure 2-2. Dredging Year 1993 Disposal Volumes**

TABLE 2-4. SUMMARY OF DY93 PSDDA DISPOSAL PROJECTS

| Site | Proponent | Dredging Contractor | Disposed Volume(CY) | Barge Loads | Off-Site | Disposal Dates |
|---|---|---|---|---|---|---|
| Bellingham Bay | Port of Bellingham | A.H. Powers | 32,883 | 22 | No | 10/13/92 to 11/03/92 |
| Elliott Bay | U.S. Navy Manchester | American Construction | 6,750 | 9 | No | 01/22/93 to 02/01/93 |
| Elliott Bay | Port of Seattle APL | A.H. Powers | 6,924 | 11 | No | 11/30/92 to 12/09/92 |
| Elliott Bay | Lone Star NW | Manson Construction | 3,258 | 5 | No | 01/25/93 to 02/03/93 |
| Elliott Bay | Redmond et al Fletcher Bay | Meridian Construction | 350 | 1 | No | 02/26/93 |
| Port Gardner | Port of Everett (12th St.) | American Construction | 91,500 | 61 | No | 01/08/93 to 03/12/93 |
| Port Gardner | Port of Everett (10th St.) | American Construction | 18,000 | 12 | No | 02/08/93 to 02/17/93 |
| Rosario Strait | Port of Bellingham | Aqua-Marine Constructors | 117,535 | 79 | No | 07/28/92 to 08/29/92 |
| Rosario Strait | Port Of Bellingham | A.H. Powers | 11,709 | 8 | No | 11/04/92 to 11/13/92 |
| Rosario Strait | Anchor Cove Marina | Meridian Construction | 4,250 | 15 | No | 12/01/92 to 03/16/93 |
| Rosario Strait | Pratt/Todd F. Harbor | Culbertson Marine | 450 | 1 | No | 03/06/93 |
| Rosario Strait | Shell Oil March Pt. | A.H. Powers | 38,000 | 20 | No | 11/30/92 to 01/22/93 |
| Rosario Strait | LaConner Boat Works | Manson Construction | 4, 542 | 6 | No | 03/02/93 to 03/08/93 |
| Anderson/ Ketron | LOTT Sewage Treatment Plant | A.H. Powers | 3,600 | 3 | No | 02/05/93 to 03/03/93 |
| Anderson/ Ketron | Day Island Yacht Club | Industrial Pond Service | 6,597 | 4 | No | 10/26/92 to 12/01/92 |
| Port Townsend | WSDOT Keystone | Aqua-Marine Constructors | 22,642 | 22 | No | 02/20/93 to 03/14/93 |

Of the six PSDDA sites used in DY93, the Rosario Strait site received the largest amount of material, 176,486 CY from six dredging operations (Table 2-4). With the exception of the Anchor Cove project, all projects involved clamshell dredging. All disposal activity occurred within the disposal site target area.

**Port Gardner.** The Port Gardner site received 109,500 CY from two Port of Everett dredging projects in DY93, the 10th Street Boat Ramp and 12th Street Marina. All disposal occurred within the site target area. The amount dredged and disposed from the 10th Street Boat Ramp exceeded the suitability determination volume by 32%, apparently due to additional sediment deposition between the time of sampling plan development and the actual dredging. The PSDDA agencies are aware of this problem, which can result in the under-characterization of a proposed dredge prism. To prevent its recurrence, the timing and quality of bathymetry information will be more closely scrutinized on a project-by-project basis. Also, in areas subject to rapid, large-scale sedimentation events and/or when significant time has passed between sediment characterization and the proposed dredging, the PSDDA agencies may require an immediate pre-dredge bathymetric survey to verify project volumes.

**Bellingham Bay**. The Bellingham Bay site was first used in DY93 for the disposal of 32,883 CY of sediment dredged from the Port of Bellingham's Squalicum Waterway (Table 2-4). Only material from the Port of Bellingham's 1992 dredging project that could not be deposited at the dispersive Rosario Strait site was placed at the Bellingham Bay site. All disposal occurred within the site target area.

**Anderson/Ketron.** The Anderson/Ketron site was first used in DY93 for a total of 10,197 CY from two projects. The Day Island Yacht Club project was hydraulically dredged and the LOTT outfall pipe excavation was done with a clamshell.

**Port Townsend.** The Washington State Department of Transportation sponsored the first use of the Port Townsend disposal site in DY93. The Keystone Ferry widening and deepening project involved clamshell dredging and barge disposal of 22,642 CY of material at the disposal site.

## B. PSDDA DISPOSAL SITE MONITORING

### Overview

Environmental monitoring is a primary tool in the management of the PSDDA non-dispersive disposal sites. The objective of disposal site monitoring is to determine whether the disposed dredged material is producing unanticipated adverse effects at the sites. Environmental monitoring can include physical, chemical, and biological assessment of the sediments and biological resources in and adjacent to the disposal sites. The PSDDA monitoring program is designed to compare the post-disposal monitoring results to "baseline" values. Baseline values of key environmental parameters, such as sediment chemistry, toxicity, and biological community structure, were determined for each PSDDA site prior to the first use of the sites (PTI, 1988; 1989).

Post-disposal site monitoring surveys, such as those described below for DY92 and DY93, address three major questions:

1. Is the dredged material deposited on site?

2. Is the deposited dredged material producing chemical and/or biological conditions on site beyond the "minor adverse effects" levels allowed for by the PSDDA Site Management Plan?

3. Is the dredged material causing any adverse impacts to biological resources beyond the disposal site boundaries?

Full PSDDA monitoring is designed to address all three questions, partial PSDDA monitoring only addresses questions 1 and 2.

DNR and the Corps are responsible for the physical (Corps), and chemical/biological (DNR) monitoring of the PSDDA non-dispersive disposal sites. This environmental monitoring is conducted, at irregular intervals, based on the "pattern" of disposal site use since the previous monitoring event. This pattern encompasses several important elements, such as: the volume and characteristics of the material disposed at a given site, the nature and recency of previous site monitoring data, and site-specific environmental concerns. Each spring, PSDDA technical staff review the previous year's disposal activity and reach consensus on which site(s) will be monitored and at what intensity.

The following sections summarize the results of the two PSDDA disposal site monitoring surveys which were conducted in DY92 and DY 93. This includes a full monitoring event in Elliott Bay in the spring of 1992 and a partial monitoring event at the Bellingham Bay site in the spring of 1993. Copies of the PSDDA monitoring reports from which this information is distilled are available from DNR (SAIC, 1992; 1993a; 1993b; 1993c).

DY92 - Elliott Bay Full Monitoring

Site Use and Monitoring History. A baseline (pre-disposal) survey of the Elliott Bay disposal site was conducted by the Department of Ecology in 1988 (PTI, 1988). In DY90 (June 89-June 90), 103,000 cubic yards (CY) of dredged material were disposed at Elliott Bay triggering PSDDA partial monitoring (SAIC, 1991a). In DY91, the Elliott Bay site received only 12,000 CY of dredged material and therefore was not monitored in 1991. In DY92, an additional 230,241 CY of material was disposed at the site prompting a full monitoring event. (SAIC, 1992a; 1993a). The 1992 results were discussed at the 1993 ARM and are summarized below. In DY93, only 17,282 CY were disposed and no additional monitoring has been conducted at Elliott Bay since the 1992 survey.

1992 Full Monitoring Results. In May/June 1992, a full monitoring survey was conducted at the Elliott Bay disposal site. Four types of data were collected during this monitoring: physical mapping (sediment vertical profiling), sediment chemistry, sediment toxicity (bioassays), and benthic community structure. The major findings of this survey follow, organized according to the major monitoring questions.

**1) Does the dredged material stay on-site?**

The sediment-profile photographic survey indicated that dredged material stayed within the boundaries of the Elliott Bay disposal site (Figure 2-3). As expected, the thickest accumulations of dredged material were over the disposal site target zone. This result is consistent with the pattern observed in the 1990 partial monitoring. Also, an independent study of sediment transport regimes in Elliott Bay conducted by the NOAA/NRDA panel in late 1993 further corroborate this depositional pattern. The results of this study indicate that the disposal site is well-located in a non-dispersive zone in the center of Elliott Bay (McClaren, 1994, in prep).

Chemical data collected along the site's perimeter indicated some elevation of metal concentrations relative to the baseline data. To further investigate this finding, sediment metal concentrations at benchmark stations were measured in archived samples. Benchmark stations are located in the Bay, but away from the potential influence of dredged material disposal. The benchmark data showed elevations similar to those observed at the site perimeter (Figure 2-4). These observations point to Elliott Bay-wide changes in sediment quality that are unrelated to PSDDA disposal activity.

**2) Is the dredged material causing biological effects beyond the "minor adverse effects" allowed for at the PSDDA site?**

On-site chemistry and bioassay data show sediment quality to be well within the allowable "minor adverse effects" levels, i.e., no PSDDA ML exceedances were observed and the bioassays results passed non-dispersive site interpretive criteria. In general, sediment contaminant concentrations were observed to be at the low end of ranges reported in the

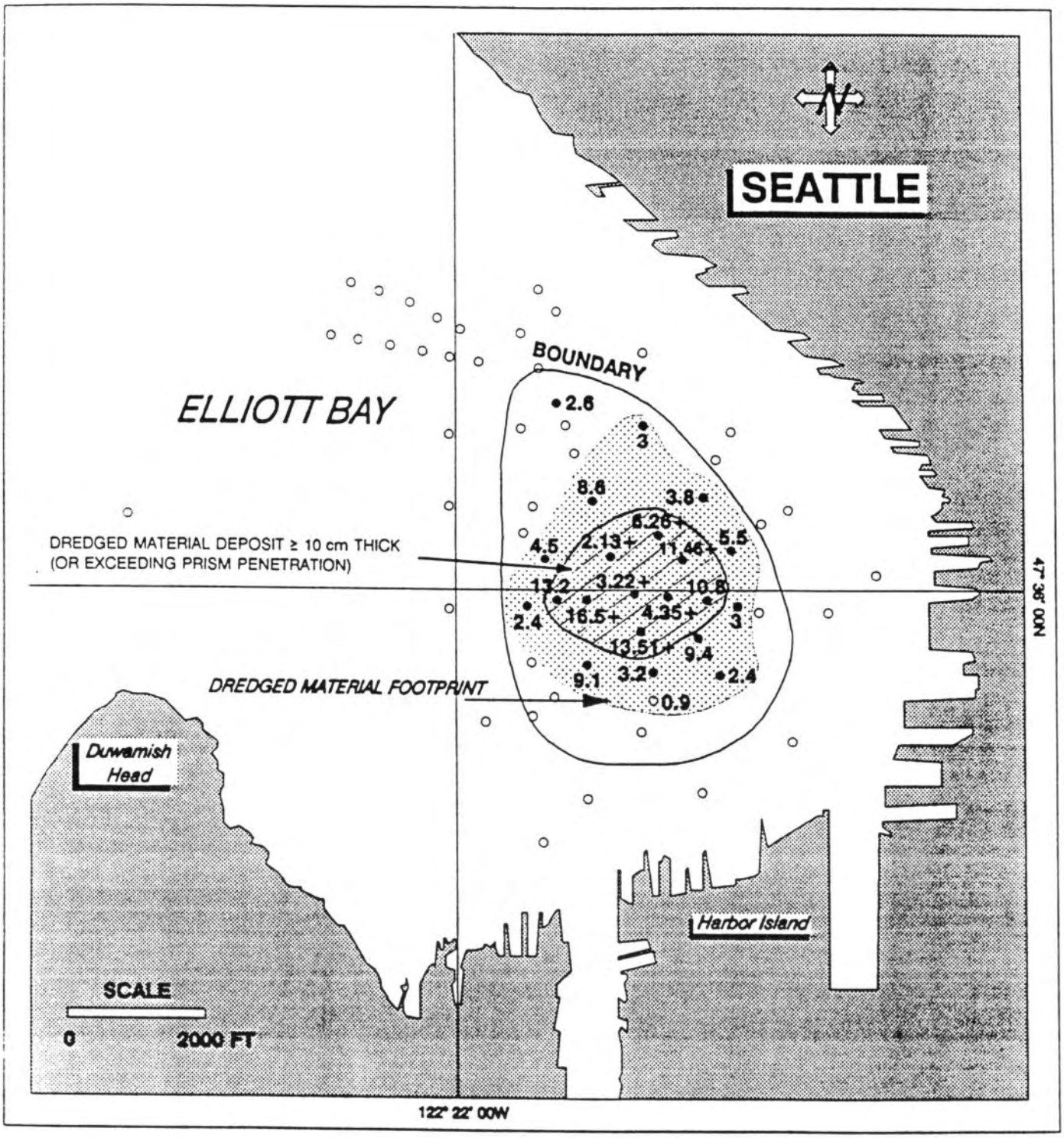
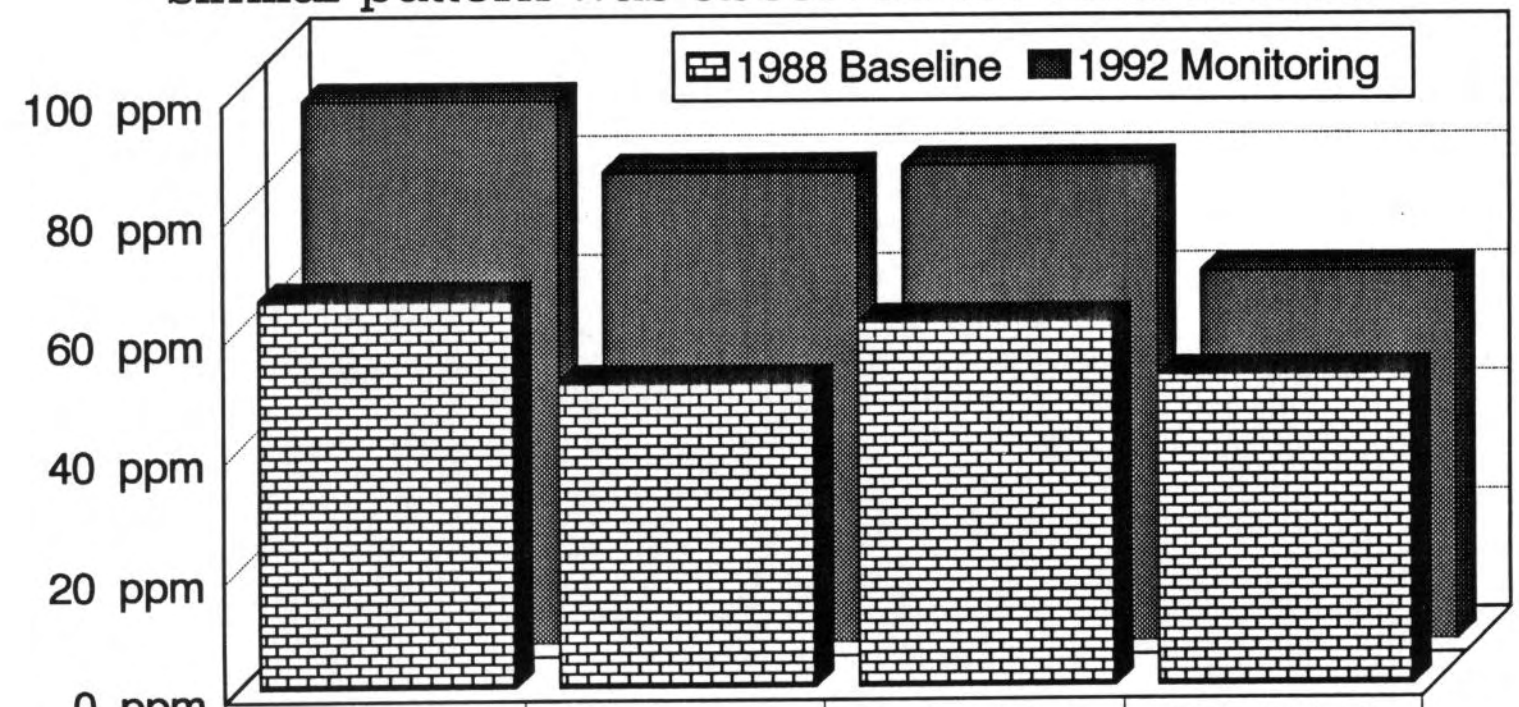



Figure 2-3. The dredged material footprint observed during the 1992 SVPS survey of the Elliott Bay PSDDA disposal site. Deposit thicknesses are reported in cm. Measurements followed by a "+" indicate a minimum value as dredged material extended beyond prism penetration.

**Figure 2-4.** The change in copper and lead concentrations at perimeter and benchmark stations between 1988 and 1992. A similar pattern was observed for other metals.




| | Benchmark: Copper | Perimeter: Copper | Benchmark: Lead | Perimeter: Lead |
|---|---|---|---|---|
| 1988 Baseline | 65 ppm | 51 ppm | 61 ppm | 52 ppm |
| 1992 Monitoring | 91 ppm | 79 ppm | 80 ppm | 62 ppm |

Copper SL = 81 ppm; Lead SL = 66 ppm

baseline (pre-disposal) survey. Since 1988, the disposal site has shown an appreciable decrease in contamination (Figures 2-5a and 2-5b). This appears to reflect the continued disposal of relatively clean dredged material in a non-pristine, urban embayment.

**3) Is the dredged material causing adverse impacts to biological resources outside the disposal site?**

For the Elliott Bay PSDDA site, the potential for adverse effects offsite is evaluated by assessing sediment chemistry and benthic infaunal abundance at three stations which are located on a transect which extends downslope beyond the site perimeter. The transect sediment chemistry results showed the same pattern of exceedances observed at the site's perimeter, i.e., there was no indication of contaminant migration from the disposal site. The abundance of major benthic taxa (e.g. annelids, crustacea, molluscs) at the transect stations in 1992 were similar to the abundance measured in the 1988 baseline survey. The largest abundance decrease measured for any single major taxa was 25%, well below the 50% benthic abundance reduction trigger value established for the PSDDA monitoring program. Overall, there was no indication of adverse environmental effects beyond the boundary of the disposal site.

DY93 - Bellingham Bay Partial Monitoring

Site Use and Monitoring History. Baseline (pre-disposal) data were collected at the Bellingham Bay disposal site in the spring of 1989 (PTI, 1989). In 1990 and 1991, additional baseline information was collected on crab and benthic tissue contaminant loading (SAIC, 1990; 1991b). The first dredged material disposal (32,883 CY) at the site occurred in the fall of 1992. To date, this has been the only use of the Bellingham Bay site. Although 32,000 CY is a relatively small volume of dredged material, the PSDDA agencies elected to conduct partial monitoring of the site in the spring of 1993. This decision reflects the agencies' acknowledgement of the concerns expressed by the Lummi Tribe and local environmental groups regarding the use of this relatively shallow-water site.

1993 Partial Monitoring Results. In April 1993, a partial monitoring survey was conducted at the Bellingham Bay disposal site (SAIC, 1993b; 1993c). The survey consisted of the standard PSDDA partial monitoring techniques, which include: sediment vertical photography to map the disposed dredged material, on-site and site perimeter sediment chemistry, and on-site sediment toxicity assessment. In addition, a side scan sonar survey was conducted as part of the physical site mapping to provide supplemental information on the distribution of dredged material and to evaluate the extent and distribution of log debris at the site (see question 1a. below). The survey findings that follow are organized according to the major monitoring questions.

**Figure 2-5a.** Concentrations of metals detected at the Elliott Bay site in the baseline (1988), partial monitoring (1990), and full monitoring (1992) surveys expressed as a percentage of the SL (solid line).

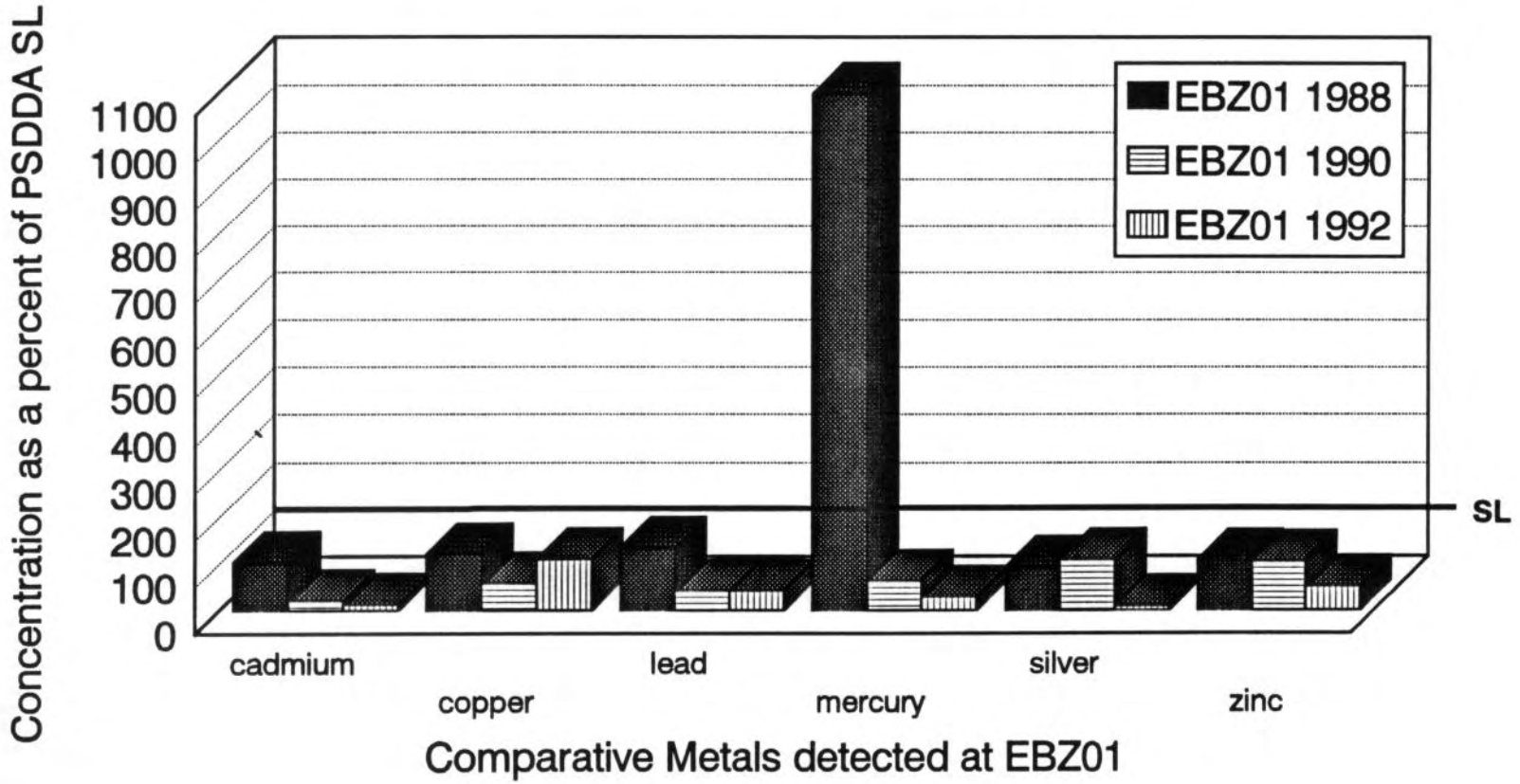
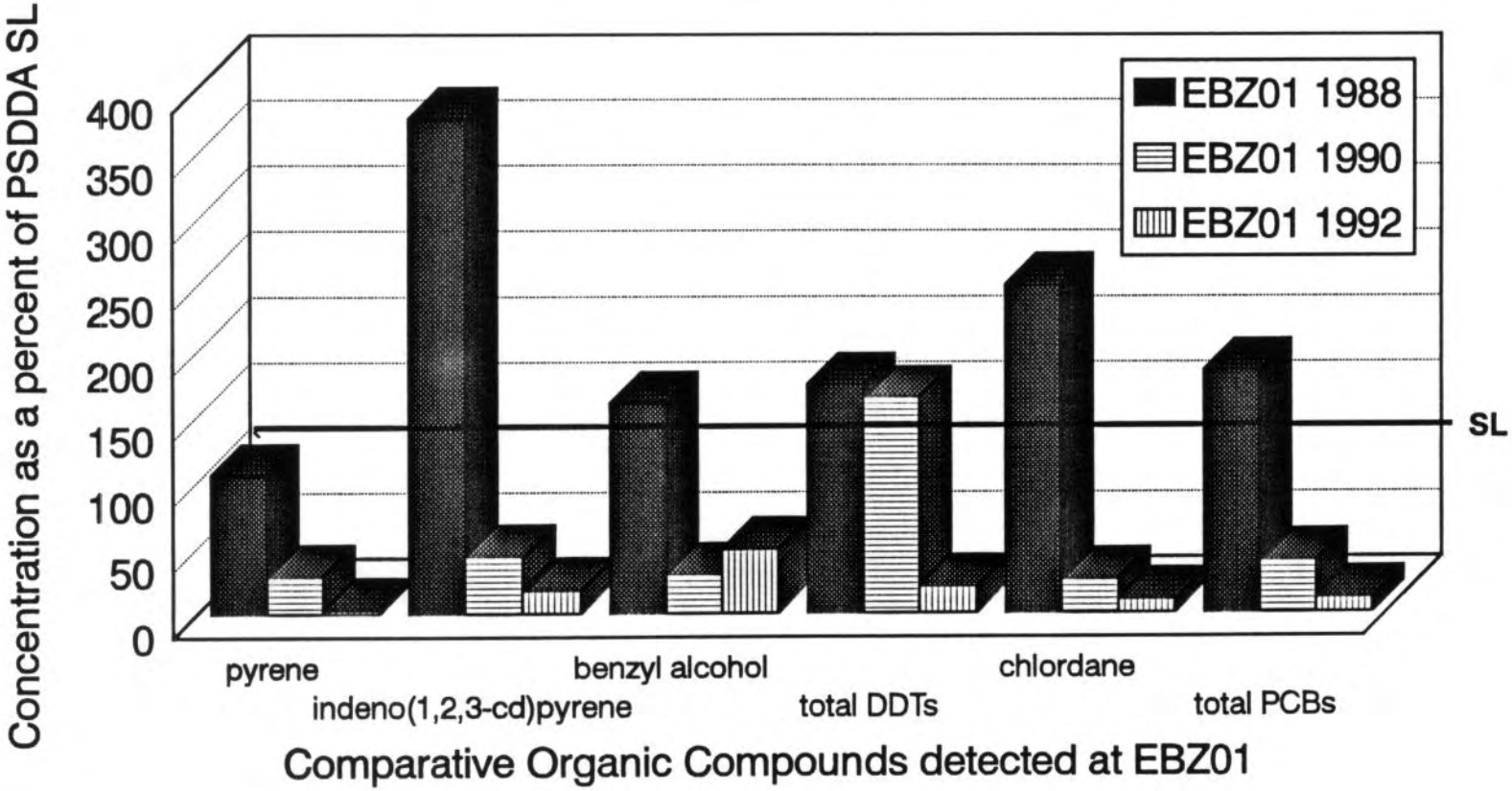


**Figure 2-5b.** Concentrations of organic compounds detected at the Elliott Bay site in the baseline (1988), partial monitoring (1990), and full monitoring (1992) surveys expressed as a percentage of the SL (solid line).



**1) Does the dredged material stay on-site?**

The sediment-profile data indicate that the disposed sediments are well within the boundaries of the Bellingham Bay disposal site (Figure 2-6). The roughly oval-shaped disposal mound is approximately 3000' in length along its longest axis. However, most of the mound consists of thin layers (< 10 cm) of dredged material. Only with a relatively small (600' diameter) central circular area exhibits dredged material overburdens greater than 10 cm in thickness. The side scan sonar survey results reveal a small, circular dredged material mound approximately 1200' in diameter. The discrepancy between the sediment-profile and the side scan results in the maximum extent of the dredged material disposal mound is expected as the acoustic side scan technique does not readily detect layers of disposed sediment which do not strongly contrast the ambient bottom in texture (as is the case here, with, fine-grained material disposed in a fine-grained area).

At stations along the site's perimeter, the concentrations of organic chemicals of concern were either much lower or comparable in 1993 relative to the 1989 baseline survey. For example, the concentration of phenol at perimeter station BBP04 was 4,800 ug/kg in 1989; this compares to 680 ug/kg in 1993. A total of four organic compounds did exceed the established trigger value (1.47X the baseline concentration) for perimeter stations. These exceedances were observed among compounds that were: 1) undetected or measured at extremely low concentrations during the baseline survey; and 2) undetected or measured at very low concentrations on the dredged material mound in 1993. Moreover, the exceedances represented only 4% of the total baseline versus post-disposal organic compound comparisons, which is well below the 20% false positive rate expected by chance (MPAR, 1992). In addition, all exceedance concentration values were below both PSDDA screening and State Sediment Quality levels (WAC 173-204).

For the metals, a similar pattern was observed. Some analytes, e.g. mercury, were measured at lower concentrations in 1993 relative to 1989, while others, such as arsenic, were slightly elevated. Overall, there was no notable change in sediment inorganic concentrations at the perimeter stations and concentrations were below PSDDA SLs and State SQS. The number of exceedances, 18%, was less than the 20% expected by chance. In total, the perimeter chemistry data support the physical mapping information. Combined, these data indicate that the dredged material was deposited and remains on site.

**1a) Is there wood debris on-site?**

The side scan traces showed evidence of small log fragments and woody debris scattered near the site center. Log debris was also evident in the side scan traces along the periphery of the site. However, the debris at the center of the dredged material mound exhibited a more distinct reflectance pattern than the outlying debris. Therefore, it seems reasonable to assume that the log fragments observed near the site center were deposited with the dredged material. The fragments are limited in number, generally small (2-3 meters in length), and project less than 0.3 meters above the bottom.

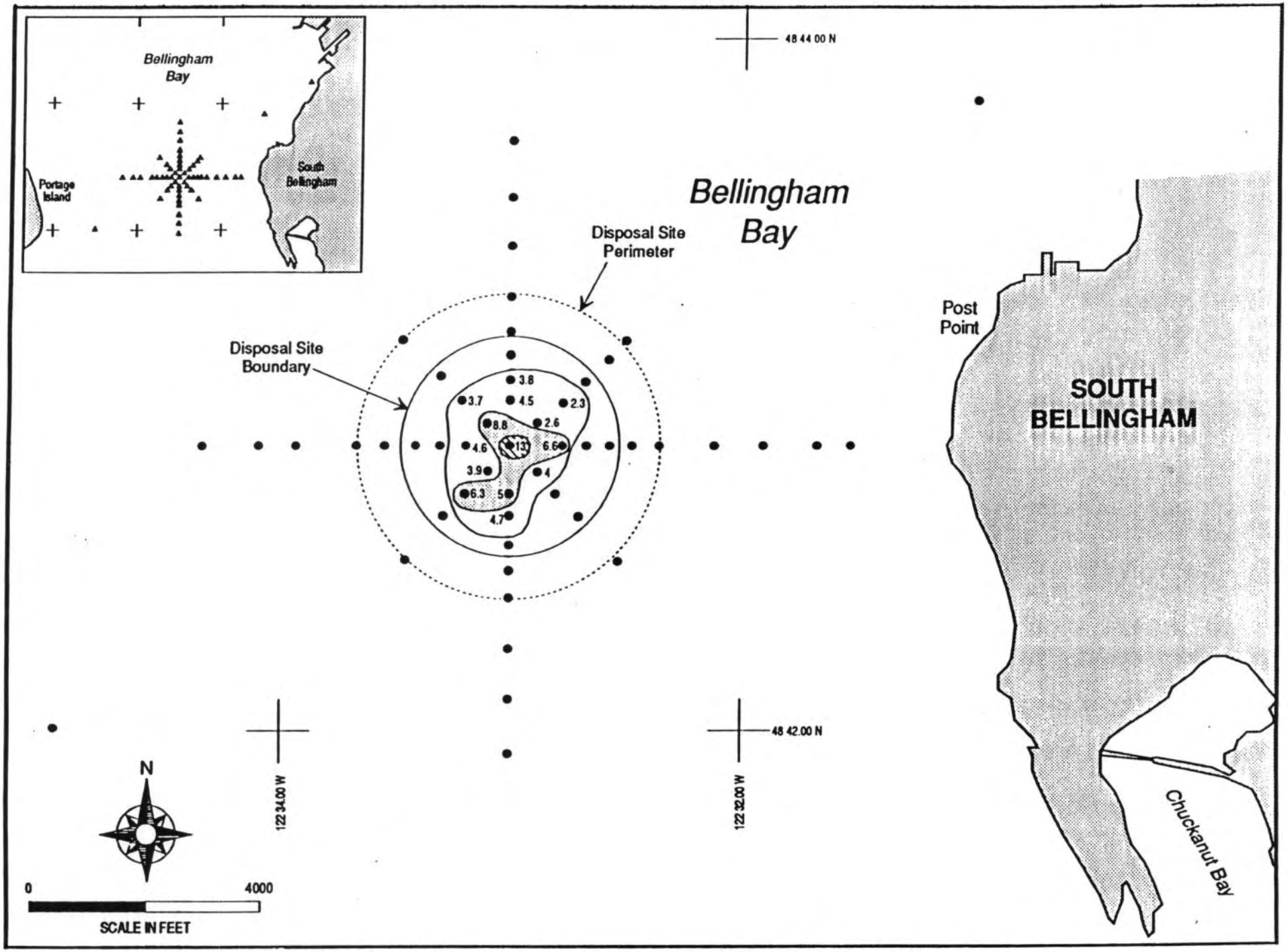



Figure 2-6. Distribution of dredged material at the Bellingham Bay PSDDA disposal site. Measurements are in centimeters. Contours are in 5 cm intervals.

During the Port of Bellingham project, the dredging contractor made every effort to physically pick out log debris and a significant amount of debris was collected and disposed of upland. Despite these efforts, it seems that some wood debris was inadvertently placed at the site. Consequently, in any future dredging with disposal scheduled for the Bellingham Bay site, the PSDDA agencies will consider imposing more rigorous debris prevention controls, such as requiring a 24" meter mesh screening of the dredged material as it is placed in the disposal barge (PSDDA, 1989). Also, a post-disposal side scan sonar survey will be considered following any dredging projects in which significant log debris is encountered to ensure that debris prevention controls are effective.

**2) Is the dredged material causing biological effects beyond the "minor adverse effects" allowed for at the PSDDA site?**

On-site chemistry and bioassay data showed sediment quality to be well below the allowable "minor adverse effects" level established for PSDDA non-dispersive sites. For sediment chemistry, the minor adverse effects level is exceeded when chemical concentrations are greater than PSDDA MLs. In the sediments collected from the disposal site in 1993, there were no ML exceedances. In fact, only two analytes (copper and nickel) exceeded the PSDDA SL; there were no exceedances of the State's SQS levels. The organic compounds were generally undetected or measured at concentrations less than those observed in the 1989 baseline survey of the site.

The full suite of PSDDA bioassays were conducted on the sediments collected from the center of the disposal mound. For biological testing data, the minor adverse effects level is set at the PSDDA non-dispersive interpretive guideline levels (i.e., is the material suitable for open-water disposal at a PSDDA non-dispersive site?). For the test suite (the acute amphipod (*Ampelisca abdita*), sediment larval (*Dendraster*), *Neanthes* biomass, and Microtox tests), there were no "hits" using either the PSDDA non-dispersive or dispersive site interpretive guidelines (Table 2-5; see Appendix C for Interpretive Guidelines).

TABLE 2-5. 1993 PSDDA SITE MONITORING BIOASSAY RESULTS, BELLINGHAM BAY.

| Station | *Ampelisca* (%mortality) | *Neanthes* individual biomass (mg) | *Dendraster* (% combined mortality) | Microtox % light reduction |
|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | Mean (SD)[a] | N/A |
| Control | 9.5 (9.3) | 18.1 (1.9) | 18.3 (10.7) | -20.60 |
| Reference | 5.0 (3.5) | 14.4 (3.8) | 12.3 (10.4) | -25.78 |
| BB site center | 24.0 (9.6) | 15.2 (1.7) | 11.3 (6.7) | -12.5 |

SD = Standard Deviation
[a]SD calculated on raw data

Overall, the 1993 PSDDA partial monitoring survey at the Bellingham Bay disposal site showed that site management objectives were satisfied. The results were consistent with those obtained at Elliott Bay in 1992 as well as in previous PSDDA disposal site surveys.

Summary: PSDDA Disposal Site Use and Monitoring since Program Implementation

The cumulative dredged material volumes disposed at each PSDDA site are shown in Table 2-6 and Figure 2-7. Seven of the eight disposal sites have been used. The large volumes disposed at Port Gardner and Rosario Strait reflect two major dredging projects - the Navy Everett Homeport (Element I - 992,074 CY disposed in DY90) and the B.P. Oil Ferndale Dock Reconstruction (601,269 CY disposed in DY91 and DY92). Also, although numerous projects have utilized the Elliott Bay site, approximately one-half of the material disposed has been USACE Duwamish O&M dredged material.

TABLE 2-6. CUMULATIVE DISPOSAL VOLUMES, DY89-93.

| Disposal Site | Dredging Years Used | Cumulative Volumes Disposed (CY) |
|---|---|---|
| Port Gardner | 90, 91, 93 | 1,118,835 |
| Rosario Strait [a] | 91, 92, 93 | 787,030 |
| Elliott Bay | 90, 91, 92, 93 | 389,065 |
| Bellingham Bay | 93 | 32,883 |
| Port Townsend [a] | 93 | 22,642 |
| Commencement Bay | 89, 91 | 17,548 |
| Anderson/Ketron | 93 | 10,197 |
| Port Angeles [a] | Not Used | 0 |

[a]Dispersive site

Table 2-7 lists the completed and scheduled PSDDA disposal site monitoring events. To date, the PSDDA agencies have conducted four post-disposal site surveys - two full and two partial monitoring events. Three of the five non-dispersive sites have been surveyed. A fifth monitoring survey will occur in Port Gardner in 1994 and a sixth will likely occur in 1995 at Commencement Bay, if a significant volume of dredged material from the Blair Waterway is disposed there in DY95. Due to the infrequent and minor use of the Anderson/Ketron site, monitoring of this site is not anticipated in DY94 or DY95.

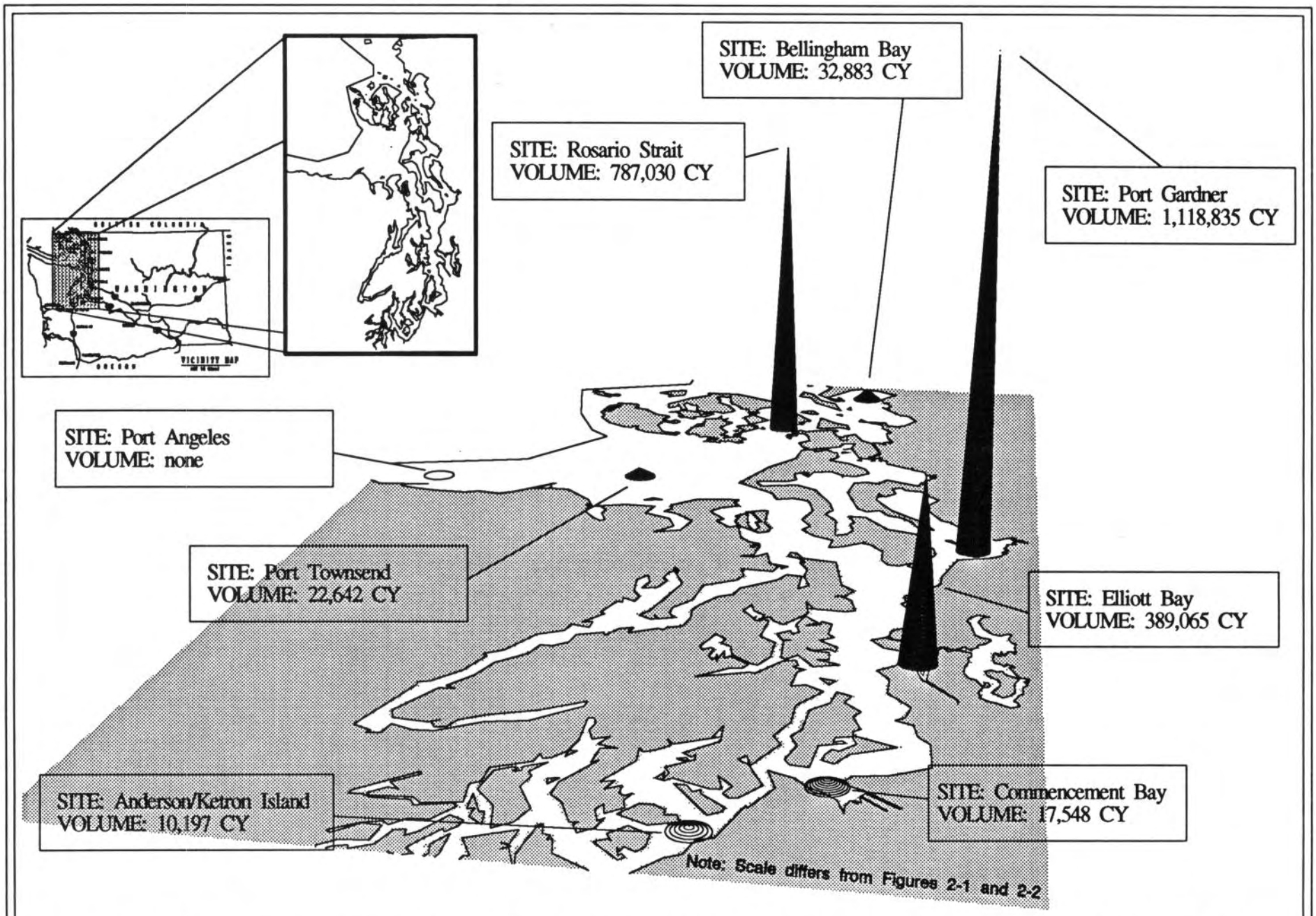



**Figure 2-7. Cumulative Disposal Volumes (Dredging Years 1989-1993)**

TABLE 2-7. PSDDA DISPOSAL SITE MONITORING SURVEYS

| YEAR | SITE | TYPE OF SURVEY |
|---|---|---|
| 1990 (Completed) | Port Gardner | Full Monitoring |
| 1990 (Completed) | Elliott Bay | Partial Monitoring |
| 1992 (Completed) | Elliott Bay | Full Monitoring |
| 1993 (Completed) | Bellingham Bay | Partial Monitoring |
| 1994 (Scheduled) | Port Gardner | Partial/Full Monitoring[a] |
| 1995 (Anticipated) | Commencement Bay | Partial/Full Monitoring[a] |

[a]Monitoring will be tiered (see text).

Based on PSDDA site monitoring data collected to date (which includes physical mapping, on and offsite sediment chemistry, sediment toxicity, offsite infaunal bioaccumulation, and offsite benthic community structure data), dredged material disposal is not causing adverse impacts at or adjacent to the non-dispersive sites. In other words, the PSDDA dredged material evaluation procedures appear to adequately protect disposal site environmental conditions. Moreover, at urban sites such as Elliott Bay, on-site sediment quality actually appears to be improving as the site is used. A similar result may occur at the Commencement Bay site.

The overall goal of the PSDDA site monitoring program is to insure that the PSDDA-prescribed disposal site conditions are maintained and verify that PSDDA dredged material evaluation procedures adequately protect the environment. Monitoring surveys provide key feedback information which allows reassessment of the adequacy of the PSDDA dredged material management process. At previous PSDDA Annual Review Meetings, site monitoring/management changes initiated as a result of post-disposal survey information have been described (MPAR, 1991; 1992).

The PSDDA Management Plan Reports (PSDDA, 1988; 1989) recognized that intensive post-disposal monitoring would need to occur early in program implementation to allow for an early response to unexpected adverse impacts. As indicated above, the four surveys conducted to date have not detected unexpected impacts. In accordance with the management plan, the PSDDA agencies anticipate that, if site monitoring continues to show positive results, then at the conclusion of the surveys listed in Table 2-6, monitoring efforts may be reduced in scope and frequency. As an interim step toward this end, the 1994 survey scheduled for Port Gardner will be tiered. That is, a full monitoring survey will be conducted in the field (both onsite/perimeter and offsite/benchmark samples will be collected), but only the partial monitoring samples analyses will be analyzed initially and the full monitoring samples archived. If these onsite/perimeter measurements indicate that there is problem, e.g. offsite transport of dredged material or contaminants, then the offsite samples will be analyzed. This tiered approach will be cost-effective without sacrificing environmental protection.

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# CHAPTER 3

# PSDDA PROGRAM REVIEW: CLARIFICATIONS, STATUS REPORTS AND ISSUE PAPERS

The purpose of this chapter is to present the various topics discussed by the PSDDA agencies during dredging years (DY) 1992-93 which may have implications to the PSDDA Management Plans. These topics warrant further discussion during the annual review process, either in this report or at the May 1994 Annual Review Meeting (ARM).

A discussion topic may be presented as a clarification, status report or issue paper. Clarifications are minor adjustments to existing PSDDA requirements. They are not usually presented formally at the ARM unless specifically requested by public comment. Status reports present the progress made to date on important projects or areas of work. They may be given orally at the ARM. Issue papers propose significant changes to PSDDA Management Plan requirements and warrant more extensive discussion at the ARM.

All agency clarifications and issue papers are included in this PSDDA Biennial Report, thus allowing public review prior to the meeting. Topics considered during DY 1992-93 are listed below. Updates to issue papers may be presented at the ARM.

Clarification papers:

- Coordination and testing of dredged material for beneficial uses projects
- Restriction on exotic species importation
- Neanthes 20-day bioassay interpretations
- Use of alternate technologies under the sediment management standards
- Interim revised test performance standards for the sediment larval bioassay

Status reports:

- Technical review of acute bioassays required by PSDDA
- Evaluation of benthic interpretive methods used by PSDDA
- Permitting Puget Sound Dredged Disposal Analysis (PSDDA) sites
- 1994 Update and evaluation of Puget Sound AET
- Draft EPA national sediment quality criteria

Issue papers:

- Refinements to bioaccumulation testing requirements

# CLARIFICATION PAPERS

## CLARIFICATION PAPER

## COORDINATION AND TESTING OF DREDGED MATERIAL FOR BENEFICIAL USES PROJECTS

Prepared by Justine Barton (EPA, 206/553-4974) for the PSDDA agencies.

### INTRODUCTION

To ensure a beneficial uses project's viability, a chemical and physical evaluation of the proposed dredged material is required. PSDDA testing requirements and the PSDDA agency review process is intended to evaluate dredged material proposed for disposal at PSDDA unconfined, open-water disposal sites.

### PROBLEM IDENTIFICATION

Material tested under PSDDA and found suitable for unconfined, open-water disposal is often proposed for beneficial uses projects. However, PSDDA evaluation does not necessarily indicate that the material is appropriate for a particular beneficial use. While the PSDDA agencies encourage beneficial uses projects, no formal process presently exists for beneficial uses project coordination or determining appropriate testing.

### PROPOSED CLARIFICATION

Applicants considering potential beneficial uses projects should bring these projects to the attention of the PSDDA agencies and other resource agencies early in the evaluation process. Depending on the adequacy and recency of project testing information (including any PSDDA testing), and the specifics of the beneficial uses project, some additional testing may or may not be required. The agencies will continue to make every effort to adequately coordinate these projects on a case by case basis.

## CLARIFICATION PAPER

## RESTRICTION ON EXOTIC SPECIES IMPORTATION

Prepared by Maria V. Peeler (Department of Ecology, 206/407-7529) for the PSDDA agencies.

## INTRODUCTION

The Washington State Departments of Fisheries and Wildlife (DFW) have promulgated regulations restricting the importation of exotic species into Washington State.[1] Department of Fisheries regulations concern the possibility of release of fish or shellfish diseases from laboratories,[2] while Department of Wildlife regulations concern the possibility of release of deleterious exotic organisms from laboratories.[3]

## PROBLEM IDENTIFICATION

Because PSDDA regulatory decisions depend on several bioassay tests which import species not native to Washington (primarily *Neanthes arenaceodentata* and *Ampelisca abdita*), clarification of exotic species importation under the PSDDA program is appropriate. The PSDDA Agencies believe laboratories are currently conscientious in their management and disposal of exotic species and exposed sediments. However, additional education/ clarification to practitioners will decrease the potential for violations. Any laboratory bioassay or bioaccumulation practice which could potentially endanger Washington State's natural resources, including fish and shellfish, should be discontinued.

## PROPOSED ACTION/MODIFICATION

Laboratories conducting bioassay or bioaccumulation tests under PSDDA are expected to meet the disposal requirements identified by Ecology's toxicity test protocols, PSEP protocols, and other regulatory requirements, as well as best management practices (BMPs) developed by DFW. Laboratories must also have documentation on the source of test organisms, the disposal practices for test organisms, and the discharge practices for test solutions, sediments and culture water, including disinfection of discharged water. This documentation must be included in the laboratory's Quality Assurance/Quality Control report, with the test results (QA1 information).

A list of approved sources for shellfish, as well as copies of the regulations, BMPs and protocols are available from Ecology's PSDDA coordinator, Tom Gries, at 206/407-6910.

## REFERENCES


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**CLARIFICATION PAPER**

**NEANTHES 20-DAY BIOASSAY - INTERPRETATION CLARIFICATIONS: ADOPTION OF GROWTH ENDPOINT; STIMULATORY EFFECT AND DISPERSIVE INTERPRETATION GUIDELINES.**

Prepared by David Kendall (Corps of Engineers, 206/764-3768) for the PSDDA agencies.

## INTRODUCTION

The PSDDA agencies implemented the *Neanthes* 20-day biomass test at the beginning of Dredging Year 1993 for a trial period to evaluate its performance and its effectiveness in identifying contaminated sediments in the PSDDA program. The test has been used successfully for approximately two years to assess dredged material suitability for unconfined open-water disposal. This paper refines the endpoint determination and clarifies certain issues relative to the interpretation guidelines.

## PROBLEM IDENTIFICATION

Growth Endpoint. Adoption of a growth endpoint is recommended in recent papers.[1,2] The investigations noted that the growth rate was linear between one week and eight weeks post emergence for *N. arenaceodentata*. The authors recommend expressing the juvenile worm growth as a rate function according to the formula.

$$G = \frac{DWt - DWi}{T}$$

where

G = estimated individual growth rate (milligrams dry weight/day)
$DW_t$ = estimated individual dry weight at termination (milligrams)
$DW_i$ = mean estimated individual dry weight at initiation (milligrams)
T = exposure time (days)

Five reasons (paraphrased) from these papers for recommending this interpretative approach are as follows:[1,2]

a. All bioassays will not be initiated with the same size worms. Expressing growth as a rate will normalize test results to account for these differences.

b. Expressing growth as a rate will permit the experimental flexibility to vary slightly from any recommended exposure period (e.g. longer than 20 days).

c. Differences due to initial worm size and test duration are normalized by the rate function; intra as well as interlaboratory comparisons are therefore possible.

d. Expressing growth as a rate function will, with time and experience, allow the establishment of data quality control criteria for test acceptance or rejection. For example, it may eventually be possible to evaluate the validity of a sediment bioassay response on the basis of the observed growth rate in control or reference treatments.

e. Much of the published literature on polychaete growth is expressed as a rate function. Expressing bioassay test results as a rate will facilitate comparisons to these literature reports.

Stimulatory Growth Effects. Contaminants can induce effects on growth that are either inhibitory or stimulatory, and the potential stimulatory effect should be acknowledged and accounted for in the regulatory interpretation guidelines[1]. The PSDDA program has observed several cases where the reference biomass outperformed the control sediment biomass. No guidance is currently available in the PSDDA program or SMS program to clarify what the regulatory interpretation will be in this situation, and whether or not it should be considered a toxic response.

Dispersive Interpretation Guidelines. The current interpretation guidelines for the *Neanthes* bioassay have generally been applied only to nondispersive site disposal over the past two years. The need exists to establish interpretation guidelines for dispersive sites, consistent with the approach taken for the amphipod and sediment larval bioassays.[3]

## PROPOSED ACTION/MODIFICATION

Growth Interpretation Endpoint Guidelines. A clarification to the interpretation guidelines for the *Neanthes* 20-day test is proposed by the PSDDA agencies. Biomass at the end of 20 days will be normalized to the initial weight at test initiation, and the biomass increase over the 20 day period will be expressed as a growth rate function (milligrams/day) rather than as an absolute increase in dry weight.

$$G = \frac{DWt - DWi}{T}$$

where

G = individual growth rate (milligrams dry weight/day)
$DW_t$ = individual dry weight at termination (milligrams)

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[1] The stimulatory effect was pointed out by Dr. Jack Word at one of the *Neanthes* expert workshops during test development, where he noted that DDT appeared to have a stimulatory effect on *Neanthes* growth during some of his work at Battelle.

$DW_i$ = mean individual dry weight at initiation (milligrams)
T = exposure time (days)

Stimulatory Effects Interpretive Guidelines. Apparent stimulatory effects (i.e., test sediment growth rate is significantly larger than the reference growth rate) will be evaluated by the PSDDA agencies using best professional judgement (BPJ) until there is a better understanding of contaminant effects on growth stimulation. Observations of apparent stimulatory effects on growth for this bioassay will be evaluated by BPJ through a careful analysis of the other bioassay responses in concert with the chemical testing results.

Nondispersive Site Interpretative Guidelines. Juvenile 20-day *Neanthes* growth test results that show a mean test individual growth rate less than 80 percent of the mean negative control growth rate (Table 1); and,

Double Hit: Test sediment growth rate less than 70 percent of the mean reference sediment growth rate and statistically different from the reference.
Single Hit: Test sediment growth rate less than 50 percent of the mean reference sediment growth rate, and statistically different from the reference.

**TABLE 1.** Nondispersive site interpretive guidelines.

| **INTERPRETIVE COMPARISON** | ***NEANTHES* 20-DAY BIOMASS TEST** |
|---|---|
| Test response comparison to negative control[a] | Mean test sediment individual growth rate < 80 % of mean control individual growth rate; and, |
| **DOUBLE HIT:** Test response comparison to reference sediment | Mean test sediment individual growth rate < 70 % of reference and statistically significant from reference ($p < 0.05$) |
| **SINGLE HIT:** Test response comparison to reference sediment | Mean test sediment individual growth rate < 50 % of reference, and statistically significant from reference ($p < 0.05$) |

a\test responses $\geq$ 80 percent of negative control growth response is considered a non-hit and suitable for unconfined open-water disposal.

Dispersive Site Interpretative Guidelines. Juvenile 20-day *Neanthes* growth test results that show a mean test individual growth rate less than 80 percent of the mean negative control growth rate (table 2); and,

Double Hit: Test sediment growth rate greater than or equal to 70 percent of the mean reference sediment growth rate, and statistically different from the reference.

Single Hit: Test sediment growth rate less than 70 percent of the mean reference sediment growth rate, and statistically different from the reference (this response is equivalent to the double hit for nondispersive sites).

**TABLE 2.** Proposed dispersive site interpretive guidelines.

| **INTERPRETIVE COMPARISON** | ***NEANTHES* 20-DAY BIOMASS TEST** |
|---|---|
| Test response comparison to negative control[a] | Mean test sediment individual growth rate < 80 % of control individual growth rate |
| **DOUBLE HIT:** Test response comparison to reference sediment | Mean test sediment individual growth rate $\geq$ 70 % of reference and statistically significant from reference ($p<0.05$) |
| **SINGLE HIT:** Test response comparison to reference sediment | Mean test sediment individual growth rate < 70 % of reference and statistically significant from reference ($p<0.05$) |

a\test responses $\geq$ 80 percent of negative control growth response is considered a non-hit and suitable for unconfined open-water disposal.

## REFERENCES


1. Dillon, T.M., D.W. Moore and A.B. Gibson. 1993. Development of a chronic sublethal bioassay for evaluating contaminated sediment with the marine polychaete worm *Nereis* (*Neanthes*) *arenaceodentata*. Environmental Toxicology and Chemistry. Vol. :589-605pp.

2. Moore, D.W., and T.M. Dillon. 1993. Chronic sublethal effects of San Francisco Bay sediments on *Nereis* (*Neanthes*) *arenaceodentata*; Interpretative guidance for a

growth end point. U.S. Army Corps of Engineers, Waterways Experiment Station. Miscellaneous Paper D-93-5. September 1993. 32pp.

3. MPR, Phase II. 1989. Management Plan Report: Unconfined open-water disposal of dredged material, Phase II (North and South Puget Sound). Prepared by the U.S. Army Corps of Engineers, Seattle District; U.S. Environmental Protection Agency, Region 10; and Washington State Departments of Ecology and Natural Resources.

## CLARIFICATION PAPER

## USE OF ALTERNATE TECHNOLOGIES UNDER THE SEDIMENT MANAGEMENT STANDARDS, CHAPTER 173-204 WAC

Prepared by Brett Betts (Department of Ecology), 206/407-6914) for the PSDDA agencies.

### INTRODUCTION

The PSDDA Agencies acknowledged the sensitivity of the Rhepoxynius amphipod test to sediments with high silt content and have used an alternate bioassay, Ampelisca abdita, for dredged material evaluations in such situations. This paper clarifies procedures for approval of alternate technologies, e.g., alternate bioassay tests, under the Sediment Management Standards (SMS), Chapter 173-204 WAC.

### PROBLEM IDENTIFICATION

Ecology adopted the SMS in March 1991. The SMS rule identifies narrative procedures and chemical and biological criteria for sediment compliance evaluations. In some cases , the PSDDA Agencies or project proponents may seek to additionally comply with the SMS rule requirements when conducting PSDDA dredged material evaluations. Due to the extended timeframes necessary to complete rule adoption/amendment procedures consistent with the SMS triennial rule revisions, the rule may not reflect current state-of-the-art knowledge. This clarification paper documents Ecology requirements for approval and use of alternate technologies under authority of the SMS rule.

### PROPOSED ACTION/MODIFICATION

To provide flexibility for use of "best available science," the SMS rule allows for the use of "alternate technologies." Ecology has determined that generic approval of any alternate technology for widespread implementation is not allowed under the requirements of the SMS. Instead the SMS rule instructs Ecology to provide advance review and approval of any alternate technical method proposed prior to its application. Ecology must also maintain files on each approved alternate technology and make them available to the public upon request. Ecology must maintain a public record of:

- Each approval for use of alternate technology;
- Follow-up data reports/results; and
- SMS designation determinations based on the use of the alternate technology.

Ecology approval of any alternate technology will routinely cite use of "best professional judgment" authority to meet the goal of the SMS, i.e., to reduce and ultimately eliminate adverse effects on biological resources and significant health threats to humans. Ecology's approval will also be conditioned on the intent to "replace or enhance the application of a specific technical method in order to accurately reflect the latest scientific knowledge." Dependent on the specific technology approved by Ecology, specific performance conditions, e.g., bioassay protocols, and interpretation requirements for SMS designation may be required by Ecology.

On a case-by-case basis, interested parties seeking approval of "alternate technologies" under the SMS must:

- Provide Ecology a written request and justification documentation for advance review and approval prior to implementation of the alternate technology and
- Provide Ecology with follow-up test results, data reports or conclusionary studies as required by Ecology to document the use and interpretation of the approved alternate technology(s).

This information should be submitted to the following address:

Attn: Brett Betts
Sediment Management Unit
Department of Ecology
P.O. Box 47703
Olympia, WA 98504-7703

## CLARIFICATION PAPER

## INTERIM REVISED PERFORMANCE STANDARDS FOR THE SEDIMENT LARVAL BIOASSAY

Prepared by David Fox and Therese Littleton (Corps of Engineers, 206/764-6550) for the PSDDA agencies.

### INTRODUCTION

Bioassays are used in the PSDDA program to assess toxic and chronic sublethal effects of sediments proposed for dredging with open-water disposal. Performance standards for both negative controls and reference sediments are used to ensure the validity of test results. At the time the sediment larval bioassay was instituted for use in the PSDDA program, high mortalities were being experienced in the bivalve test and the performance standard for the negative seawater control combined mortality and abnormality (effective mortality) was set at fifty percent.[1] The reference sediment seawater-normalized effective mortality was set at twenty percent, which matched the reference sediment performance standard in the amphipod test. Five years have elapsed since the implementation of the PSDDA sediment larval test and a review of the compiled data has provided the PSDDA agencies the opportunity to re-examine the performance standards for this bioassay.

### PROBLEM IDENTIFICATION

The current PSDDA guideline for reference sediment seawater-normalized effective mortality is twenty percent. Under this guideline, a large percentage of reference data has been rejected from use in decision-making under the PSDDA program. When this occurs, the PSDDA agencies must require a retest, set aside the test results and make a decision based on the results from the other bioassays, or rely on best professional judgment in interpreting the data.

Using the PSDDA bioassay data residing in the Dredged Analysis Information System (DAIS), frequency distributions for effective mortality and abnormality in the seawater controls (Figure 1), and effective mortality in test sediments and reference sediments (Figure 2), were derived. The distributions of effective mortality for the test and reference sediments are similar and overlap to a great degree. This result was not unexpected, since a relatively small fraction of the sediments tested under PSDDA have exhibited significant toxicity. However, the mortality distribution of larvae in both reference sediments and test sediments exhibits a degree of variability not anticipated when the sediment larval test was first implemented. The performance standards for this test do not adequately reflect this variability.

The seawater control performance standard, on the other hand, has been unnecessarily flexible. Very few projects have exhibited mortality in the seawater control greater than the PSEP standard of thirty percent.

Previous work has suggested guideline modifications to the sediment larval bioassay. The Sediment Management Unit of the Washington Department of Ecology proposed standard deviation guidelines of 22% for reference samples and 15% for test samples, reflecting the 95th and 80th percentiles, respectively, of the standard deviation distributions.[2] Review of the DAIS data resulted in similar distributions, with the majority of sediments exhibiting standard deviations of 20% or less (Figure 3). Other studies have suggested stronger consideration of non-treatment factor effects on sediment larval mortality. An EPA-contracted report emphasized un-ionized ammonia and sulfide-related mortality; however, no samples in the PSDDA database exceeded the threshold level for un-ionized ammonia, and the institution of aeration in the sediment larval test has effectively addressed the sulfide concerns.[3] Additional work has shown that no non-treatment factors are significantly correlated with reference sediment larval mortality.[4]

## PROPOSED ACTION/MODIFICATION

The seawater control performance standard for mortality should be adjusted to thirty percent (from fifty percent for effective mortality), in line with PSEP recommendations.[5] Past control data show that this adjustment would have resulted in only a small number of tests exceeding the seawater control performance standard.

The reference performance standards need to more accurately reflect the variability exhibited historically in this test. Adjusting the seawater-normalized performance standard to thirty-five percent will result in fewer reference sediments being rejected. However, in light of the demonstrated variability, additional adjustments must be made to ensure that the test possesses adequate power to minimize Type II errors (accepting the null hypothesis of no difference between test and reference responses when, in fact, they are different).[6] Establishing a performance standard for both reference and test standard deviations of 20% and adjusting the alpha level (the probability of making a Type I error, rejecting the null hypothesis of no difference between test and reference responses when, in fact, they are not different) from 0.05 to 0.1, will assure a power greater than 0.60 with a minimum detectable difference of twenty percent.[7]

These adjustments provide a win-win situation. Environmental protectiveness is increased by the adjustment to alpha and the fact that the maximum possible uncorrected combined mortality and abnormality for reference sediments is actually reduced slightly (from 60% to 59%). Test viability is increased (and the number of retests decreased) by providing greater latitude for the reference sediment performance. A summary of the current and proposed guidelines, and the number of sediments in DAIS which would fail to meet these performance standards, are shown in Table 1.

**Table 1.** Current and proposed performance standards for the larval test.

| GUIDELINE | CURRENT PARAMETER | REJECTED SEDIMENTS | PROPOSED PARAMETER | REJECTED SEDIMENTS |
|---|---|---|---|---|
| Alpha level: | a = 0.05 | NA | a = 0.10 | NA |
| Seawater Control | 50% EM | 0 (n=41) | 30% M | 4 (n=41) |
| Reference Sediment | 20% NEM | 24 (n=61) | 35% NEM | 7 (n=61) |

N = Normalized (to the negative seawater control), E = Effective, M = Mortality

With the proposed guideline changes, reference test performance failures would be reduced significantly (from 39% to 11%) and the guideline would more accurately reflect the data distribution. To preserve the environmental protectiveness of the test in a statistically valid way, the standard deviation guidelines will be implemented, resulting in some test rejections due to exceedances of this guideline. Overall, these changes translate into greater environmental protectiveness and a more reliable sediment larval bioassay, with fewer retests required.

The pressing need to increase the utility of this test resulted in the promulgation of these interim guidelines. Before more permanent guidelines are established, it is proposed that the sediment larval data used to establish these interim guidelines be considered, along with other pertinent data, by the technical working group which will be reviewing the sediment larval test during DY95.

To summarize, the recommended interim method for evaluating sediment larval bioassay data would proceed as follows:

1) Examine seawater control and reference sediment performance:

   - If seawater control mortality exceeds 30%, reject the test.
   - If seawater-normalized reference effective mortality exceeds 35%, reject the reference sediment.

2) Examine the test sediment data for toxicity:

   - If the seawater-normalized effective mortality of the test sediment is less than or equal to 20%, no statistical analysis of the data is needed; accept the test results.
   - If the seawater-normalized effective mortality of the test sediment is greater than 20% and is statistically different from reference (alpha = 0.1) but less than or equal to 30% over reference (15% for dispersive sites), the test sediment scores a hit under the two-hit rule.

- If the seawater-normalized effective mortality of the test sediment is greater than 20% and is statistically different from reference (alpha = 0.1) and greater than 30% over reference (15% for dispersive sites), the test sediment scores a hit under the one-hit rule.

3) For non-hits, examine the standard deviations:

   - If the standard deviations for both the test and reference sediments are less than or equal to 20%, accept the test results.

   - If the standard deviation for either test or reference exceeds 20%, perform a power analysis.

4) For non-hits, with reference and/or test sediment standard deviation greater than 20%, evaluate the power:

   - If the difference between the test and reference mortality is less than 20%, check the power of the test at a minimum detectable difference of 20%.

     → If the power is less than 0.6, reject the test results.

     → If the power is greater than or equal to 0.6, accept the test results.

   - If the difference between the test and reference mortality is greater than 20%, check the power at that difference.

     → If the power is less than 0.6, reject the test results.

     → If the power is greater than or equal to 0.6, accept the test results.

## REFERENCES


1. Puget Sound Dredged Disposal Analysis. 1989. Phase II Management Plan Report.

2. Gries, T. and K. Waldow 1994. Re-evaluation of Some Puget Sound Apparent Effects Thresholds. Washington Department of Ecology.

3. USEPA. 1993. Refinements of Current PSDDA Bioassays-Final Report. Submitted by: Thompson, T., Science Applications International Corporation, Environmental Sciences Division, Bothell, WA.

4. Fox, D.F. 1993. The Effects of Nontreatment Factors in the PSDDA Sediment Larval Test (unpublished).

5. Puget Sound Estuary Program. 1991. Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments, Interim Final. U.S. Environmental Protection Agency, Region 10, Seattle, WA.

6. Sokal, R.R. and F.J. Rohlf. 1969. Biometry. W.H. Freeman and Company, San Francisco.

7. Borenstein, M. and J. Cohen. 1988. Statistical Power Analysis: A Computer Program. Lawrence Erlbaum Associates, Inc., 365 Broadway, Hillsdale, NJ 07642.

Figure 1. Sediment Larval Seawater Control Performance

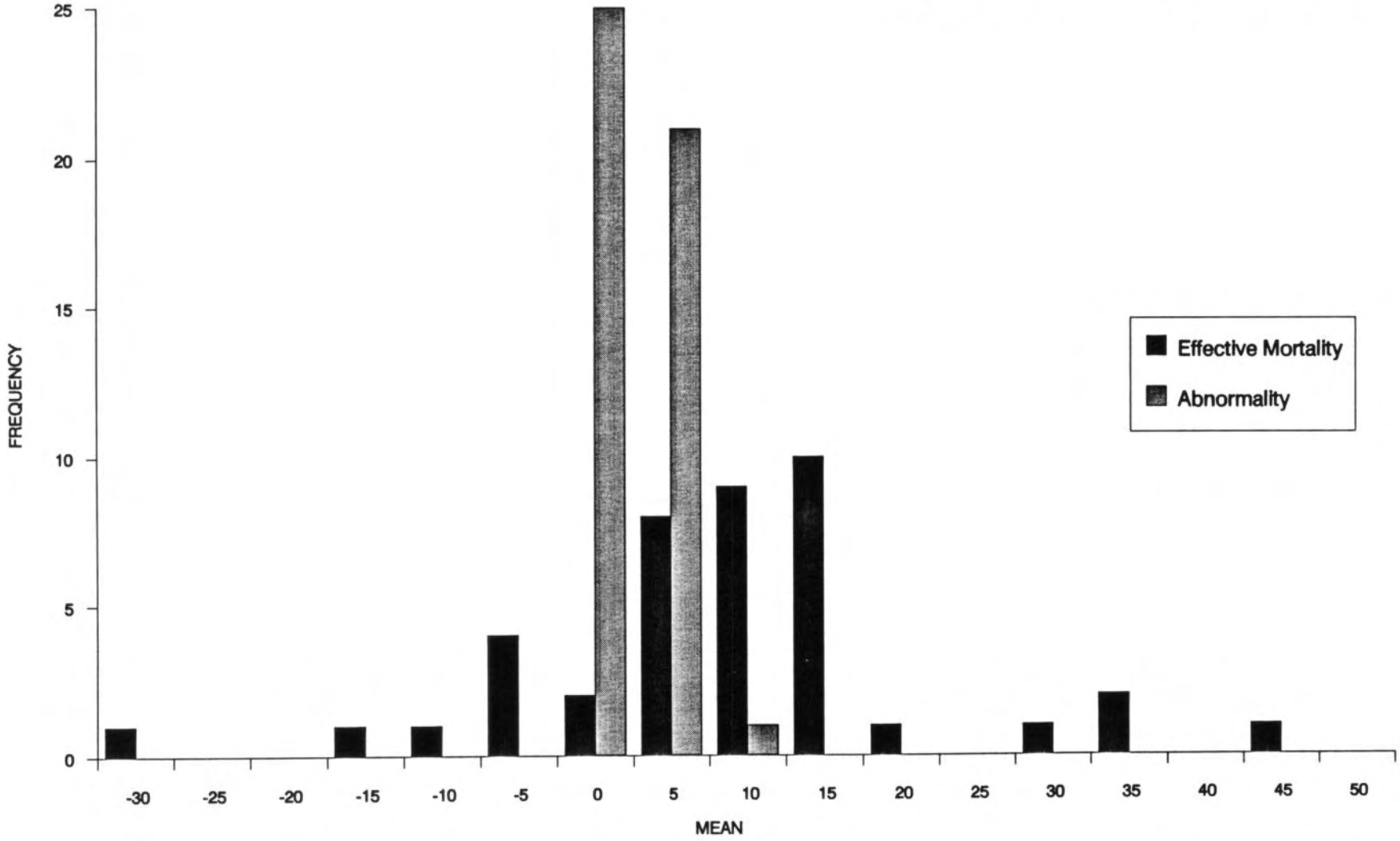


Figure 2. Sediment Larval Reference and Test Sediment Performance

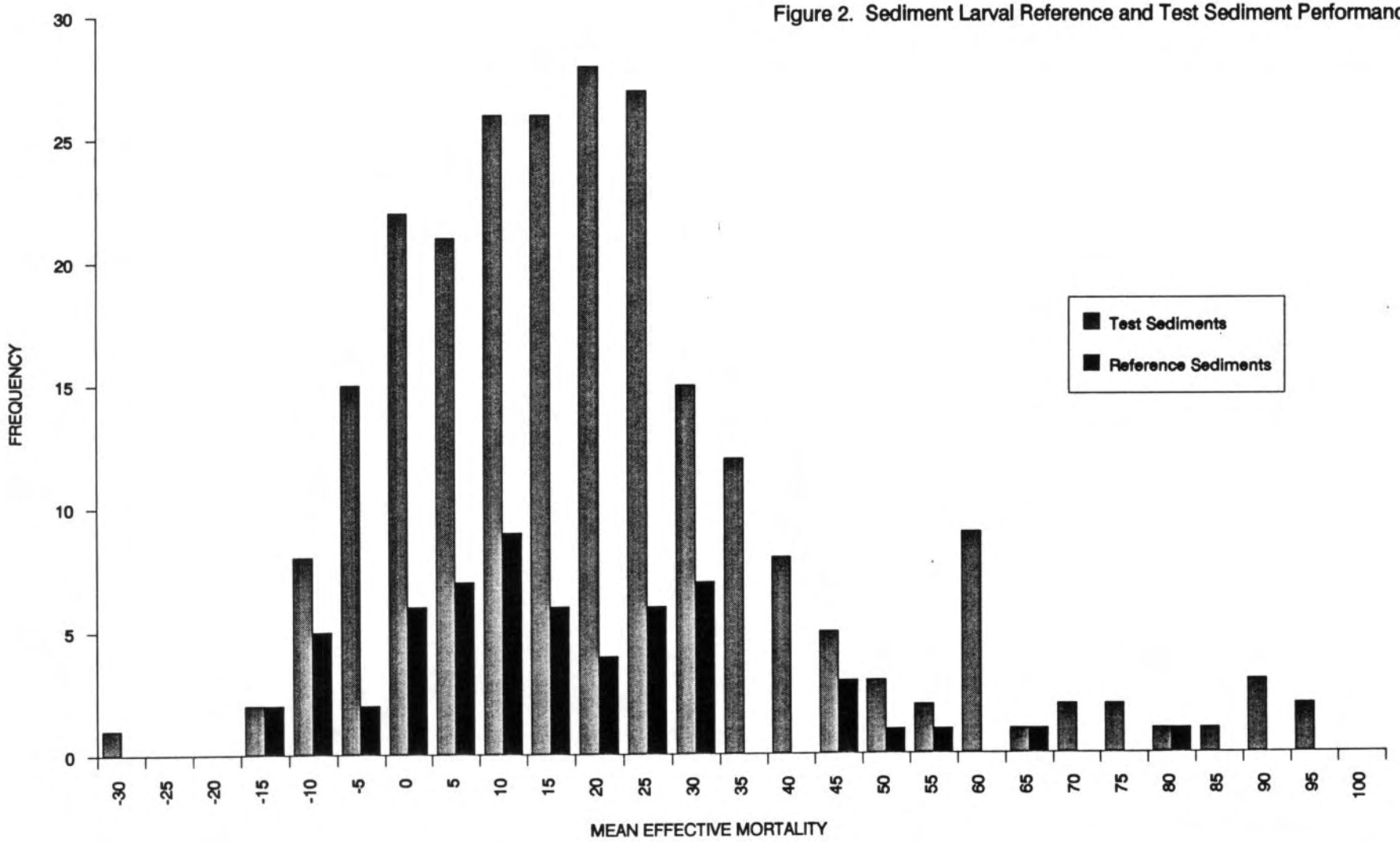
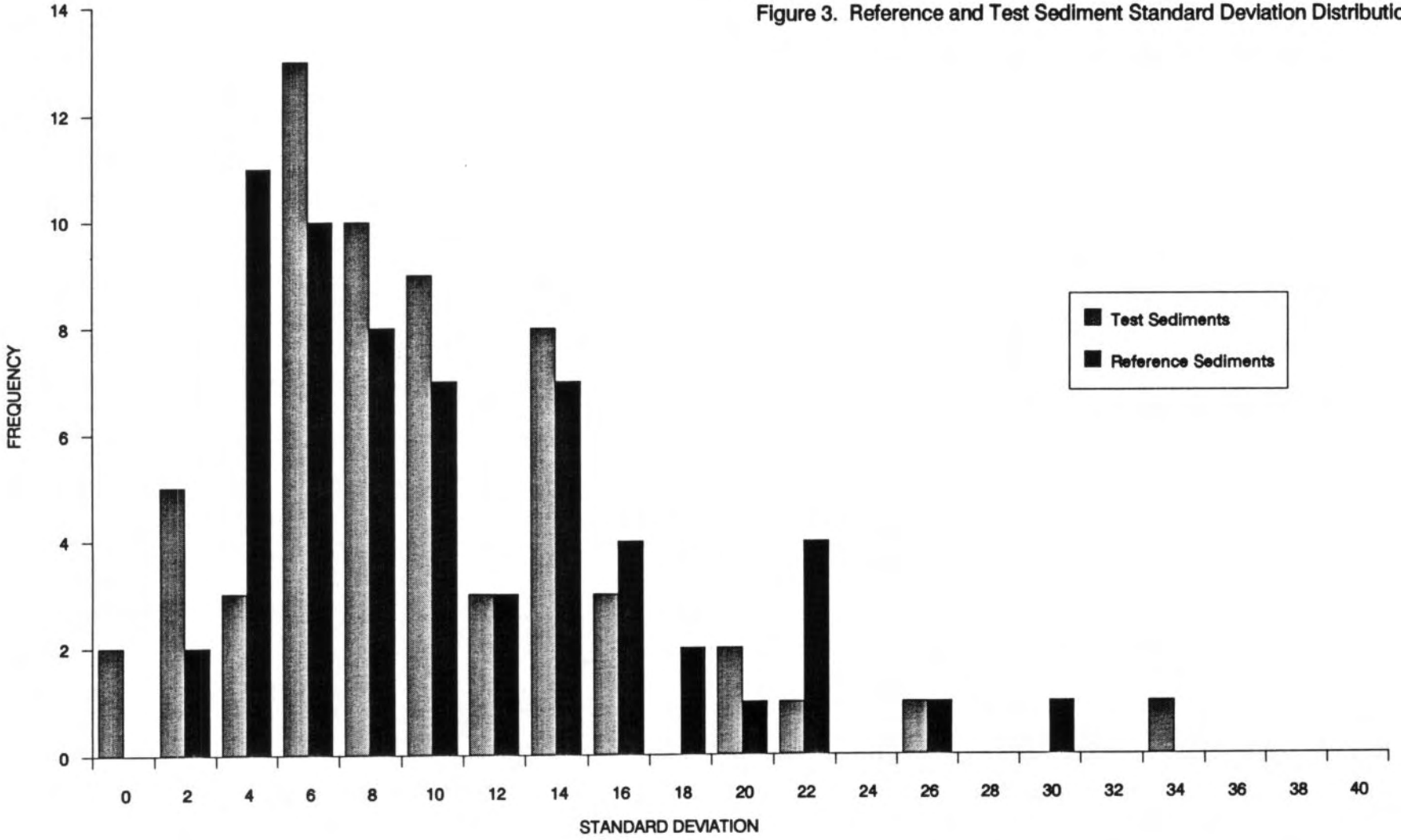


Figure 3. Reference and Test Sediment Standard Deviation Distributions



# STATUS REPORTS

## STATUS REPORT

## TECHNICAL REVIEW OF ACUTE BIOASSAYS REQUIRED BY PSDDA

Prepared by Justine Barton (EPA, 206/553-4974) for the PSDDA agencies.

## INTRODUCTION

The PSDDA agencies are committed to improving dredged material evaluation procedures as new scientific information becomes available and program experience grows. This commitment includes technical review of the PSDDA bioassay requirements.

A number of bioassay test performance issues have been raised during PSDDA implementation and recorded by the annual review process. These issues have generally been addressed by test protocol and/or test interpretation modifications, training workshops, and laboratory studies. The PSDDA agencies have proposed that large protocol changes for individual bioassays be reviewed by technical review teams and a Regulatory Work Group. However, this level of review and work group participation has not been required for any of the acute bioassays to date.

## PROBLEM IDENTIFICATION

During early PSDDA implementation, a number of relatively minor acute bioassay performance issues were observed and documented. These did not require large changes in protocols. The PSDDA agencies addressed these issues by making minor clarifications or modifications to testing protocols and/or test interpretations, and by conducting training workshops for testing laboratories. Some outstanding issues remain and are detailed below.

## STATUS OF WORK

Amphipod Bioassay:

Previous issues have included effects of fine-grained sediments and reference sediment performance. To address fine-grained sediment effects on *Rhepoxinius abronius* results, a substitution of the amphipod species *Ampelisca abdita* or *Eohaustorius estuarius* is allowed in specified instances. Applicants can propose substitution of *Ampelisca* in DMMU's with marine sediments >60% fines and greater than 25 parts per thousand salinity.[1] Applicants can propose substitution of *Eohaustorius* in DMMU's with sediments >60% fines and between 2 and 25 parts per thousand salinity.[1] Amphipod reference sediment performance and fine-grained sediment effects seem to be adequately addressed in projects tested subsequent to this change.

The analysis of the reburial endpoint remains a low priority task and was not addressed during the past year. It is unlikely that resources will be available to conduct work on this issue in the upcoming year.

Larval Bioassay:

A PSDDA study entitled "Refinements of Current PSDDA Bioassays" explored a number of outstanding issues for the sediment larval test.[2] Following an analysis of non-treatment factors including effects of ammonia, aeration, grain size, and counting scenarios for both oyster and sand dollar larvae, the recommendation for mandatory aeration for echinoderms was adopted. No major changes in the protocol resulted. For copies of the "Refinements" report contact Justine Barton (206/553-4974).

Natural variability in the larval test is an important issue currently being analyzed. This issue is described in detail in a separate clarification paper entitled, "Interim Revised Test Performance Standards for the Sediment Larval Bioassay." This effort, using reference area and test data in the DAIS database, has resulted in interim revised guidelines for larval bioassay performance.

Microtox Bioassay:

PSDDA continued scoping the issues concerning the current saline microtox test by convening a meeting of experts and practitioners on July 13, 1993. The discussion focussed on interpretation of the enhanced luminescence response and development of new protocols by Microbics, the test's manufacturer. The PSDDA agencies are considering the solid phase microtox test as a possible replacement to the current saline extract method. Microbics recently cooperated with the PSDDA Agencies in a comparison test of both microtox test protocols using sediment from a PSDDA dredging project. These test results have yet to be fully analyzed. Work will continue in the upcoming year.

## REFERENCES


1. PSDDA Fifth Annual Review Meeting Minutes. June 21, 1993.

2. "Refinements of Current PSDDA Bioassays", Final Report Summary and Final Data Package, August 1993. EPA Report Nos. 910/R-9-93-014a and b.

## STATUS REPORT

## EVALUATION OF BENTHIC INTERPRETIVE METHODS USED BY PSDDA

Prepared by Sandra Manning (Department of Ecology, 206/407-6912) for the PSDDA agencies.

## INTRODUCTION

Washington Department of Ecology (Ecology), the Puget Sound Water Quality Authority (PSWQA) and Region X of the Environmental Protection Agency (EPA) conducted a benthic experts workshop in February 1993 to evaluate the appropriateness of the benthic interpretive method and biological effects endpoint that is required under the Puget Sound Dredged Disposal Analysis (PSDDA) and the Sediment Management Standard Programs (SMS). The benthic method is used to determine adverse impacts to benthic invertebrate communities, thus indicating an impact to the environment. The criterion for predicting an adverse impact is based on changes in major taxa (polychaetes, molluscs, crustaceans) abundance relative to abundance in reference areas. If any one major taxa group shows a reduction in abundance greater than 50% from reference, an adverse effect is indicated.

## PROBLEM IDENTIFICATION

Several recommendations for improvement to the current methods were contributed by the experts at the benthic experts workshop.[1] These included: Identification to species level, apply multiple indices for accurate interpretation, apply integrative assessments including chemistry and biology (triad), define appropriate reference areas for Puget Sound, and using univariate statistical tests (t-test and ANOVA) to compare the study area and reference conditions.

Valuable information was also provided in a report prepared for the Agencies by Roy F. Weston, Inc. (Weston), Evaluation of Techniques for Assessing Benthic Endpoints for Use in Puget Sound Sediment Management Programs.[2] This report summarizes various benthic interpretive indices that are used in regulatory programs throughout the nation.

## STATUS OF WORK

The PSDDA Agencies are committed to evaluating the benthic index and endpoint currently in use, and improving to the method (if necessary) in order to provide the best protection for the environment in a consistent, cost effective manner. To accomplish this, Ecology has undertaken work to define benthic reference areas in Puget Sound.

Striplin Environmental Associates (SEA), Ecology and Weston have completed Phase I of the reference criteria development task. The benthic database was updated and improved in order to define benthic reference criteria and to evaluate other proposed recommendations from the experts. SEA then separated the data into contaminated vs. uncontaminated sites based on the following criteria: a) chemistry levels of the uncontaminated sites were below the Sediment Quality Standard (SQS) and b) all levels above the 90th percentile were eliminated for the uncontaminated sites. Preliminary review of the data indicates the critical endpoint is grain-size, followed by water depth. See Tables 1 and 2 for results of the Phase I work.[3]

Table 1 shows the number of samples in each habitat category using the SQS as the cutoff between contaminated and uncontaminated stations. These are stations having no SQS exceedances.

**Table 1.** SQS as cutoff.

| | **PERCENT FINES** | | | |
|---|---|---|---|---|
| **WATER DEPTH (ft)** | **<20** | **20-50** | **50-80** | **>80** |
| **<150** | 214 | 83 | 104 | 118 |
| **150-300** | 6 | 2 | 23 | 13 |
| **300-500** | 3 | 29 | 1 | 28 |
| **>500** | 8 | 21 | 36 | 112 |

Table 2 shows the number of samples in each habitat category based on defining unimpacted stations as stations with chemistry below the 90th percentile. The 90th percentile was computed using stations with no SQS exceedances.

## FUTURE WORK

Phase II of this task will include definition of reference area criteria. Individual endpoints will be defined by calculating diversity, major taxa abundance, and other indices to determine the health of the community. A combination of endpoints may be recommended based on physical, biological, or chemical impacts.

Proposals to continue review of the benthic methods include evaluating the recommendations to 1) require identification to species level, and 2) to require the application of multiple methods. These proposal could be approached by completing multiple case studies using

available Puget Sound data and applying several benthic indices to each site. The results of each index could be analyzed using chemistry data at the site, and biological data if available. The indices and/or combinations thereof, would then be compared to determine which methods are the most accurate predictors of environmental health.

**Table 2.** 90th percentile as cutoff.

| | PERCENT FINES | | | |
|---|---|---|---|---|
| **WATER DEPTH (ft)** | **<20** | **20-50** | **50-80** | **>80** |
| **<150** | 81 | 35 | 74 | 44 |
| **150-300** | 4 | 1 | 12 | 0 |
| **300-500** | 3 | 25 | 0 | 5 |
| **>500** | 5 | 13 | 9 | 27 |

Deliverables of these studies would include a report with recommendations addressing the following issues:

a) Evaluate if major taxa abundance is appropriate for determining the condition of sediments.

b) Determine if a different index should be implemented; provide recommended methods and/or endpoints to implement.

c) Determine if a combination of indices or endpoints is necessary to predict environmental health.

d) Determine sensitivity of identification levels based on comparisons of results for several taxonomic levels (major taxa, family, genus, and species). Recommend level that is necessary for predicting impacts.

e) Evaluate the possibility of re-calculating the AET's, based on more restricted benthic tests is necessary. This could result in changes to the SMS-SQS or PSDDA SLs. The information obtained would be used by the PSDDA Agencies to determine if re-calculation would be necessary.

Other future work has been considered to evaluate data sets for benthic data from Puget Sound to define indicator species. The data that was compiled for the reference area task

could be utilized to list the species and/or genus that are commonly found in most data sets for clean and contaminated sediments. This information could be used for a quick screening of environmental health based on ratio of sensitive or tolerant species present in a sample.

## REFERENCES


1. PTI Environmental 1993. Recommendations for Assessing Adverse Benthic Effects in Puget Sound.

2. Roy F. Weston, Inc. 1993. Evaluation of Techniques for Assessing Benthic Endpoints for Use in Puget Sound Sediment Management Programs.

3. Striplin Environmental Associates (SEA) 1993. Status Report: Benthic Infauna Reference Value Project.

## STATUS REPORT

## PSDDA DISPOSAL SITE SHORELINE PERMITS

Prepared by Eric Gilman (DNR, 206/902-1068)/Gene Revelas (DNR, 206/902-1086) for the PSDDA agencies.

## INTRODUCTION

As part of its PSDDA responsibilities, the Washington State Department of Natural Resources (DNR) must obtain shoreline permits from local governments to establish dredged material disposal sites in subtidal areas under county or city jurisdiction. From 1985 through 1989, the PSDDA Agencies identified potential sites and conducted baseline surveys at eight unconfined located throughout Puget Sound, open-water, dredged material disposal sites (results are documented in PTI, 1988, 1989). From 1988 through 1990, DNR applied for and was issued shoreline permits by eight municipality or county agencies. These 5-year permits expire between 1993 and 1995. Therefore, DNR is in the process of applying for new shoreline permits to maintain the availability of the eight PSDDA sites for dredged material disposal.

## PROBLEM IDENTIFICATION

Shoreline permits are granted for five years from their date of approval by the local government. Because the PSDDA sites are expected to be used for 15 or more years, DNR needs to reapply for new shoreline permits from each of the eight local governments every five years. This status report provides information on the shoreline permit reissuance process at this point in PSDDA program implementation.

## STATUS OF WORK

Table 1 below identifies when dredged material disposal shoreline permits were issued from local jurisdictions for the eight PSDDA sites, and when these initial permits expire or expired.

**Table 1.** Summary of PSDDA site initial shoreline permit approval and end dates. The approval date signifies the date the permit was approved by the local government, while the end date is five years after the approval of the permit by the local government (WAC 173-14-060) unless a one year permit extension was granted by the local government.

| SITE | PERMIT APPROVAL DATE | PERMIT END DATE |
|---|---|---|
| 1. Anderson/Ketron | 25 October 1989 | 24 October 1994 |
| 2. Bellingham Bay | 10 October 1989 | 09 October 1994 |
| 3. Commencement Bay | 17 August 1988 | 16 August 1993 |
| 4. Elliott Bay | 05 January 1989 | 04 January 1995 |
| 5. Port Angeles | 23 March 1990 | 22 March 1995 |
| 6. Port Gardner | 03 August 1988 | 03 August 1994 |
| 7. Port Townsend | 23 January 1990 | 22 January 1995 |
| 8. Rosario Strait | 20 March 1990 | 19 March 1995 |

WAC 173-14-060 stipulates that shoreline permits may be rescinded before their expiration date if "substantial progress toward completion of a permitted activity" is not undertaken within two years of the permit approval by the local government. In addition, all eight local jurisdictions include a condition in their shoreline permits that allows for a one-year extension of valid permits. The "substantial progress" and "extension" options were used or considered for use in the following instances:

- On 24 October 1991 Whatcom County agreed with DNR that substantial progress had been made toward completing the permitted activity through monitoring projects even though the Bellingham Bay site had not been used for the dumping of dredged material.
- On 1 December 1993 the City of Seattle issued DNR a one-year extension of their Elliott Bay shoreline permit, making the permit valid until 4 January 1995.
- On 17 January 1992, the City of Port Angeles agreed with DNR that substantial progress had been made toward completing the permitted activity through planning and evaluation projects even though the Port Angeles site had not been used for the disposal of dredged material.
- On 9 April 1993 the City of Everett issued DNR a one-year extension of their Port Gardner shoreline permit, making the permit valid until 3 August 1994.

- On 24 January 1992 Clallam County asserted that WAC 173-14-060 allowed them to terminate DNR's shoreline permit because no dredged material had been disposed of at the Port Townsend PSDDA site within two years of permit issuance. However, the county exercised the one-year extension to this substantial progress provision. Dredged material disposal occurred at this site in the following year, and therefore the permit is valid until 22 January 1995.

The status (as of March 1994) of reissued permits for the eight PSDDA sites is shown in Table 2. DNR submitted a shoreline permit application for the Elliott Bay PSDDA site to the City of Seattle in December 1993, and the application is being processed by the local jurisdiction at the time of this writing. DNR will submit applications to re-issue the remaining five PSDDA sites between March and May of 1994.

**Table 2.** Summary of PSDDA site shoreline permit status. Local approval and permit termination dates are provided.

| SITE | PERMIT APPROVAL DATE | PERMIT END DATE |
|---|---|---|
| 1. Commencement Bay | 13 September 1993 | 12 September 1998 |
| 2. Port Gardner | 26 January 1994 | 25 January 1999 |
| 3. Elliott Bay | Applied for in Dec. 93. Pending | |

## REFERENCES


1. Puget Sound Dredged Disposal Analysis. Management Plan Report, Unconfined Open Water Disposal of Dredged Material, Phase I (Central Puget Sound). 1988.

2. Puget Sound Dredged Disposal Analysis. Management Plan Report, Unconfined Open Water Disposal of Dredged Material, Phase II (North and South Puget Sound). 1989.

3. PTI. 1988. Puget Sound Dredged Disposal Analysis: Baseline Survey of Phase I Disposal Sites. Prepared for Washington Department of Ecology. PTI Environmental Services, Bellevue, WA.

4. PTI. 1989. Puget Sound Dredged Disposal Analysis: Baseline Survey of Phase II Disposal Sites. Prepared for Washington Department of Ecology. PTI Environmental Services, Bellevue, WA.

**STATUS REPORT**

**1993 UPDATE OF PUGET SOUND APPARENT EFFECTS THRESHOLDS**

Prepared by Tom Gries (Department of Ecology, 206/407-6910) on behalf of the PSDDA agencies.

## INTRODUCTION

PSDDA Agencies agreed in 1988 to periodically re-evaluate Maximum Level (ML) and Screening Level (SL) guideline values, based upon Apparent Effects Thresholds (AETs) recalculated from the SEDQUAL database maintained by Ecology.[1] Although this re-evaluation was intended to be an annual effort, it was twice postponed because of limited resources, insufficient new data or lack of essential quality assurance information (QA2).

At the 1992 Annual Review Meeting (ARM), although seven individual SLs had previously been raised,[2,3] Ecology proposed a schedule for completion of the overall task.[4] The PSDDA Agencies clearly prioritized re-evaluation of amphipod and larval AETs. They also concurred that the best initial approach would be to closely follow the methods used to calculate the 1988 AETs.[5]

New benthic AETs would depend on a) final recommendations from the February 25, 1993 benthic experts workshop, b) analysis and adoption of performance standards for benthic reference area samples, and c) an agreement among PSDDA Agencies regarding which interpretive endpoints to use. The agencies also decided more research and discussion were necessary before recent Microtox bioassay results could be used to recalculate Microtox AET values.

Ecology presented results from preliminary recalculations of amphipod and larval AET values at the 1993 ARM,[6] and a regional meeting of the Society for Environmental Toxicology And Chemistry held soon thereafter.[7]

## PROBLEM IDENTIFICATION

It was agreed at the spring 1993 ARM meeting that several tasks must be completed before the PSDDA agencies can propose adopting new guideline values. These tasks included:

1. *Completing the amphipod and sediment larval AET recalculations.* Specifically, larval AETs must be calculated using PSDDA's combined mortality and abnormality interpretive endpoint, in addition to the abnormality endpoint.

2. *Determining the accuracy of any new AET values and ML/SL guidelines.* There must be no appreciable loss in the predictive reliability of the entire suite of AETs (pooled reliability) when compared to 1988 pooled reliability values.

3. *Assessing the likely implications of new ML and SL values on the PSDDA program and dredging community.* This task was not clearly defined, but the Corps and Ecology could compare past dredging project test results, decisions and costs with those obtained using new guideline values.

In addition, three requirements are implicit in the PSDDA process for adopting new ML and SL values. These are:

4. *Assuring the quality of data setting new AET and PSDDA ML/SL values.* Surveys containing station and sample data establishing new AETs must meet QA2 requirements.

5. *Convening the PSDDA "Regulatory Work Group."* This group, composed of both agency and non-agency technical experts, is tasked to reach consensus on which final guideline values need to be revised.

6. *Providing an adequate period of time (at least 30 days) for public review.* This review includes final technical findings, recommendations and programmatic implications.

## STATUS OF WORK

Ecology has completed most of the analytical tasks deemed necessary to propose adoption of new PSDDA ML and SL values. An initial draft report has been distributed for review and comment. This report included technical findings to date, some possible program implications and needs for additional analysis. Ecology is currently responding to comments it has received and hopes the final draft AET report will be available by the 1994 ARM.

Of particular interest to the PSDDA program will be any changes to the highest dry weight-normalized AET (HAET) for a given chemical. This is because MLs are usually based on the HAETs, while SLs are often set at 1/10th the ML values. Thus, a partial summary of new HAET results is presented below.

Ecology found that values for 16 HAETs changed as a result of its calculations using its greatly expanded database. Nine HAETs increased in magnitude (cadmium, lead, mercury, nickel, silver, zinc, bis(2-ethylhexyl)phthalate, chrysene, dibenzo(a,h)anthracene, and dimethyl phthalate) and 6 decreased (ethylbenzene, hexachlorobutadiene, LPAH, n-nitrosodiphenylamine, phenanthrene and total xylenes).

AETs would not normally be expected to decrease with the addition of new data. But Ecology calculated the 1993 larval AETs using only synoptic data gathered since 1988, and excluding the original oyster larvae AET data set from Commencement Bay. Eliminating these data opened the door to an entirely new set of sediment larval abnormality AET values, some possibly less than previous ones. This decision was made because the newer larval data:

- were consistent with PSEP bioassay protocols which specify use of five laboratory replicates (the Commencement Bay oyster AETs were based on two lab replicates),

- were more numerous, being comprised of some 220 stations (compared to 56 oyster larvae AET stations), and

- were geographically more representative of the Puget Sound in general.

The PSDDA agencies have begun to examine some of the potential implications of adopting new ML and SL values. Specific PSDDA projects contained in the Corps' DAIS and Ecology's SEDQUAL databases were compared to ML/SL values which might be proposed based on the 1993 AETs.

The 1993 AET values, their predictive reliability, potential changes to guideline values and possible program implications will be presented at the 1994 ARM. However, some key tasks remain to be completed subsequent to the 1994 ARM. These are the ones implicit in the PSDDA process:

4. ensuring that all station/sample data causing changes to AET and/or PSDDA guideline values are fully quality assured,

5. convening the Regulatory Work Group, which also includes non-PSDDA members, to formulate consensus recommendations, and

6. providing for adequate public review of the technical findings, Regulatory Work Group and final PSDDA recommendations.

The PSDDA agencies anticipate completing these last remaining tasks during the summer of 1994. Adoption of new ML and/or SL values may be proposed at the 1995 ARM.

## REFERENCES


1. PSDDA. 1989. Management Plan Report. Unconfined Open-Water Disposal of Dredged Material, Phases I and II.

2. PSDDA. 1990. Minutes to the Annual Review Meeting for Dredging Year 1989. Prepared by the Washington Department of Natural Resources.

3. PSDDA. 1991. Minutes to the Annual Review Meeting for Dredging Year 1990. Prepared by the U.S. Environmental Protection Agency, Region 10.

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5. PSEP. 1988. Sediment Quality Values Refinement, Volume I. Update and Evaluation of Puget Sound AET. Prepared for the U.S. EPA Region 10 by PTI Environmental Services, Inc.

6. PSDDA. 1993. Minutes to the Annual Review Meeting for Dredging Year 1992. Prepared by the U.S. Army Corps of Engineers - Seattle District.

7. Gries, T.H. and K.H. Waldow. 1993. Presentation at the 2nd Annual Meeting of the Pacific Northwest Chapter of the Society for Environmental Toxicology And Chemistry. May 1993.

## STATUS REPORT

## DRAFT EPA NATIONAL SEDIMENT QUALITY CRITERIA

Prepared by Justine Barton (EPA, 206/553-4974) and John Malek (EPA, 206/553-1286) for the PSDDA agencies.

## INTRODUCTION

Pursuant to Section 304(a)(1) of the Clean Water Act, the U.S. EPA has developed, and requested public comments on, documents presenting proposed sediment quality criteria for the protection of benthic organisms for five priority pollutant chemicals, guidelines for deriving these criteria on a site-specific basis, and the technical basis for deriving the criteria. Chemicals include acenaphthene, dieldrin, endrin, fluoranthene, and phenanthrene. The criteria have been developed using the Equilibrium Partitioning approach.[1] The State of Washington has already developed Sediment Quality Standards, which have been approved by EPA, Region 10.

## PROBLEM IDENTIFICATION

Sediment quality criteria may form the basis for enforceable standards if adopted by a state into water quality standards. A state may opt to develop site specific criteria consistent with EPA guidelines.[2] Replacement of national criteria with site specific criteria may be necessary if a) species at the site are more or less sensitive than those included in the national criteria data set or b) the sediment or chemical quality characteristics at that site alter the bioavailability and consequently the toxicity of the sediment bound chemical predicted by Equilibrium Partitioning.

## STATUS OF WORK

The PSDDA agencies are currently reviewing the proposed criteria to see how they might affect PSDDA and other sediment management standards projects. Following the analysis, including tests for sensitivity, efficiency, and overall reliability using the SEDQUAL database, the PSDDA agencies may decide to adopt the proposed numbers or retain the existing PSDDA program numbers.

## REFERENCES

1. "Technical Basis for Deriving Sediment Quality Criteria for Nonionic Organic Contaminants for the Protection of Benthic Organisms by using Equilibrium Partitioning" (EPA-822-R-93-011).

2. "Guidelines for Deriving Site-Specific Sediment Quality Criteria for the Protection of Benthic Organisms" (EPA-822-R-017).

Specific documentation for each proposed chemical, as well as the above referenced documents, are available upon request from the Office of Water Resource Center (202) 260-7786.

# ISSUE PAPERS

**ISSUE PAPER**

# REFINEMENTS TO BIOACCUMULATION TESTING REQUIREMENTS: ADOPTION OF SECOND TEST SPECIES FOR CONSISTENCY WITH NATIONAL GUIDANCE

David Kendall (Corps of Engineers, 206/764-3768) for the PSDDA agencies.

## INTRODUCTION

The PSDDA program requirements for bioaccumulation testing currently require a single 28-day test using the facultative deposit-feeding adult bivalve, *Macoma nasuta* to evaluate human and ecological health concerns.[1] The current guidance specifies how human health assessments will be done but does not provide specificity on how ecological health assessments will be conducted. The 1993 draft Inland (404) Testing Manual and 1991 "Green Book" (Ocean Dumping Guidance Manual) provide additional guidance on how bioaccumulation testing should be conducted on dredged material.[2,3]

The current human health sediment guidelines used by the PSDDA program were developed for deep water disposal sites somewhat removed from natural resources and human resource conflict areas. Future human health sediment criteria being developed by Ecology and the Department of Health may significantly alter the chemicals of concern list, testing triggers and action levels used in regulating dredged material and contaminated sediments.

Development of these criteria are mandated as part of the State of Washington's Sediment Management Standards (SMS, WAC 173-204).[4] The standards developed must consider the adverse impacts of contaminated sediments on the environment (aquatic, and other organisms) and on human beings. The criteria are being developed and are expected to be in draft form sometime during 1994 for review.

Subsequent to adoption by Ecology through the rule-making process, the new criteria will be implemented in Puget Sound. They may replace the current "reason to believe" sediment bioaccumulation triggers (BTs) and human health interpretive guidelines. The PSDDA program will continue to use the BTs and interpretive guidance specified in the Evaluation Procedures Technical Appendix and Phase II Management Plan Report.

## PROBLEM IDENTIFICATION

The PSDDA program is currently out of compliance with national Corps/EPA guidance, and needs to adopt a second bioaccumulation test species to provide a better assessment of bioaccumulation potential. Current national guidance specified in the draft Inland Testing Manual calls for conducting bioaccumulation tests using appropriately sensitive species from two trophic niches, and representing a suspension-feeding/filter-feeding organism and the other a burrowing deposit-feeding organism.[2]

The PSDDA program also needs to update its bioaccumulation testing requirements consistent with current national guidance contained within the Green Book and draft Inland Testing Manual.[1,2] However, bioaccumulation testing guidance and human health criteria development are in a state of flux at the national and regional level, and will not be finalized for at least another year. Therefore, formal changes to the bioaccumulation test evaluation and test interpretation guidelines would better be addressed in the future after these issues are finalized. Until more definitive guidance is adopted, the PSDDA agencies will use best professional judgement to conduct bioaccumulation testing and test interpretation.

## PROPOSED ACTION/MODIFICATION

To be consistent with national Corps/EPA guidance the PSDDA program proposes to add an additional bioaccumulation test to the current test suite using a deposit-feeding adult polychaete (i.e., either *Nereis virens* or *Arenicola marina*). This will augment the test currently conducted with the adult facultative deposit-feeding bivalve, *Macoma nasuta*.

Conducting Tier III 28-day bioaccumulation tests on a dredged material management unit will require two separate tests using the adult bivalve, *Macoma nasuta*, and an adult polychaete (*Nereis virens* or *Arenicola marina*). The test exposure duration will be 28 days utilizing the EPA protocol,[5] after which a chemical analysis will be conducted of the tissue residue to determine the concentration of selected chemicals of human health concern triggering the test. The results of the test sediment tissue assays will assess ecological effects through a statistical comparison with bioaccumulation results from a suitable reference area sediment. Protocols for tissue digestion and chemical analysis will follow the PSEP-recommended procedures for metals and organic chemicals.[6, 7]

## REFERENCES


1. EPTA, 1988. Puget Sound Dredged Disposal Analysis (PSDDA) Evaluation Procedures Technical Appendix. Prepared by the Corps of Engineers in cooperation with the Environmental Protection Agency Region X, and the Washington State Departments of Ecology and Natural Resources.

2. Inland Testing Manual, 1993. Evaluation of Dredged Material Proposed for Discharge in Inland and Near Coastal Waters - testing Manual (Draft) - Inland Testing Manual. Prepared by the United States Environmental Protection Agency, and the Department of the Army, U.S. Army Corps of Engineers.

3. Green Book, 1991. Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual. EPA-503/8-91/001, Washington, D.C. Prepared by United States Environmental Protection Agency, and the Department of the Army, U.S. Army Corps of Engineers.

4. SMS, 1991. Sediment Management Standards. Chapter 173-204 WAC, April 1991. Prepared by Washington State Department of Ecology.

5. Lee, H., B.L. Boese, J. Pelliter, M. Winsor, D.T. Specht, and R.C. Randall. 1989. Guidance Manual: Bedded Sediment Tests. U.S. Environmental Protection Agency, Pacific Ecosystems Branch, Bioaccumulation Team, Newport, OR. EPA-600/x-89-302.

6. PSEP. 1989. Recommended guidelines for measuring metals in Puget Sound water, sediment, and tissue samples. Prepared for Puget Sound Estuary Program by PTI Environmental Services. In: Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound. U.S. Environmental Protection Agency Region 10, Seattle, WA.

7. PSEP. 1989. Recommended guidelines for measuring organic compounds in Puget Sound sediment and tissue samples. Prepared for Puget Sound Estuary Program by PTI Environmental Services. In: Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound. U.S. Environmental Protection Agency Region 10, Seattle, WA.

# APPENDIX A

The following discussion includes those projects requiring explanation beyond the summaries provided in Chapter 1 for ranking, sampling plan development, chemical testing, biological testing, or those for which the PSDDA agencies used best professional judgement as part of the decision-making process.

## Dredging Year 1992

Port of Everett 10th Street Boat Ramp. The Phase II MPR (page A-10) ranked the subtidal areas of the Snohomish River in the project vicinity as "moderate", while the intertidal areas were ranked "high". Because the majority of project sediments were subtidal and there were no active sources on-site, the entire project site was ranked "moderate" by the PSDDA agencies. While a single DMMU would have sufficed for the 12,340 cubic yards of project sediments in a "moderate" ranked area, the Port elected to break the dredging prism into two DMMUs.

Port of Everett-12th Street Channel. A portion of the property constituting the 12th Street Channel maintenance dredging area was previously characterized as a "pilot study" for the project known as the Hulbert Mill Site (see 1991 DMEAR Report), and these data supported downranking to "moderate" for full characterization. This property was subsequently purchased by the Port of Everett and the redesigned maintenance dredging prism was ranked "moderate" for full characterization, based on a review of the Hulbert Mill Site pilot study data and a thorough review of the site history. In addition to the full PSDDA chemical of concern list, guaiacols, chlorinated guaiacols, dioxins and furans were also required analytes for the full characterization.

LaConner Boat Works. Dredging for this project was proposed to provide adequate moorage depth for a new facility on the Swinomish Channel. The Swinomish Channel was ranked "low", except for existing fueling, berthing and construction facilities. Because the dredging was associated with construction of a new facility, with no current sources of contamination, this project was ranked "low" for the initial dredging. The 4,200 cubic yards which were proposed for dredging were less than the "no-test" guideline of 8,000 cubic yards for a low-ranked project. Therefore, no sampling or testing were required. As a berthing facility, a "moderate" rank will be applied to future maintenance dredging.

LOTT Olympia Wastewater Treatment Plant Outfall. Sampling and testing, at two stations along the proposed pipeline route, were conducted without consultation with the PSDDA agencies. The results were presented in a supplemental environmental impact statement for the project. The PSDDA agencies reviewed the data, finding the results at one station acceptable. However, data deficiencies existed at the second station and the applicant was given the option to either retest for metals and conduct tiered biological testing, or conduct the full suite of bioassays upfront with no chemical testing. The applicant opted for the tiered testing approach.

Morton Marine. Sampling and testing had originally occurred for this project in 1990, with a suitability determination signed on 3 May 1990 covering 3,990 cubic yards of material. An

additional volume of 4,000 cubic yards of sediment accumulated in the project area during the winter of 1990/91. This is the material represented by the sampling and testing data in this report.

City of Renton, Cedar River Delta. The project sponsor proposed to dredge sediments from the mouth of the Cedar River. In addition to open-water disposal at a PSDDA site, a proposed disposal option included use of the material as fill in an area of Lake Washington. To meet requirements of several state and Federal agencies, freshwater bioassays were conducted as a part of the testing sequence. No SLs were exceeded, so marine bioassays were not required under the PSDDA program. The freshwater bioassays were not used in determining the suitability of this material for open-water disposal.

Port of Tacoma, Blair Waterway. The initial ranking of sediments in Commencement Bay (except Milwaukee Waterway) was "high". A large data set was compiled for the Blair Waterway, however, during three studies conducted between 1984 and 1990. Efforts to determine the vertical extent of elevated concentrations of COCs were part of these studies. The PSDDA agencies deemed the data adequate to downrank both the surface and subsurface sediments, and further, to provide differential ranks for the surface and subsurface sediments. Although the existing data supported downranking the surface sediments to "low-moderate" in the project area, the age of some of the data and the presence of active sources cautioned against downranking two levels. The surface sediments were, therefore, downranked to "moderate". Because the entire subsurface volume was native material, however, and because an earlier study had established the deepest point of moderate-ranked material in the entire Blair Waterway at 2.7 feet below the surface, the subsurface sediments were downranked to "low-moderate".

Based on dredging records, the maximum historical depth of the Blair Waterway was known and the volume of infill above this maximum depth was calculated. These calculations indicated that eighty-eight percent of the surface sediment proposed for dredging was native material, while one hundred percent of the subsurface sediments were native. Due to the large volume of native material present in the surface stratum, the sampling requirements were reduced below those required under the "moderate" ranking assigned. The number of samples required, per surface DMMU, was reduced from four to three.

While only one DMMU had an exceedance of a PSDDA SL, concurrent biological testing was conducted on all project DMMUs. During biological testing, the Jetty Island reference sediment which was run with the Blair sediment larval test failed to meet the performance standard. The reference sediment exhibited a combined mortality and abnormality of 26.1 percent, exceeding the performance standard of 20 percent. Round 3 of the USACE Bellingham project was run concurrently with the Blair sediments. Another Jetty Island reference sediment was collected for the Bellingham bioassays and performed adequately, with a combined mortality and abnormality of 8.0 percent. Therefore, the PSDDA agencies were able to use both reference sediments together in determining the suitability of the Blair sediments for open-water disposal.

The two Jetty Island reference sediments were relatively similar in grain-size, containing 38.1 and 49.1 percent fines for the Blair and Bellingham sediments respectively. The mean

effective mortality for the pooled reference sediments was 17.1 percent, which met the reference sediment performance standard. Therefore, a statistical comparison was made between the Blair test sediments and the pooled results from the two Jetty Island references.

One DMMU exhibited hits for both the amphipod and sediment larval tests. Under PSDDA bioassay interpretation guidelines, hits under the two-hit rule for two bioassays would result in this DMMU being judged unacceptable for open-water disposal. In this case, mitigating evidence existed to contraindicate this decision. This DMMU had no SL exceedances and mortality for one replicate in the sediment larval test was much higher than the others and appeared to be an outlier. The weight of evidence supported the argument that the echinoderm hit for this DMMU was not due to chemical toxicity. The PSDDA agencies decided to pass this DMMU based on the supporting evidence and best professional judgement.

USACE / Port of Bellingham. The three waterways to be characterized in this sampling effort were the I & J Street, Squalicum Creek and Whatcom Waterways. The PSDDA agencies ranked Whatcom Waterway and I & J Creek Waterways "high" and Squalicum Creek Waterway "moderate" for full characterization. The PSDDA agencies reviewed all historical sediment quality data relevant to area ranking before arriving at their determination.

The federally authorized navigation channels from Squalicum Creek Waterway, I&J Street Waterway and Whatcom Waterway, along with adjacent Port of Bellingham berthing areas in all three waterways were jointly sampled and analyzed. Due to the size of this project, and the number of DMMUs involved, it was originally intended to conduct both chemical and biological testing in two rounds. Problems were encountered during the first round of biological testing and necessitated a third round, in which Round 1 sediments were retested. Furthermore, the Port of Bellingham chose to characterize additional sediments during a fourth round.

Chemical testing of samples from Squalicum Creek indicated that high zinc levels (above the PSDDA ML) existed in some of the composited lab samples. Subsequent resampling was conducted to isolate and further delineate the zinc distribution. However, chemical testing of these uncomposited samples did not corroborate the initial zinc concentrations. In an effort to determine the source of the zinc in the original samples, archived samples were reanalyzed by two independent testing labs. Data from this reanalysis failed to confirm the initial high zinc results.

In collaboration with the prime contractor and the original testing laboratory, the PSDDA agencies conducted a thorough QA/QC evaluation to ascertain the source of the zinc in the composited samples. The PSDDA agencies concluded that zinc contamination must have occurred at some point after field collection. The initial high zinc concentrations were considered anomalous and were not used in the suitability determination.

Exploratory samples were collected from berthing areas in Whatcom Waterway. No sampling was conducted within the federal navigation channel. These samples were taken to assess general sediment quality in this waterway, and no attempt was made to conduct a full PSDDA characterization.

During the first round of biological testing, three reference sediments from Sequim Bay were used. Reference sediment performance problems were encountered in both the amphipod and sediment larval tests. Grain-size effects were hypothesized to have caused the problem with the amphipod test. Relatively high effective mortalities for both the test and reference sediments were exhibited in the sediment larval test. Ammonia toxicity was strongly implicated in this bioassay with both bulk and dissolved ammonia statistically correlated with effective mortality. A statistically significant correlation was also found between mortality and bulk sulfides concentrations. The amphipod and sediment larval tests were both rerun for the Round 1 test sediments in Round 3.

During the second round of testing (with sediments different from the first round), aeration was conducted for the first time in the sediment larval test in an attempt to ameliorate potential ammonia and sulfides effects. Two reference sediments from Samish Bay were used. In the sediment larval test, The reference sediments still failed to meet the performance standard of 20% seawater-normalized effective mortality, although the mortalities exhibited were significantly less those seen in Round 1. No problems were encountered in the amphipod test.

The third round of testing was a retest of sediments from Round 1 for the amphipod and sediment larval tests. Aeration was conducted in the sediment larval test. Two reference sediments collected near Jetty Island were used. In this round of testing the reference sediments met the performance standard and the results from this round were deemed acceptable for decision-making for both tests.

In making the suitability determination, the PSDDA agencies considered both the chemical and biological testing data. In I & J Waterway, one DMMU exceeded the BT for mercury and was judged unsuitable for PSDDA disposal because bioaccumulation testing was not performed as required under the PSDDA evaluation procedures. Similarly, in Squalicum Creek Waterway, two DMMUs exceeded the BT for DDT and were found unsuitable for PSDDA disposal in the absence of bioaccumulation testing. Bioassay results were interpreted relative to both nondispersive and dispersive disposal guidelines to enable flexibility in using either the Bellingham Bay or Rosario Strait disposal site.

The interpretation of Round 3 bioassay data was straightforward, since the Jetty Island reference sediments performed well for both the amphipod and sediment larval tests. In order to interpret data from Round 2, in which the Samish Bay reference sediments exceeded the performance standard for the sediment larval test, the data for the reference sediments from Rounds 2 and 3 were pooled to reflect an average response. This pooled reference sediment response was used to statistically compare each test sediment with the pooled reference. The grain sizes for the Samish Bay and Jetty Island references bracketed the test sediment grain sizes, making this analysis possible. The pooled reference sediments had a mean effective mortality of 23.9%. This number still exceeded the performance standard for reference sediments and best professional judgement was exercised in using this number for interpretation.

In I & J Waterway, there was one subsurface DMMU which exhibited a single-hit failure in the *Neanthes* 10-day mortality test. However, there was a high degree of within-treatment variability suggesting that this result was spurious. Chemical data for this DMMU indicated no exceedances of the current SLs. The material from this subsurface DMMU was not dredged. However, the PSDDA agencies determined that surface DMMU overlying it could be dredged.

USACE Duwamish, DY92. Sampling for this project was conducted in two phases, the first in 1990 and the second in 1991. The chemical testing subcontractor failed to quantitate the pesticides during the first phase of testing. The Phase I sediments were resampled and tested for pesticides and PCBs during the second phase, along with additional Phase II DMMUs.

The Samish Bay reference sediment used for Phase I biological testing failed to meet the performance limit of twenty percent combined mortality and abnormality in the sediment larval test. High ammonia levels were encountered during testing. The Phase II bioassays required two rounds of testing. The second round was necessitated by QA problems encountered in Round 1. In Round 1, one DMMU exhibited unusually high inter-replicate variability in the amphipod test. High variability was also encountered during the sediment larval test for initial counts, final seawater control counts and some test sediment counts. The PSDDA agencies required the entire sediment larval test to be rerun in Round 2. High variability was also encountered for one DMMU for the *Neanthes* mortality test and this DMMU was rerun during Round 2. During Round 2 testing, relatively high ammonia concentrations were again encountered in the sediment larval test.

The testing results from Phase 1 and both rounds of testing for Phase 2 were combined to make a suitability determination. Due to the high levels of ammonia encountered in the sediment larval test during both phases of testing, the results from this bioassay were set aside and a suitability determination was made using the other bioassays. Four DMMUs had PCBs detected above the BT. In the absence of bioaccumulation testing data, these DMMU were found unsuitable for open-water disposal.

US Navy, Bangor, TRF Drydock (Delta Pier). New information about this project came to light during the public interest review process. Data collected during the Superfund site remedial investigation were reviewed, and it was determined that no additional chemicals of concern, beyond the standard list of PSDDA COCs, were found at this location. The PSDDA agencies determined that this material was suitable for open-water disposal.

US Navy Bremerton Pier D, Round 1. The presence of a three-barge housing installation for Navy personnel and an aircraft carrier within the project perimeter created special problems for sampling. The prime contractor established the DMMUs in such a way as to enable sampling for subsurface sediments around these obstacles. However, divers were required to sample the surface sediments beneath the carrier.

For biological testing, two reference sediments from Samish Bay were used, one coarse-grained and the other much finer. In the amphipod test, the coarse-grained reference sediment

performed well, but the fine-grained reference exhibited a mortality of 47%, which was 40% over the negative control. It therefore failed to meet the performance standard for reference sediments.

For the sediment larval and amphipod bioassays, the coarser-grained sediments were compared to the coarse-grained Samish Bay reference sediment, while the finer-grained sediments were compared to the fine-grained reference sediment. The two reference sediments had a mean of 47.6% fines; all test sediments with fines content less than this number were considered coarse, while test sediments with fines content greater than this number were considered fine.

As was stated previously, the fine-grained reference sediment (Samish 6) failed to meet its performance standard in the amphipod test. However, a highly significant correlation was found for this project between percent fines and percent mortality. The PSDDA Management Plan Report (MPR) - Phase II (page 5-33) recognizes this correlation. When the reference sediment mortality exceeds the nominal performance standard, the MPR recommends comparison to the grain size/mortality model presented in "Effects of Natural Sediment Features on Survival of the Phoxocephalid Amphipod, *Rhepoxynius abronius*", DeWitt, et al, Marine Environmental Research (1988).

DeWitt's model is based on a linear regression of amphipod survival, in the 10-day acute toxicity test, versus the percent fines (<62.5 microns) in the sediment. The model predicts the number of survivors (out of 20 organisms at the beginning of the test), given the fines content of the sediment. The model also includes the 95% confidence interval bracketing this regression line. The lower limit of the 95% confidence interval is referred to as the lower prediction limit (LPL). Any sediment with amphipod survival falling below this line is presumed to be demonstrating toxicity beyond that attributable to grain size (or a covarying sediment conventional parameter such as total organic carbon).

The survival rate exhibited by Samish 6 was compared to DeWitt's LPL. The LPL for a fines content of 86.1% (equal to that of Samish 6) equates to a survival rate of 11.8/20 organisms (41.1% mortality). The Samish 6 reference mortality (47%) exceeds this value. Therefore, consistent with the MPR-Phase II, the PSDDA agencies considered the Samish 6 reference sediment results invalid for use in test interpretation.

The PSDDA agencies looked at two options relative to the amphipod bioassay. One was to resample both test and reference sediments and rerun the test. The other was to use the DeWitt model to interpret the results of the original test. The consensus decision was to 1) provide the Navy with the option of resampling and conducting a retest of the amphipod bioassay, and in the absence of this resampling effort, 2) use DeWitt's model to interpret the data. The Navy considered these options and decided not to pursue additional sampling and testing. Therefore, the PSDDA agencies interpreted the amphipod bioassay results using DeWitt's model.

The PSDDA agencies agreed to use DeWitt's model in the following way: 1) if the observed survival for a test sediment fell above the LPL defined by the model then no hit would be scored; 2) if the observed survival fell below the LPL but the percent survival was not greater than 30% absolute below the value predicted by the model's line of regression, then a hit under the

two-hit rule would be scored; 3) if the observed survival both fell below the LPL and was greater than 30% absolute below the value predicted by the model's line of regression, then a hit under the single-hit rule would be scored. This interpretation paralleled the interpretation normally used under PSDDA evaluation procedures to assign hits.

The hits resulting for the amphipod test using DeWitt's model for interpretation were combined with the hits exhibited in the sediment larval test to determine which sediments failed biological testing.

One DMMU, which passed bioassay testing, was assumed to be unacceptable for open-water disposal in the absence of additional Tier IV data, due to the high level of DDT, which exceeded the ML by greater than 100%. Additionally, another DMMU passed standard bioassay testing, but the total DDT concentration for this DMMU was above the BT. The Navy opted not to pursue bioaccumulation testing and, in the absence of bioaccumulation data, this DMMU was found unacceptable for open-water disposal.

Subsequent to the PSDDA agencies making a suitability determination for Pier D, the Navy decided to redesign the dredging configuration for this project and pursue additional sampling and testing. The results of Round 2 will be presented in the next biennial report along with the final suitability determination.

US Navy, Keyport, KB Dock. It was discovered during sampling that the bathymetric data submitted with the original sampling plan were incorrect. The dredging volume had been overestimated, as had been the sampling depths. As a result, the proposed dredging volume was reduced from 8,000 to 4,500 cubic yards. The maximum dredging depth, using the revised bathymetric data, was only 4-5 feet and all the material could be considered surface sediment. As such, the surface composite from the original sampling plan was still representative of the proposed dredged material and was sufficient, in and of itself, to fully characterize the dredging prism.

During the public review process, new information concerning past uses of the site came to light, as well as information regarding its status as an operable unit of a superfund site. The PSDDA agencies reviewed data collected as part of the Superfund remedial investigation, and determined that the material proposed for dredging was suitable for open-water disposal.

Dredging Year 1993

Boyer Alaska Barge Lines. Concurrent chemical and biological testing were undertaken for Boyer Alaska Barge Lines. Exceedances of PSDDA SLs and MLs occurred, and biological testing was started but not completed. The data were not submitted for decision-making, and no suitability determination was made for PSDDA disposal. The Corps section 404 permit application for open-water disposal was withdrawn.

Port of Everett South Terminal Partial Characterization. Because of the large volume of sediment proposed for dredging, which included a large percentage of native sediments, the Port of Everett decided to conduct a partial characterization in an attempt to downrank the project and delineate native sediments. The PSDDA agencies reviewed data which had been compiled from previous surveys of South Terminal sediments. Previous surveys employing grab samples showed high concentrations (above ML) of numerous organic chemicals. Core samples from another survey exceeded the ML for benzyl alcohol.

Due to the level of concern created by these data, the agencies used the flexibility provided in EPTA to go beyond the minimum requirements for a partial characterization. The sampling and analysis plan called for cores to be collected at fourteen sampling stations. Chemistry analyses were to be conducted for the surface (0-4 feet) core sections at each location, while subsurface cores were to be analyzed at a limited number of the stations. The subsurface cores were to be used to identify the interface between native and post-industrial sediments and to determine the level of contamination in subsurface sediments.

Guaiacols were required to be analyzed along with the standard suite of PSDDA chemicals for all samples. Dioxins and furans were to be analyzed for a limited number of samples.

The testing of South Terminal sediments for the PC resulted in the discovery of a large quantity of sawdust (> 100,000 CY) in the vicinity of a sawmill which once occupied the site. Other subareas within the project contained substantial quantities of wood debris from historical log-rafting and pulpmill operations. The high wood content of some of the samples presented analytical difficulties, resulting in matrix interference and elevated detection limits.

The PC data indicated that the native sediments could be readily identified by color, consistency, density and lack of wood content. None of the chemical analyses performed on native sediments exhibited concentrations of chemicals of concern above the screening level.

King County Sammamish River. The freshwater sediments from this project were adjusted for salinity prior to running the amphipod and *Neanthes* 20-day biomass tests. The PSEP salinity adjustment protocol for the amphipod bioassay was followed. Because of the low fines content of the dredged material, West Beach sediment was used as both negative control and reference.

In the sediment larval test, the reference sediment seawater-normalized combined mortality and abnormality (23.4%) did not meet the performance standard of 20%. Therefore, the PSDDA agencies requested a retest. The retest commenced one day beyond the holding time limit of 56 days. The reference sediment performed well during the retest and the PSDDA agencies concluded that the minor holding time exceedance did not significantly impact the results of the test.

LaConner Marina. This project is located in a boat maintenance area. Because tributyltin has been associated with boat maintenance activities, the PSDDA agencies required its analysis in addition to the standard suite of chemicals of concern. One composite was tested, with additional

composites archived for future analysis if TBT was detected over the SL. TBT was detected, but at levels well below the PSDDA SL. Further testing was not required, and the material was found suitable for open-water disposal.

Lone Star Northwest/West Terminal. This project was at the volume limit for small project biological testing. In order to be environmentally conservative, the PSDDA agencies required that all four bioassays be run. The sediment larval reference sediment failed to meet performance criteria, and the test was rerun. The second sediment larval test exhibited 100% mortality in all replicates, including seawater control. A third test was run, with the same results. Due to the high mortality, especially in the seawater control, there is reason to believe that some confounding factor (water temperature, ammonia etc.) influenced the results. Laboratory QA/QC on the sediment larval test did not meet PSDDA standards. The PSDDA agencies set aside the anomalous sediment larval test data.

Pratt/Todd Personal Moorages. This project involved two small moorage owners in Friday Harbor. Each proposed to dredge less than 500 cubic yards from their boat docks near Friday Harbor, and for cost reasons, proposed to dredge and dispose of the projects at one time. The volume slightly exceeded the no test volume of 500 cubic yards. Based on the lack of known sources of contamination in the area, and the relatively small volume of each project, the PSDDA agencies agreed that testing was not required for this project.

Port of Seattle, Southwest Harbor. A partial characterization under PSDDA guidelines was conducted for sediments proposed for open-water disposal as a part of this large-scale development project. Six samples (2 surface, 4 subsurface) were taken from two sample locations. Based upon the chemical characterizations, this area was reranked low-moderate for full characterization.

Port of Seattle Pier 91. This project proposed the dredging of a long narrow prism of material along Pier 91. Although the sediments were as deep as 12 feet (with overdepth), over 75% of the material was contained in the surface stratum (0-4 feet). The most feasible dredging plan required removing the sediments in a single pass along the pier. The PSDDA agencies therefore treated all of the sediments as "surface" sediments and divided the prism lengthwise into three DMMU. To obtain samples which were representative of the dredging prism, the applicant was required to include proportional subsamples of the 0-4 foot stratum and 4+ foot stratum in the composite for each DMMU, in the ratio of 4 to 1 respectively.

Two of the three DMMU failed biological testing and were found unsuitable for open-water disposal. The third DMMU passed standard biological testing, but in the absence of Tier III bioaccumulation testing and Tier IV evaluation, the PSDDA agencies found this material unsuitable for open-water disposal due to two detected exceedances of ML and one detected exceedance of BT. In addition, there were numerous other detection limit exceedances of BT and ML. Therefore, all the Pier 91 sediment was found unsuitable for open-water disposal.

Port of Seattle Terminal 115. The total volume of proposed dredged material was only 3,000 cubic yards which would normally require only one DMMU. Because this volume was split into two distinct subareas, the Port of Seattle decided to establish two separate DMMUs.

USACE Duwamish DY93 Maintenance. The U. S. Army Corps of Engineers proposed to dredge up to 60,000 cubic yards of material from the upper turning basin on the Duwamish River. This area was tested in 1989 and again in 1991. Based upon the frequency guidelines outlined in the Evaluation Procedures Technical Appendix, testing was not required for this project.

USACE Everett. A partial characterization was conducted for the purposes of downranking the project area. Five uncomposited surface samples were analyzed and the results supported downranking the project from "moderate" to "low-moderate" for full characterization.

During the full characterization biological testing, West Beach sediment was used as a reference for the coarse-grained test sediments, while a Carr Inlet sediment was used for the fine-grained test sediments. Very high concentrations of ammonia were encountered for one DMMU in the amphipod test and this DMMU exhibited 40% mortality. The ammonia levels for this DMMU were similarly high in the *Neanthes* biomass test. The Carr Inlet reference sediment did not meet the reference sediment performance standard in the *Neanthes* test.

The DMMU which exhibited some toxicity in both the amphipod and *Neanthes* biomass was found suitable by the PSDDA agencies using best professional judgement. The levels of ammonia encountered were among the highest ever seen in PSDDA testing. There was only a single chemical of concern above the SL, with 4-methylphenol having been detected at 150 ug/kg. This was an order of magnitude below the 1988 AET for the amphipod test (3600 ug/kg). The State of Washington Sediment Quality Standard for 4-methylphenol is 670 ug/kg. In the *Neanthes* test, this DMMU outperformed the reference sediment. The PSDDA agencies considered these facts in making their determination of suitability.

US Navy Everett Homeport Project, Element II. The Element I dredging area, immediately to the southeast of the proposed Element II dredging area, was previously characterized utilizing PSDDA guidelines (see 1990 DMEAR) and approximately one million cubic yards of material was dredged and disposed of at the Port Gardner disposal site in 1989/1990. The characterization of Element I demonstrated the general sediment quality in this area of the harbor to be relatively clean and supported a low-moderate rank. Therefore, the PSDDA agencies ranked the Element II dredging area low-moderate for full characterization.

Biological testing resulted in a hit for one of the DMMUs. The Navy elected to resample and characterize the six individual field samples which comprised this DMMU in an attempt to isolate the source of the exhibited toxicity. Chemical testing indicated that the contamination was restricted to a single sample from the original composite and the material represented by this sample was found unsuitable for PSDDA disposal based on two exceedances of ML.

A suitability determination was made based on these two rounds of testing. However, the final project design resulted in a reduction in the proposed dredging volume from 428,000 cubic yards to 150,000 cubic yards and a revised suitability determination was made to accommodate this change.

## APPENDIX B - DY92/93 GUIDELINE VALUES (CHEMISTRY)

| CHEMICAL | SL | BT | ML | (SL+ML)/2 |
|---|---|---|---|---|
| METALS (ppm dry wgt): | | | | |
| Antimony | 20 | 146 | 200 | 110 |
| Arsenic | 57 | 507.1 | 700 | 378.5 |
| Cadmium | 0.96 | | 9.6 | 5.3 |
| Copper | 81 | | 810 | 445.5 |
| Lead | 66 | | 660 | 363 |
| Mercury | 0.21 | 1.5 | 2.1 | 1.2 |
| Nickel | 140 | 1,022 | | |
| Silver | 1.2 | 4.6 | 6.1 | 3.7 |
| Zinc | 160 | | 1,600 | 880 |
| ORGANIC CHEMICALS (ppb dry wgt): | | | | |
| LPAH | | | | |
| 2-Methylnaphthalene | 67 | | 670 | 368.5 |
| Acenaphthene | 63 | | 630 | 346.5 |
| Acenaphthylene | 64 | | 640 | 352 |
| Anthracene | 130 | | 1,300 | 715 |
| Fluorene | 64 | | 640 | 352 |
| Naphthalene | 210 | | 2,100 | 1,155 |
| Phenanthrene | 320 | | 3,200 | 1,760 |
| Total LPAH | 610 | | 6,100 | 3,355 |
| HPAH | | | | |
| Benzo(a)anthracene | 450 | | 4,500 | 2,475 |
| Benzo(a)pyrene | 680 | 4,964 | 6,800 | 3,740 |
| Benzo(g,h,i)perylene | 540 | | 5,400 | 2,970 |
| Benzofluoranthenes | 800 | | 8,000 | 4,400 |
| Chrysene | 670 | | 6,700 | 3,685 |
| Dibenzo(a,h)anthracene | 120 | | 1,200 | 660 |
| Fluoranthene | 630 | 4,600 | 6,300 | 3,465 |
| Indeno(1,2,3-c,d)pyrene | 69 | | 5,200 | 2,634.5 |
| Pyrene | 430 | | 7,300 | 3,865 |
| Total HPAH | 1,800 | | 51,000 | 26,400 |
| CHLORINATED HYDROCARBONS | | | | |
| 1,2,4-Trichlorobenzene | 13 | | 64 | 38.5 |
| 1,2-Dichlorobenzene | 19 | 37 | 350 | 184.5 |
| 1,3-Dichlorobenzene | 170 | 1,241 | | |
| 1,4-Dichlorobenzene | 26 | 190 | 260 | 143 |
| Hexachlorobenzene | 23 | 168 | 230 | 126.5 |

APPENDIX B - DY92/93 GUIDELINE VALUES (CHEMISTRY)

| CHEMICAL | SL | BT | ML | (SL+ML)/2 |
|---|---|---|---|---|
| PHTHALATES | | | | |
| Bis(2-ethylhexyl) phthalate | 3,100 | 13,870 | | |
| Butyl benzyl phthalate | 470 | | | |
| Di-n-butyl phthalate | 1,400 | 10,220 | | |
| Di-n-octyl phthalate | 6,200 | | | |
| Diethyl Phthalate | 97 | | | |
| Dimethyl Phthalate | 160 | 1,168 | | |
| PHENOLS | | | | |
| 2-Methylphenol | 20 | | 72 | 46 |
| 2-4-Dimethylphenol | 29 | | 50 | 39.5 |
| 4-Methylphenol | 120 | | 1,200 | 660 |
| Pentachlorophenol | 100 | 504 | 690 | 395.0 |
| Phenol | 120 | 876 | 1,200 | 660 |
| MISCELLANEOUS EXTRACTABLES | | | | |
| Benzoic Acid | 400 | | 690 | 545 |
| Benzyl Alcohol | 25 | | 73 | 49 |
| Dibenzofuran | 54 | | 540 | 297 |
| Hexachlorobutadiene | 29 | 212 | 290 | 159.5 |
| Hexachloroethane | 1,400 | 10,220 | 14,000 | |
| N-Nitrosodiphenylamine | 28 | 161 | 220 | 124 |
| VOLATILE ORGANICS | | | | |
| Ethylbenzene | 10 | 27 | 50 | 30 |
| Tetrachloroethene | 14 | 102 | 210 | 112 |
| Total Xylene | 12 | | 160 | 86 |
| Trichloroethene | 160 | 1,168 | 1,600 | 880 |
| PESTICIDES and PCBs | | | | |
| Aldrin | 10 | 37 | | |
| Chlordane | 10 | 37 | | |
| Dieldrin | 10 | 37 | | |
| Heptachlor | 10 | 37 | | |
| Lindane | 10 | 37 | | |
| Total DDT | 6.9 | 50 | 69 | 38 |
| Total PCBs | 130 | 38* | 2,500 | 1,315 |

* Value in ppm normalized to Total Organic Carbon

APPENDIX B - DY92/93 EVALUATION GUIDELINES (BIOASSAYS)

| Bioassay | Negative Control Performance Standard | Reference Sediment Performance Standard | Dispersive Disposal Site Interpretation Guidelines | | Nondispersive Disposal Site Interpretation Guidelines | |
|---|---|---|---|---|---|---|
| | | | 1-hit rule | 2-hit rule | 1-hit rule | 2-hit rule |
| Amphipod | $M_C \leq 10\%$ | $M_R - M_C \leq 20\%$ | $M_T - M_C > 20\%$ and $M_T$ vs $M_R$ SD ($p=.05$) and | | $M_T - M_C > 20\%$ and $M_T$ vs $M_R$ SD ($p=.05$) and | |
| | | | $M_T - M_R > 10\%$ | NOCN | $M_T - M_R > 30\%$ | NOCN |
| Larval | $N_C \div I \geq 0.50$[1] $A_C \leq 10\%$ | $N_R \div N_C \geq 0.80$[1] | $N_T \div N_C < 0.80$ and $N_T/N_C$ vs $N_R/N_C$ SD ($p=.05$)[1] and | | $N_T \div N_C < 0.80$ and $N_T/N_C$ vs $N_R/N_C$ SD ($p=.05$)[1] and | |
| | | | $N_R/N_C - N_T/N_C > 0.15$ | NOCN | $N_R/N_C - N_T/N_C > 0.30$ | NOCN |
| *Neanthes* mortality | $M_C \leq 10\%$ | $M_R - M_C \leq 20\%$ | $M_T - M_C > 20\%$ and $M_T$ vs $M_R$ SD ($p=.05$) and | | $M_T - M_C > 20\%$ and $M_T$ vs $M_R$ SD ($p=.05$) and | |
| | | | $M_T - M_R > 10\%$ | NOCN | $M_T - M_R > 30\%$ | NOCN |
| *Neanthes* biomass | $M_C \leq 10\%$ | $MIW_R \div MIW_C \geq 0.80$ | $MIW_T \div MIW_C < 0.80$ and $MIW_T$ vs $MIW_R$ SD ($p=.05$) and | | $MIW_T \div MIW_C < 0.80$ and $MIW_T$ vs $MIW_R$ SD ($p=.05$) and | |
| | | | $MIW_T/MIW_R < 0.70$ | NOCN | $MIW_T/MIW_R < 0.50$ | $MIW_T/MIW_R < 0.70$ |
| Microtox | N/A | $BLD_R \leq 20\%$ | N/A | | $BLD_T > 20\%$ and $BLD_T$ vs $BLD_R$ SD ($p=.05$) and | |
| | | | N/A | N/A | N/A | NOCN |

M = mortality, A = abnormality, N = normals, I = initial count, MIW = mean individual weight, BLD = blank-corrected light decrease
SD = statistically different, NOCN = no other conditions necessary, N/A = not applicable
Subscripts: R = reference sediment, C = negative control, T = test sediment

[1]see Chapter 3 for proposed modification for DY95

# APPENDIX C - LEGEND

| | | |
|---|---|---|
| S | = | reported concentration exceeds screening level |
| B | = | reported concentration exceeds bioaccumulation trigger |
| M | = | reported concentration exceeds maximum level |
| BM | = | reported concentration exceeds bioaccumulation trigger and maximum level |
| u | = | detection limit exceeds screening level |
| b | = | analyte detected in corresponding blank |
| d | = | quantitation performed on a diluted sample |
| e | = | estimate |
| j | = | detected between the SDL and the CRDL |
| L | = | the highest reported concentration was below SL |
| LM | = | the highest reported concentration was between SL and (SL + ML)/2 |
| M | = | the highest reported concentration was between (SL + ML)/2 and ML |
| H | = | the highest reported concentration exceeded ML |
| H* | = | the sediment rank is based on biological testing results |
| (1) | = | no bioaccumulation trigger exists for this analyte |
| (2) | = | no maximum level exists for this analyte |
| (3) | = | no bioaccumulation trigger or maximum level exists for this analyte |
| X | = | a hit under the two-hit rule |
| XX | = | a hit under the single-hit rule |
| X(X) | = | a hit under the two-hit rule for nondispersive sites; a hit under the single-hit rule for dispersive sites |
| QC | = | bioassay results were set aside due to QA/QC problems |
| P | = | test sediment passed PSDDA guidelines for open-water unconfined disposal |
| F | = | test sediment failed PSDDA guidelines for open-water unconfined disposal |
| P(F) | = | passes nondispersive guidelines; fails dispersive guidelines |
| F(C) | = | DMMU found unsuitable for open-water disposal in the absence of bioaccumulation and/or Tier IV testing data |
| NA | = | not applicable; this test sediment was included in a partial characterization or planning study; no suitability determination was made for this test sediment |
| - | = | this test was not done |

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | Day Island Yacht Club | Port of Everett 10th Street Boat Ramp | Port of Everett 12th Street Channel | | | | | | LOTT Olympia Wastewater Outfall | American Presidents Line |
|---|---|---|---|---|---|---|---|---|---|---|
| | C1 | C1 | C1 | C2 | C4 | C5 | C6 | C7 | C1 | C1 |
| METALS | | | | | | | | | | |
| Mercury | | | | | | | | | | S |
| Antimony | | | | | | | | | | |
| Arsenic | | | | | | | | | | |
| Cadmium (1) | | | | | | | | | S | |
| Copper (1) | | | | | | | | | | |
| Lead (1) | | | S | S | S | S | S | S | | |
| Silver | | | | | | | | | | |
| Zinc (1) | | | | | | | | | | |
| LPAH | | | | | | | | | | |
| 2-Methylnaphthalene (1) | | | | | | | | | | |
| Acenaphthene (1) | | | | | | | | | | |
| Acenaphthylene (1) | | S | | | | | | | | |
| Anthracene (1) | | | | | | | | | | |
| Fluorene (1) | | | | | | | | | | |
| Naphthalene (1) | | | | | | | | | | |
| Phenanthrene (1) | S | | | | | | | | | |
| Total LPAH (1) | S | | | | | | | | | |
| HPAH | | | | | | | | | | |
| Benzo(a)anthracene (1) | | | | | | | | | | |
| Benzo(a)pyrene | | | | | | | | | | |
| Benzo(g,h,i)perylene (1) | | | | | | | | | | |
| Benzofluoranthenes (1) | | | | | | | | | | |
| Chrysene (1) | | | | | | | | | | |
| Dibenzo(a,h)anthracene (1) | | | | | | | | | | |
| Fluoranthene | | | | | | | | | | |
| Indeno(1,2,3-c,d)pyrene (1) | S | | | | | | | | | S |
| Pyrene (1) | S | | | | | | | | | S |
| Total HPAH (1) | S | | | | | | | | | S |
| CHLORINATED HYDROCARBONS | | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | S u | S u | S u | S u | S u | S u | S u | S u | | |
| 1,2-Dichlorobenzene | | | | | | | | | | |
| 1,3-Dichlorobenzene (2) | | | | | | | | | | |
| 1,4-Dichlorobenzene | | | | | | | | | | |
| Hexachlorobenzene | | | | | | | | | | |

(Continued on facing page)

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | Day Island Yacht Club | Port of Everett 10th Street Boat Ramp | Port of Everett 12th Street Channel | | | | | | LOTT Olympia Wastewater Outfall | American Presidents Line |
|---|---|---|---|---|---|---|---|---|---|---|
| | C1 | C1 | C1 | C2 | C4 | C5 | C6 | C7 | C1 | C1 |
| PHTHALATES | | | | | | | | | | |
| Butyl benzyl phthalate (3) | | | | | | | | | | |
| Di-n-butyl phthalate (2) | | | | | | | | | | |
| Diethyl phthalate (3) | | | | | | | | | | |
| Dimethyl phthalate (2) | | | | | | | | | | |
| PHENOLS | | | | | | | | | | |
| 2 Methylphenol (1) | | | | | | | | | | |
| 2,4-Dimethylphenol (1) | | | | | | | | | | |
| 4 Methylphenol (1) | | S | | | | | | | | |
| Pentachlorophenol | S | | | | | | | | | |
| Phenol | | | | | | | | | | |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | | | |
| Benzoic acid (1) | | | | | | | | | | |
| Benzyl alcohol (1) | S u | | | | | | | | | |
| Dibenzofuran (1) | | | | | | | | | | |
| Hexachlorobutadiene | | S u | S u | S u | S u | S u | S u | S u | | |
| N-Nitrosodiphenylamine | | | | | | | | | | |
| VOLATILES | | | | | | | | | | |
| Ethylbenzene | | | | | | | | | | |
| Tetrachloroethene | | | | | | | | | | |
| Total Xylene (1) | | | | | | | | | | |
| Trichloroethene | | | | | | | | | | |
| PESTICIDES AND PCBs | | | | | | | | | | |
| Aldrin (2) | | | | | | | | | | |
| Chlordane (2) | | | | | | | | | | |
| Dieldrin (2) | | | | | | | | | | |
| Heptachlor (2) | | | | | | | | | | |
| Lindane (2) | | | | | | | | | | |
| Total DDT | | | | | | | | | | |
| Total PCBs | | | | | | | | | | |
| BIOASSAYS | | | | | | | | | | |
| Amphipod | | | | | | | X | | | |
| Sediment Larval | | X | | X | | | | | X | |
| Juvenile Infaunal Mortality | | | | | | | | | | |
| Juvenile Infaunal Biomass | - | - | - | - | - | - | - | - | - | - |
| Microtox | | | | | | | | | | |
| PASS/FAIL | P | P | P | P | P | P | P | P | P | P |
| HIGHEST RANKING: | M | LM | LM | LM | LM | LM | LM | LM | LM | LM |

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | Port of Seattle Terminal 5 | | South Park Marina | | Port of Tacoma Blair Waterway | USACE/Port of Bellingham Squalicum Creek Waterway | | | USACE/Port of Bellingham I & J Waterways | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C1 | C2 | C1 | C2 | C5 | C2 | C4 | C6 | C18 | S1 |
| METALS | | | | | | | | | | |
| Mercury | | S | | | | | | S | S | S |
| Antimony | | | | | | | | | | |
| Arsenic | | | | | | | | | | |
| Cadmium (1) | | | S | S | | | | | | S |
| Copper (1) | | | | | | | | | | |
| Lead (1) | | S | | | | | | | | |
| Silver | | | | S | | | | | | |
| Zinc (1) | | | | | | | | | | |
| LPAH | | | | | | | | | | |
| 2-Methylnaphthalene (1) | | | | | | | | | | |
| Acenaphthene (1) | | S | | | S | | | | | |
| Acenaphthylene (1) | | | | | | | | | | |
| Anthracene (1) | | | | | | | | | | |
| Fluorene (1) | | S | | | S | | | | | |
| Naphthalene (1) | | | | | S | | | | | |
| Phenanthrene (1) | | | | | S | | | | | |
| Total LPAH (1) | | S | | | S | | | | | |
| HPAH | | | | | | | | | | |
| Benzo(a)anthracene (1) | | | | | | | | | | |
| Benzo(a)pyrene | | | | | | | | | | |
| Benzo(g,h,i)perylene (1) | | | | | | | | | | |
| Benzofluoranthenes (1) | | S | | | | | | | | |
| Chrysene (1) | | | | | | | | | | |
| Dibenzo(a,h)anthracene (1) | | | | | | | | | | |
| Fluoranthene | | | | | S | | | | | |
| Indeno(1,2,3-c,d)pyrene (1) | S | S | | | S | | | | | |
| Pyrene (1) | S | S | | | S | | | | | S |
| Total HPAH (1) | S | S | | | S | | | | | |
| CHLORINATED HYDROCARBONS | | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | | | | | | | | | | |
| 1,2-Dichlorobenzene | | | | | | | | | | |
| 1,3-Dichlorobenzene (2) | | | | | | | | | | |
| 1,4-Dichlorobenzene | | | | | | | | | | |
| Hexachlorobenzene | | | | | | | | | | |

(Continued on facing page)

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | Port of Seattle Terminal 5 | | South Park Marina | | Port of Tacoma Blair Waterway | USACE/Port of Bellingham Squalicum Creek Waterway | | | USACE/Port of Bellingham I & J Waterways | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C1 | C2 | C1 | C2 | C5 | C2 | C4 | C6 | C18 | S1 |
| PHTHALATES | | | | | | | | | | |
| Butyl benzyl phthalate (3) | | | | | | | | | | |
| Di-n-butyl phthalate (2) | | | | | | | | | | |
| Diethyl phthalate (3) | | | | | | | | | | |
| Dimethyl phthalate (2) | | | | | | | | | | |
| PHENOLS | | | | | | | | | | |
| 2 Methylphenol (1) | | | | | | | | | | |
| 2,4-Dimethylphenol (1) | | | | | | | | | | |
| 4 Methylphenol (1) | | | | | | | | | | |
| Pentachlorophenol | | | | | | | | | | |
| Phenol | | | | | | | | | | |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | | | |
| Benzoic acid (1) | | | | | | | | | | |
| Benzyl alcohol (1) | | | | | | | | | | |
| Dibenzofuran (1) | | S | | | S | | | | | |
| Hexachlorobutadiene | | | | | | | | | | |
| N-Nitrosodiphenylamine | | | | | | | | | | |
| VOLATILES | | | | | | | | | | |
| Ethylbenzene | | | | | | | | | | |
| Tetrachloroethene | | | | | | | | | | |
| Total Xylene (1) | | | S | | | | | | | |
| Trichloroethene | | | | | | | | | | |
| PESTICIDES AND PCBs | | | | | | | | | | |
| Aldrin (2) | | | | | | | | | | |
| Chlordane (2) | | | | | | | | | | |
| Dieldrin (2) | | | | | | | | | | |
| Heptachlor (2) | | | | | | | | | | S |
| Lindane (2) | | | | | | | | | | |
| Total DDT | S | S | | | | B | S | | | S |
| Total PCBs | S | S | | | | S | | | | |
| BIOASSAYS | | | | | | | | | | |
| Amphipod | | | | | | - | | | X(X) | |
| Sediment Larval | | | | | X | - | QC | | | |
| Juvenile Infaunal Mortality | | | | | | - | | | | |
| Juvenile Infaunal Biomass | - | - | - | - | - | - | - | - | - | - |
| Microtox | | | | | | - | | | | |
| PASS/FAIL | P | P | P | P | P | F(C) | P | P | P(F) | P |
| HIGHEST RANKING: | LM | LM | LM | LM | LM | M | LM | LM | LM | LM |

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | Bellingham<br>I & J Waterways<br>(continued) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 | S10 | S11 |
| METALS | | | | | | | | | | |
| Mercury | S | S | S | S | S | S | B | S | S | S |
| Antimony | S | | | | | | | | | |
| Arsenic | S | | | | | | | | | |
| Cadmium (1) | | | | S | S | S | S | S | S | S |
| Copper (1) | S | | | | | | | | | |
| Lead (1) | S | | | | | | | | | |
| Silver | | | | | | | | | | |
| Zinc (1) | | | | | | | | | | S |
| LPAH | | | | | | | | | | |
| 2-Methylnaphthalene (1) | | S | | | | | | | | S |
| Acenaphthene (1) | S | | | | | | | | | S |
| Acenaphthylene (1) | | | | | | | | | | |
| Anthracene (1) | S | | | | | | | | | S |
| Fluorene (1) | S | | | | | | | | | S |
| Naphthalene (1) | | | | | | | | | | S |
| Phenanthrene (1) | S | | | | | | | | | S |
| Total LPAH (1) | S | | | | | | | | | S |
| HPAH | | | | | | | | | | |
| Benzo(a)anthracene (1) | | | | | | | | | | S |
| Benzo(a)pyrene | | | | | | | | | | |
| Benzo(g,h,i)perylene (1) | | | | | | | | | | |
| Benzofluoranthenes (1) | | | | | | | | | | |
| Chrysene (1) | | | | | | | | | | S |
| Dibenzo(a,h)anthracene (1) | | | | | | | | | | |
| Fluoranthene | | | | | | | | | | S |
| Indeno(1,2,3-c,d)pyrene (1) | | | | | | | | | | S |
| Pyrene (1) | S | | | | | | | | | S |
| Total HPAH (1) | S | | | | | | | | | S |
| CHLORINATED HYDROCARBONS | | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | | | | | | | | | | |
| 1,2-Dichlorobenzene | | | | | | | | | | |
| 1,3-Dichlorobenzene (2) | | | | | | | | | | |
| 1,4-Dichlorobenzene | | | | | | | | | | |
| Hexachlorobenzene | | | | | | | | | | |

(Continued on facing page)

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | Bellingham I & J Waterways (continued) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 | S10 | S11 |
| PHTHALATES | | | | | | | | | | |
| Butyl benzyl phthalate (3) | | | | | | | | | | |
| Di-n-butyl phthalate (2) | | | | | | | | | | |
| Diethyl phthalate (3) | | | | | | | | | | |
| Dimethyl phthalate (2) | | | | | | | | | | |
| PHENOLS | | | | | | | | | | |
| 2 Methylphenol (1) | | | | | | | | | | |
| 2,4-Dimethylphenol (1) | | S | | | | | | | | |
| 4 Methylphenol (1) | | | | | | | | | | S |
| Pentachlorophenol | | | | | | | | | | |
| Phenol | | | | | | | | | | |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | | | |
| Benzoic acid (1) | | | | | | | | | | |
| Benzyl alcohol (1) | | | | | | | | | | |
| Dibenzofuran (1) | S | S | | | | | | | | S |
| Hexachlorobutadiene | | | | | | | S u | | S u | S u |
| N-Nitrosodiphenylamine | | | | | | | | | | |
| VOLATILES | | | | | | | | | | |
| Ethylbenzene | | | | | | | | | | |
| Tetrachloroethene | | | | | | | | | | |
| Total Xylene (1) | | | | | | | | | | |
| Trichloroethene | | | | | | | | | | |
| PESTICIDES AND PCBs | | | | | | | | | | |
| Aldrin (2) | S | | S | | | | | | | S |
| Chlordane (2) | | | | | | | | | | |
| Dieldrin (2) | | | | | | | | | | |
| Heptachlor (2) | S | S | S | | | | | | | |
| Lindane (2) | | | | | | | | | | |
| Total DDT | S | S | S | S | S | S | S | | | S |
| Total PCBs | | | | | | | | | | S |
| BIOASSAYS | | | | | | | | | | |
| Amphipod | | | X(X) | | | | - | XX | X(X) | |
| Sediment Larval | | | | | | X(X) | - | X(X) | X(X) | XX |
| Juvenile Infaunal Mortality | | | | | | | - | | | |
| Juvenile Infaunal Biomass | - | - | - | - | - | - | - | - | - | - |
| Microtox | | | | | | | - | | | |
| PASS/FAIL | P | P | P(F) | P | P | P(F) | F(C) | F | F | F |
| HIGHEST RANKING: | LM | LM | LM | LM | LM | M | M | H* | H* | H* |

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | Bellingham I & J Waterways (continued) | | USACE/Port of Bellingham Whatcom Waterway | | | USACE Duwamish Phase 1 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S12 | S14 | S24 | S28 | S32 | S1 | S2 | S3 | S4 | S5 |
| METALS | | | | | | | | | | |
| Mercury | S | S | S | BM | BM | | S | | | |
| Antimony | | | | | | | | | | |
| Arsenic | | | | | | | | | | |
| Cadmium (1) | S | S | S | S | S | | | | | |
| Copper (1) | | | | | S | | | | | |
| Lead (1) | | | S | S | | | | | | |
| Silver | | | | | | | | | | |
| Zinc (1) | | | | S | | | | | | |
| LPAH | | | | | | | | | | |
| 2-Methylnaphthalene (1) | | | | S | | | | | | |
| Acenaphthene (1) | | | | S | S | | | | | |
| Acenaphthylene (1) | | | | S | | | | | | |
| Anthracene (1) | | S | | S | S | | | | | |
| Fluorene (1) | | | | S | S | | | | | |
| Naphthalene (1) | | | | S | | | | | | |
| Phenanthrene (1) | | | | S | S | | | | | |
| Total LPAH (1) | | | | S | S | | | | | |
| HPAH | | | | | | | | | | |
| Benzo(a)anthracene (1) | | S | | S | S | | | | | |
| Benzo(a)pyrene | | | | | | | | | | |
| Benzo(g,h,i)perylene (1) | | | | | | | | | | |
| Benzofluoranthenes (1) | | S | | | S | | | | | |
| Chrysene (1) | | S | | | S | | | | | |
| Dibenzo(a,h)anthracene (1) | | | | | | | | | | |
| Fluoranthene | | S | | | | | | | | |
| Indeno(1,2,3-c,d)pyrene (1) | | S | | S | S | | | | | |
| Pyrene (1) | S | S | | S | S | | | | | |
| Total HPAH (1) | S | S | | S | S | | | | | |
| CHLORINATED HYDROCARBONS | | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | | | | S | | | | | | |
| 1,2-Dichlorobenzene | | | | | | | | | | |
| 1,3-Dichlorobenzene (2) | | | | | | | | | | |
| 1,4-Dichlorobenzene | | | | | | | | | | |
| Hexachlorobenzene | | | | S | | | | | | |

(Continued on facing page)

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | Bellingham I & J Waterways (continued) | | USACE/Port of Bellingham Whatcom Waterway | | | USACE Duwamish Phase 1 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S12 | S14 | S24 | S28 | S32 | S1 | S2 | S3 | S4 | S5 |
| PHTHALATES | | | | | | | | | | |
| Butyl benzyl phthalate (3) | | | | | | | | | | |
| Di-n-butyl phthalate (2) | | | | | | | | | | |
| Diethyl phthalate (3) | | | | | | | | | | |
| Dimethyl phthalate (2) | | | | | | | | | | |
| PHENOLS | | | | | | | | | | |
| 2 Methylphenol (1) | | | | | | | | | | |
| 2,4-Dimethylphenol (1) | | | | | | | | | | |
| 4 Methylphenol (1) | | | S | M | S | | | | | |
| Pentachlorophenol | | | | S u | | S | S | S | | |
| Phenol | | | | | | | | | | |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | | | |
| Benzoic acid (1) | | | | | | | | | | |
| Benzyl alcohol (1) | | | | | | | | | | |
| Dibenzofuran (1) | S | | | S | S | | | | | |
| Hexachlorobutadiene | | | | S u | | | | | | |
| N-Nitrosodiphenylamine | | | | | | | | | | |
| VOLATILES | | | | | | | | | | |
| Ethylbenzene | | | | | | | | | | |
| Tetrachloroethene | | | | | | | | | | |
| Total Xylene (1) | | | | | | | | | | |
| Trichloroethene | | | | | | | | | | |
| PESTICIDES AND PCBs | | | | | | | | | | |
| Aldrin (2) | | | | | | | - | | | |
| Chlordane (2) | | | | | | | - | | | |
| Dieldrin (2) | | | | | | | - | | | |
| Heptachlor (2) | | | | | | | - | | | |
| Lindane (2) | | | | | | | - | | | |
| Total DDT | S | S | S | BM | S | S | - | S | S | S |
| Total PCBs | | S | | B | | S | B | S | S | S |
| BIOASSAYS | | | | | | | | | | |
| Amphipod | | | QC | - | - | | - | | | |
| Sediment Larval | | | QC | - | - | QC | - | QC | QC | QC |
| Juvenile Infaunal Mortality | | | XX | - | - | | - | | | |
| Juvenile Infaunal Biomass | - | - | - | - | - | - | - | - | - | - |
| Microtox | | | | - | - | | - | | | |
| PASS/FAIL | P | P | F | F(C) | F(C) | P | F(C) | P | P | P |
| HIGHEST RANKING: | LM | LM | H* | H | H | M | LM | M | LM | LM |

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | USACE Duwamish Phase 1 (continued) | | | USACE Duwamish Phase 2 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S6 | S7 | S8 | C2 | C3 | S1 | S3 | S4 | S5 | S6 |
| METALS | | | | | | | | | | |
| Mercury | | S | S | | | | | | | |
| Antimony | | | | | | | | | | |
| Arsenic | | | | | | | | | | |
| Cadmium (1) | | | | | | | | | | |
| Copper (1) | | | | | | | | | | |
| Lead (1) | | | | | | | | | | |
| Silver | | | | | | | | | | |
| Zinc (1) | | | | | | | | | | |
| LPAH | | | | | | | | | | |
| 2-Methylnaphthalene (1) | | | | | | | | | | |
| Acenaphthene (1) | | | | | | | | | | |
| Acenaphthylene (1) | | | | | | | | | | |
| Anthracene (1) | | | | | | | | | | |
| Fluorene (1) | | | | | | | | | | |
| Naphthalene (1) | | | | | | | | | | |
| Phenanthrene (1) | | | | | | | | | | |
| Total LPAH (1) | | | | | | | | | | |
| HPAH | | | | | | | | | | |
| Benzo(a)anthracene (1) | | | | | | | | | | |
| Benzo(a)pyrene | | | | | | | | | | |
| Benzo(g,h,i)perylene (1) | | | | | | | | | | |
| Benzofluoranthenes (1) | | | | | | | | | | |
| Chrysene (1) | | | | | | | | | | |
| Dibenzo(a,h)anthracene (1) | | | | | | | | | | |
| Fluoranthene | | | | | | | | | | |
| Indeno(1,2,3-c,d)pyrene (1) | | | | | | S | | | | |
| Pyrene (1) | | | | | | | | | | |
| Total HPAH (1) | | | | | | | | | | |
| CHLORINATED HYDROCARBONS | | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | | | | | | | | | | |
| 1,2-Dichlorobenzene | | | | | | | | | | |
| 1,3-Dichlorobenzene (2) | | | | | | | | | | |
| 1,4-Dichlorobenzene | | | | | | | | | | |
| Hexachlorobenzene | | | | | | | | | | |

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## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | USACE Duwamish Phase 1 (continued) | | | USACE Duwamish Phase 2 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S6 | S7 | S8 | C2 | C3 | S1 | S3 | S4 | S5 | S6 |
| PHTHALATES | | | | | | | | | | |
| Butyl benzyl phthalate (3) | | | | | | | | | | |
| Di-n-butyl phthalate (2) | | | | | | | | | | |
| Diethyl phthalate (3) | | | | | | | | | | |
| Dimethyl phthalate (2) | | | | | | | | | | |
| PHENOLS | | | | | | | | | | |
| 2 Methylphenol (1) | | | | | | | | | | |
| 2,4-Dimethylphenol (1) | | | | | | | | | | |
| 4 Methylphenol (1) | | | | S | S | | S | S | | |
| Pentachlorophenol | | | | | | | | | | |
| Phenol | | | | | | | | | | |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | | | |
| Benzoic acid (1) | | | | | | | | | | |
| Benzyl alcohol (1) | | | | | | | | | | |
| Dibenzofuran (1) | | | | | | | | | | |
| Hexachlorobutadiene | | | | | | | | | | |
| N-Nitrosodiphenylamine | | | | | | | | | | |
| VOLATILES | | | | | | | | | | |
| Ethylbenzene | | | | | | | | | | |
| Tetrachloroethene | | | | | | | | | | |
| Total Xylene (1) | | | | | | | | | | |
| Trichloroethene | | | | | | | | | | |
| PESTICIDES AND PCBs | | | | | | | | | | |
| Aldrin (2) | - | - | - | | | | | | | |
| Chlordane (2) | - | - | - | | | | | | | |
| Dieldrin (2) | - | - | - | | | | | | | |
| Heptachlor (2) | - | - | - | | | | | | | |
| Lindane (2) | - | - | - | | | | | | | |
| Total DDT | - | - | - | | | S | | | S | S |
| Total PCBs | B | B | BM | | | | | | | |
| BIOASSAYS | | | | | | | | | | |
| Amphipod | - | - | - | | | X | | | | |
| Sediment Larval | - | - | - | X | X | QC | X | | | X |
| Juvenile Infaunal Mortality | - | - | - | | | | | | | |
| Juvenile Infaunal Biomass | - | - | - | - | - | - | - | - | - | - |
| Microtox | - | - | - | | | | | | | |
| PASS/FAIL | F(C) | F(C) | F(C) | p | p | P | p | p | p | p |
| HIGHEST RANKING: | M | M | H | LM | LM | LM | LM | LM | LM | LM |

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | USACE Duwamish Phase 2 (continued) | | | | | | US Navy Bremerton Pier D - Round 1 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S7 | S8 | S10 | S12 | S13 | S14 | C2 | C4 | C5 | C6 |
| METALS | | | | | | | | | | |
| Mercury | | S | | | | | | | | |
| Antimony | | | | | | | | | S | |
| Arsenic | | | | | | | | | | |
| Cadmium (1) | | | | | | | | | | |
| Copper (1) | | | | | | | S | S | | |
| Lead (1) | | | | | | | | | S | |
| Silver | | | | | | | | | S | |
| Zinc (1) | | | | | | | | | | |
| | | | | | | | | | S | |
| LPAH | | | | | | | | | | |
| 2-Methylnaphthalene (1) | | | | | | | | | | |
| Acenaphthene (1) | | | | | | | | | | |
| Acenaphthylene (1) | | | | | | | | | | |
| Anthracene (1) | | | | | | | | | | |
| Fluorene (1) | | | | | | | | | | |
| Naphthalene (1) | | | | | | | | | | |
| Phenanthrene (1) | | | | | | | | | | |
| Total LPAH (1) | | | | | | | | | | |
| HPAH | | | | | | | | | | |
| Benzo(a)anthracene (1) | | | | | | | | | | |
| Benzo(a)pyrene | | | | | | | | | | |
| Benzo(g,h,i)perylene (1) | | | | | | | | | | |
| Benzofluoranthenes (1) | | | | | | | | | | |
| Chrysene (1) | | | | | | | | | | |
| Dibenzo(a,h)anthracene (1) | | | | | | | | | | |
| Fluoranthene | | | | | | | | | | |
| Indeno(1,2,3-c,d)pyrene (1) | S | | | S | | | | | S | |
| Pyrene (1) | | | | | | | | | S | |
| Total HPAH (1) | | | | | | | | | S | |
| CHLORINATED HYDROCARBONS | | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | | | | | | | | | | |
| 1,2-Dichlorobenzene | | | | | | | | | | |
| 1,3-Dichlorobenzene (2) | | | | | | | | | | |
| 1,4-Dichlorobenzene | | | | | | | | | | |
| Hexachlorobenzene | | | | | | | | | | |

(Continued on facing page)

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | USACE Duwamish Phase 2 (continued) | | | | | | US Navy Bremerton Pier D - Round 1 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S7 | S8 | S10 | S12 | S13 | S14 | C2 | C4 | C5 | C6 |
| PHTHALATES | | | | | | | | | | |
| Butyl benzyl phthalate (3) | | | | | | | | | | |
| Di-n-butyl phthalate (2) | | | | | | | | | | |
| Diethyl phthalate (3) | | | | | | | | | | |
| Dimethyl phthalate (2) | | | | | | | | | | |
| PHENOLS | | | | | | | | | | |
| 2 Methylphenol (1) | | | | | | | | | | |
| 2,4-Dimethylphenol (1) | | | | | | | | | | |
| 4 Methylphenol (1) | | | | | | | | | | |
| Pentachlorophenol | | | | | | | | | | |
| Phenol | | | | | | | | | | |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | | | |
| Benzoic acid (1) | | | | | | | | | | |
| Benzyl alcohol (1) | | | | | | | | | | |
| Dibenzofuran (1) | | | | | | | | | | |
| Hexachlorobutadiene | | | | | | | S u | S u | | |
| N-Nitrosodiphenylamine | | | | | | | | | | |
| VOLATILES | | | | | | | | | | |
| Ethylbenzene | | | | | | | | | | |
| Tetrachloroethene | | | | | | | | | | |
| Total Xylene (1) | | | | | | | | | | |
| Trichloroethene | | | | | | | | | | |
| PESTICIDES AND PCBs | | | | | | | | | | |
| Aldrin (2) | | | | | | | | | | |
| Chlordane (2) | | | | | | | | | | |
| Dieldrin (2) | | | | | | | | | | |
| Heptachlor (2) | | | | | | | | | | |
| Lindane (2) | | | | | | | | | | S |
| Total DDT | | S | S | | S | | | | S | S |
| Total PCBs | | S | | | S | S | | | S | |
| BIOASSAYS | | | | | | | | | | |
| Amphipod | | | | | X | | X | XX | | XX |
| Sediment Larval | | | | | | | | | | |
| Juvenile Infaunal Mortality | | | | | | | | | | |
| Juvenile Infaunal Biomass | - | - | - | - | - | - | - | - | - | - |
| Microtox | | | | | | | | | | |
| PASS/FAIL | p | p | p | p | p | p | P | F | P | F |
| HIGHEST RANKING: | LM | LM | LM | LM | LM | LM | LM | H* | M | H* |

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | US Navy Bremerton Pier D - Round 1 (continued) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C7 | C8 | C9 | C10 | C11 | S1 | S2 | S3 | S4 | S5 |
| METALS | | | | | | | | | | |
| Mercury | | | B | S | S | S | | | S | |
| Antimony | | | | | | | | | | |
| Arsenic | | | | | | | | | | |
| Cadmium (1) | S | S | S | S | S | | S | S | | S |
| Copper (1) | | | S | S | S | | | | S | |
| Lead (1) | | | S | S | S | | | | | |
| Silver | | | | S | | | | | | |
| Zinc (1) | | | S | S | S | | | | | |
| LPAH | | | | | | | | | | |
| 2-Methylnaphthalene (1) | | | | | | | | | | |
| Acenaphthene (1) | | | | | | | | | | |
| Acenaphthylene (1) | | | | | | | | | | |
| Anthracene (1) | | | | | | | | | | |
| Fluorene (1) | | | | | | | | | | |
| Naphthalene (1) | | | | | | | | | | |
| Phenanthrene (1) | | | | | | | | | | |
| Total LPAH (1) | | | | | | | | | | |
| HPAH | | | | | | | | | | |
| Benzo(a)anthracene (1) | | | | | | | | | | |
| Benzo(a)pyrene | | | | | | | | | | |
| Benzo(g,h,i)perylene (1) | | | | | | | | | | |
| Benzofluoranthenes (1) | | | | | | | | | S | |
| Chrysene (1) | | | | | | | | | | |
| Dibenzo(a,h)anthracene (1) | | | | | | | | | | |
| Fluoranthene | | | | | | | | | | |
| Indeno(1,2,3-c,d)pyrene (1) | | | S | | S | | | | S | |
| Pyrene (1) | | | S | S | S | | | | S | |
| Total HPAH (1) | | | S | S | S | | | | S | |
| CHLORINATED HYDROCARBONS | | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | | | | | | | | | | |
| 1,2-Dichlorobenzene | | | | | | | | | | |
| 1,3-Dichlorobenzene (2) | | | | | | | | | | |
| 1,4-Dichlorobenzene | | | | | | | | | | |
| Hexachlorobenzene | | | | | | | | | S u | |

(Continued on facing page)

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | US Navy Bremerton Pier D - Round 1 (continued) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C7 | C8 | C9 | C10 | C11 | S1 | S2 | S3 | S4 | S5 |
| PHTHALATES | | | | | | | | | | |
| Butyl benzyl phthalate (3) | | | | | | | | | | |
| Di-n-butyl phthalate (2) | | | | | | | | | | |
| Diethyl phthalate (3) | | | | | | | | | | |
| Dimethyl phthalate (2) | | | | | | | | | | |
| PHENOLS | | | | | | | | | | |
| 2 Methylphenol (1) | | | | | | | | | | |
| 2,4-Dimethylphenol (1) | | | | | | | | | | |
| 4 Methylphenol (1) | | | | | | | | | | |
| Pentachlorophenol | | | S u | S u | | | | | S u | S u |
| Phenol | | | | | | | | | | |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | | | |
| Benzoic acid (1) | | | | | | | | | | |
| Benzyl alcohol (1) | | | | | | | | | | |
| Dibenzofuran (1) | | | | | | | | | | |
| Hexachlorobutadiene | S u | S u | S u | S u | S u | | S u | S u | S u | S u |
| N-Nitrosodiphenylamine | | | | | | | | | | |
| VOLATILES | | | | | | | | | | |
| Ethylbenzene | | | | | | | | | | |
| Tetrachloroethene | | | | | | | | | | |
| Total Xylene (1) | | | | | | | | | | |
| Trichloroethene | | | | | | | | | | |
| PESTICIDES AND PCBs | | | | | | | | | | |
| Aldrin (2) | | | | | | | | | | |
| Chlordane (2) | | | S u | S u | S u | | | | | |
| Dieldrin (2) | | | S u | | | | | | | |
| Heptachlor (2) | | | S u | | | | | | | |
| Lindane (2) | | | | | | | | | | |
| Total DDT | | | BM | BM | BM | | | | S | |
| Total PCBs | | | S | S | S | | | | S | |
| BIOASSAYS | | | | | | | | | | |
| Amphipod | XX | XX | | X | X | | X | XX | XX | X |
| Sediment Larval | | | | X | X | | | | | |
| Juvenile Infaunal Mortality | | | | | | | | | | |
| Juvenile Infaunal Biomass | - | - | - | - | - | - | - | - | - | - |
| Microtox | | | | | | | | | | |
| PASS/FAIL | F | F | F(C) | F | F | P | P | F | F | P |
| HIGHEST RANKING: | H* | H* | H | H | H | LM | LM | H* | H* | LM |

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | US Navy Bremerton Pier D - Round 1 (continued) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S6 | S7 | S8 | S9 | S10 | S11 | S12 | S13 | S14 | S15 |
| METALS | | | | | | | | | | |
| Mercury | S | S | S | S | S | B | S | S | S | S |
| Antimony | | | | | | | | | | |
| Arsenic | | | | | | | | | | |
| Cadmium (1) | | S | S | S | S | S | S | S | S | S |
| Copper (1) | | S | S | S | S | S | S | S | S | S |
| Lead (1) | | S | S | S | S | S | S | S | S | S |
| Silver | | | | | | | S | | S | S |
| Zinc (1) | | S | S | S | S | S | S | S | S | S |
| LPAH | | | | | | | | | | |
| 2-Methylnaphthalene (1) | | | | | | | | | | |
| Acenaphthene (1) | | | | | | | | | | S |
| Acenaphthylene (1) | | | | | | | | | | |
| Anthracene (1) | | | | | | | | | S | S |
| Fluorene (1) | | | | | | | | | | S |
| Naphthalene (1) | | | | | | | | | | |
| Phenanthrene (1) | | S | | | | | | | | S |
| Total LPAH (1) | | | | | | | | | | S |
| HPAH | | | | | | | | | | |
| Benzo(a)anthracene (1) | | | | | | | | | S | S |
| Benzo(a)pyrene | | | | | | | | | | S |
| Benzo(g,h,i)perylene (1) | | | | | | | | | | |
| Benzofluoranthenes (1) | | S | | | | S | S | | S | S |
| Chrysene (1) | | | | | | | | | S | S |
| Dibenzo(a,h)anthracene (1) | | | | | | | | | | |
| Fluoranthene | | | | | | | | | | S |
| Indeno(1,2,3-c,d)pyrene (1) | S | S | S | S | S | S | S | S | S | S |
| Pyrene (1) | | S | S | S | S | S | S | | S | S |
| Total HPAH (1) | | S | S | S | S | S | S | | S | S |
| CHLORINATED HYDROCARBONS | | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | | | | | | | | | | |
| 1,2-Dichlorobenzene | | | | | | | | | | |
| 1,3-Dichlorobenzene (2) | | | | | | | | | | |
| 1,4-Dichlorobenzene | | | | | | | | | | |
| Hexachlorobenzene | | | S u | S u | | | | | S u | S u |

(Continued on facing page)

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | US Navy Bremerton Pier D - Round 1 (continued) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S6 | S7 | S8 | S9 | S10 | S11 | S12 | S13 | S14 | S15 |
| PHTHALATES | | | | | | | | | | |
| Butyl benzyl phthalate (3) | | | | | | | | | | |
| Di-n-butyl phthalate (2) | | | | | | | | | | |
| Diethyl phthalate (3) | | | | | | | | | | |
| Dimethyl phthalate (2) | | | | | | | | | | |
| PHENOLS | | | | | | | | | | |
| 2 Methylphenol (1) | | | | | | | | | | |
| 2,4-Dimethylphenol (1) | | | | | | | | | | |
| 4 Methylphenol (1) | | | | | | | | | | |
| Pentachlorophenol | | S u | S u | S u | S u | S u | | | S u | S u |
| Phenol | | | | | | | | | | |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | | | |
| Benzoic acid (1) | | | | | | | | | | |
| Benzyl alcohol (1) | | | | | | | | | | |
| Dibenzofuran (1) | | | | | | | | | | S |
| Hexachlorobutadiene | | S u | S u | S u | S u | S u | S u | S u | S u | S u |
| N-Nitrosodiphenylamine | | | | | | | | | S u | S u |
| VOLATILES | | | | | | | | | | |
| Ethylbenzene | | | | | | | | | | |
| Tetrachloroethene | | | | | | | | | | |
| Total Xylene (1) | | | | | | | | | | |
| Trichloroethene | | | | | | | | | | |
| PESTICIDES AND PCBs | | | | | | | | | | |
| Aldrin (2) | | | | | | | | | | |
| Chlordane (2) | | S u | S u | S u | | S u | S u | | | S u |
| Dieldrin (2) | | S | | | | S | S | | | |
| Heptachlor (2) | | | | | | | S u | | | S u |
| Lindane (2) | | | | | | | | | | |
| Total DDT | S | B | S | S u | S | S | BM | | | S u |
| Total PCBs | S | S | S | S | S | S | S | | S | S u |
| BIOASSAYS | | | | | | | | | | |
| Amphipod | X | XX | | XX | XX | XX | X | XX | X | |
| Sediment Larval | | X | | X | | X | | | X | X |
| Juvenile Infaunal Mortality | | | | | | | | | | |
| Juvenile Infaunal Biomass | - | - | - | - | - | - | - | - | - | - |
| Microtox | | | | | | | | | | |
| PASS/FAIL | P | F | P | F | F | F | F(C) | F | F | P |
| HIGHEST RANKING: | LM | H* | M | H* | H* | H* | H | H* | H* | M |

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | US Navy Bremerton Pier D - Round 1 (continued) | | Boyer Alaska Barge Line | Port of Everett South Terminal Partial Characterization | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S16 | S17 | C1 | S1 | S2 | S3 | S4 | S5 | S6 | S7 |
| METALS | | | | | | | | | | |
| Mercury | BM | S | | | | | | S b | S | |
| Antimony | | | | | | | | | | |
| Arsenic | | | | | | | | | | |
| Cadmium (1) | S | | | S | | | S | | | |
| Copper (1) | S | S | | S e | | | | | | |
| Lead (1) | S | S | | S | | | S | | | |
| Silver | S | | | | | | | | | |
| Zinc (1) | S | S | | S | | | | | | |
| LPAH | | | | | | | | | | |
| 2-Methylnaphthalene (1) | | | M | S | | | S | M | S | |
| Acenaphthene (1) | | | M | S | S e | | S | M | M | |
| Acenaphthylene (1) | | | S | S | S | S | S | S | S | |
| Anthracene (1) | | | M | S | | | | S | M | |
| Fluorene (1) | | | M | S | | | S | M | M | |
| Naphthalene (1) | | | M | S | S | S | S | M | S | S |
| Phenanthrene (1) | | | M | S | | | S | S | S | |
| Total LPAH (1) | | | M | S | S | S | S | M | S | |
| HPAH | | | | | | | | | | |
| Benzo(a)anthracene (1) | | | S | S | | | | | S | |
| Benzo(a)pyrene | | | | | | | | | S | |
| Benzo(g,h,i)perylene (1) | | | | | | | | | | |
| Benzofluoranthenes (1) | S | | S | S e | | | | | S | |
| Chrysene (1) | | | S | S | | | | | S | |
| Dibenzo(a,h)anthracene (1) | | | S u | | | | | | S | |
| Fluoranthene | | | BM | S | | | | S | BM | |
| Indeno(1,2,3-c,d)pyrene (1) | S | S | S | S e | | | | S e | S | |
| Pyrene (1) | S | S | S | S e | | | | | S | |
| Total HPAH (1) | S | S | S | S | | | | S | S | |
| CHLORINATED HYDROCARBONS | | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | | | M u | S u | S u | S u | S u | S u | M u | |
| 1,2-Dichlorobenzene | | | B u | S u | | S u | S u | S u | B u | |
| 1,3-Dichlorobenzene (2) | | | S u | B u | | | | | | |
| 1,4-Dichlorobenzene | | | B u | BM u | | S u | | S u | S u | |
| Hexachlorobenzene | | | BM u | S u | S u | S u | | S u | S u | |

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## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | US Navy Bremerton Pier D - Round 1 (continued) | | Boyer Alaska Barge Line | Port of Everett South Terminal Partial Characterization | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S16 | S17 | C1 | S1 | S2 | S3 | S4 | S5 | S6 | S7 |
| PHTHALATES | | | | | | | | | | |
| Butyl benzyl phthalate (3) | | | | | | | | | | |
| Di-n-butyl phthalate (2) | | | | | | | | | | |
| Diethyl phthalate (3) | | | S u | | | | | | | |
| Dimethyl phthalate (2) | | | S u | | | | | | | |
| PHENOLS | | | | | | | | | | |
| 2 Methylphenol (1) | | | S u | S u | M | M | M | M | S u | |
| 2,4-Dimethylphenol (1) | | | S u | | M | M | M | M | M e | |
| 4 Methylphenol (1) | | | S u | S | M | M | S | M | | S |
| Pentachlorophenol | | | S u | S u | S u | S u | S u | S u | S u | |
| Phenol | | | S u | | | S | | | S u | |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | | | |
| Benzoic acid (1) | | | M u | | S u | | | | S u | |
| Benzyl alcohol (1) | | | M u | M u | S u | | | S e | M u | S u |
| Dibenzofuran (1) | S | | M | S | S | | S | M | S | |
| Hexachlorobutadiene | S u | | B u | S u | S u | S u | S u | S u | S u | |
| N-Nitrosodiphenylamine | | | BM u | S u | S u | | | | S u | |
| VOLATILES | | | | | | | | | | |
| Ethylbenzene | | | | BM u | | BM u | | B u | | |
| Tetrachloroethene | | | | BM u | | BM u | | S u | | |
| Total Xylene (1) | | | | M u | | M u | | S u | | |
| Trichloroethene | | | | B u | | BM u | | | | |
| PESTICIDES AND PCBs | | | | | | | | | | |
| Aldrin (2) | | | | S u | | | | | S u | |
| Chlordane (2) | S u | | | S u | | | | | S u | |
| Dieldrin (2) | B | | | S u | | | | | S u | |
| Heptachlor (2) | S u | | | | | | | | S u | |
| Lindane (2) | | | | | | | | | S u | |
| Total DDT | BM | S | | S u | S u | | | | S u | |
| Total PCBs | B | S | | S | S u | S u | S u | S u | S u | S u |
| BIOASSAYS | | | | | | | | | | |
| Amphipod | X | X | - | - | - | - | - | - | - | - |
| Sediment Larval | X | X | - | - | - | - | - | - | - | - |
| Juvenile Infaunal Mortality | | | - | - | - | - | - | - | - | - |
| Juvenile Infaunal Biomass | - | - | - | - | - | - | - | - | - | - |
| Microtox | | | - | - | - | - | - | - | - | - |
| PASS/FAIL | F | F | F(C) | NA | NA | NA | NA | NA | NA | NA |
| HIGHEST RANKING: | H | H* | H | H | H | H | H | H | H | LM |

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | Port of Everett South Terminal PC (continued) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S9 | S10 | S11 | S16 | S17 | S18 | S19 | S20 | S21 | S22 |
| METALS | | | | | | | | | | |
| Mercury | | | | | | | B b | | | |
| Antimony | | | | | | | | | | |
| Arsenic | | | | | | | | | | |
| Cadmium (1) | S j | | | | | S j | S | | | |
| Copper (1) | | | | | | | | | | |
| Lead (1) | | | | | | | | | | |
| Silver | | | | | | | | | | |
| Zinc (1) | S | | | | | | | | | |
| LPAH | | | | | | | | | | |
| 2-Methylnaphthalene (1) | | | S u | | | S u | S u | | | |
| Acenaphthene (1) | S | | M u | | | | | | | |
| Acenaphthylene (1) | | | S u | | | S u | S u | | | |
| Anthracene (1) | | | S u | | | | | | | |
| Fluorene (1) | S | | S u | S | | | | | | |
| Naphthalene (1) | | | S u | | | | | | | |
| Phenanthrene (1) | | | | S | | | | | | |
| Total LPAH (1) | S | | S u | S | | | S | | | |
| HPAH | | | | | | | | | | |
| Benzo(a)anthracene (1) | | | | | | | | | | |
| Benzo(a)pyrene | | | | | | | | | | |
| Benzo(g,h,i)perylene (1) | | | S u | | | | | | | |
| Benzofluoranthenes (1) | | | S e | | | | | | | |
| Chrysene (1) | | | | | | | | | | |
| Dibenzo(a,h)anthracene (1) | | | S u | | | | | | | |
| Fluoranthene | | | S | S | | | | | | |
| Indeno(1,2,3-c,d)pyrene (1) | | | S u | S e | | | S e | | | |
| Pyrene (1) | | | S | S | | S | S | | | |
| Total HPAH (1) | | | S | S | | S | S | | | |
| CHLORINATED HYDROCARBONS | | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | S u | S u | M u | | S u | M u | M u | | | |
| 1,2-Dichlorobenzene | S u | S u | | | | B u | B u | | | |
| 1,3-Dichlorobenzene (2) | | | | | | | | | | |
| 1,4-Dichlorobenzene | | | | | | S u | S u | | | |
| Hexachlorobenzene | | | BM u | | | S u | S u | | | |

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## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | Port of Everett South Terminal PC (continued) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S9 | S10 | S11 | S16 | S17 | S18 | S19 | S20 | S21 | S22 |
| PHTHALATES | | | | | | | | | | |
| Butyl benzyl phthalate (3) | | | S u | | | | | | | |
| Di-n-butyl phthalate (2) | | | | | | | | | | |
| Diethyl phthalate (3) | | | S u | | | S u | | | | |
| Dimethyl phthalate (2) | | | S u | | | | | | | |
| PHENOLS | | | | | | | | | | |
| 2 Methylphenol (1) | S u | S u | M u | | | M u | M u | | | |
| 2,4-Dimethylphenol (1) | S u | S m | M u | | S u | M u | M u | | | |
| 4 Methylphenol (1) | | | S u | | | | S | | | |
| Pentachlorophenol | | S u | BM u | | | B u | S u | | | |
| Phenol | | | BM u | | | S | | | | |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | | | |
| Benzoic acid (1) | | | M u | | | M u | M u | | | |
| Benzyl alcohol (1) | | | M u | | M u | M u | M u | | S u | |
| Dibenzofuran (1) | S | | M u | | | | | | | |
| Hexachlorobutadiene | S u | S u | BM u | | S u | B u | S u | | | |
| N-Nitrosodiphenylamine | | | BM u | | | S u | S u | | | |
| VOLATILES | | | | | | | | | | |
| Ethylbenzene | BM u | | | | | BM u | BM u | BM u | | BM u |
| Tetrachloroethene | BM u | | | | | BM u | BM u | B u | | BM u |
| Total Xylene (1) | M u | | | | | M u | M u | M u | | M u |
| Trichloroethene | BM u | | | | | B u | S u | S u | | S u |
| PESTICIDES AND PCBs | | | | | | | | | | |
| Aldrin (2) | | | | | | | | | | |
| Chlordane (2) | | | | | | | | | | |
| Dieldrin (2) | | | | | | | | | | |
| Heptachlor (2) | | | | | | | | | | |
| Lindane (2) | | | | | | | | | | |
| Total DDT | | | | | | | | | | |
| Total PCBs | S u | S u | S u | | S u | | S u | S u | S u | S u |
| BIOASSAYS | | | | | | | | | | |
| Amphipod | - | - | - | - | - | - | - | - | - | - |
| Sediment Larval | - | - | - | - | - | - | - | - | - | - |
| Juvenile Infaunal Mortality | - | - | - | - | - | - | - | - | - | - |
| Juvenile Infaunal Biomass | - | - | - | - | - | - | - | - | - | - |
| Microtox | - | - | - | - | - | - | - | - | - | - |
| PASS/FAIL | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| HIGHEST RANKING: | H | M | H | LM | H | H | H | H | LM | H |

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | King County Sammamish River | Lonestar NW West Terminal | Port of Seattle SW Harbor Partial Characterization | | | Port of Seattle Terminal 91 | | | Port of Seattle Terminal 115 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S2 | C1 | S1 | S2 | S4 | S1 | S2 | S3 | C1 | C2 |
| METALS | | | | | | | | | | |
| Mercury | | - | | | | S | S j | S | | |
| Antimony | | S | | | | | | | | |
| Arsenic | | S | | | | | | | | |
| Cadmium (1) | | | | | | S | S | | | |
| Copper (1) | | S | S | | | S | | | | |
| Lead (1) | | S | S | | | S | | | S | |
| Silver | | | | | | | | | | |
| Zinc (1) | | S | S | | | S | S | | | |
| LPAH | | | | | | | | | | |
| 2-Methylnaphthalene (1) | | | | | | S | S | M | | |
| Acenaphthene (1) | | S | S | | | M | S | M | S | |
| Acenaphthylene (1) | | | | | | S | S | S | | |
| Anthracene (1) | | S | | | | M | M | M | S | |
| Fluorene (1) | | S | S | | | M | S | M | | |
| Naphthalene (1) | | | | S | | S | S | M | | |
| Phenanthrene (1) | | S | S | | | M | S | S | S | |
| Total LPAH (1) | | S | S | S | | M | S | M | S | |
| HPAH | | | | | | | | | | |
| Benzo(a)anthracene (1) | | S | | | | M | S | S | S | |
| Benzo(a)pyrene | | | | | | S | S | S | | |
| Benzo(g,h,i)perylene (1) | | | | | | S | S | S | | |
| Benzofluoranthenes (1) | | | S | | | S | S | S | S | |
| Chrysene (1) | | | | | | S | S | S | S | |
| Dibenzo(a,h)anthracene (1) | | | | | | S | S | S | | |
| Fluoranthene | | S | | | | BM d | B | S | S | |
| Indeno(1,2,3-c,d)pyrene (1) | | S | S | | S | S | S | S | S | |
| Pyrene (1) | | S | S | | S | M d | M | S d | S | |
| Total HPAH (1) | | S | S | | S | M | S | S | S | |
| CHLORINATED HYDROCARBONS | | | | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | | | | | | S u | M u | S u | | |
| 1,2-Dichlorobenzene | | | | | | B u | B u | B u | | |
| 1,3-Dichlorobenzene (2) | | | | | | | | | | |
| 1,4-Dichlorobenzene | | | | | | S u | S u | S u | | |
| Hexachlorobenzene | | | | | | S u | S u | S u | | |

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## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | King County Sammamish River | Lonestar NW West Terminal | Port of Seattle SW Harbor Partial Characterization | | | Port of Seattle Terminal 91 | | | Port of Seattle Terminal 115 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S2 | C1 | S1 | S2 | S4 | S1 | S2 | S3 | C1 | C2 |
| PHTHALATES | | | | | | | | | | |
| Butyl benzyl phthalate (3) | | | | | | | | | | |
| Di-n-butyl phthalate (2) | | | | | | S b | | | | |
| Diethyl phthalate (3) | | | | | | | S u | | | |
| Dimethyl phthalate (2) | | | | | | | | | | |
| PHENOLS | | | | | | | | | | |
| 2 Methylphenol (1) | | | | | | S u | M u | S u | | |
| 2,4-Dimethylphenol (1) | | | | | | M u | M u | S u | | |
| 4 Methylphenol (1) | | | | | | | S | | | |
| Pentachlorophenol | | | | | | S u | B u | S u | | |
| Phenol | | | | | | | S | | | |
| MISCELLANEOUS EXTRACTABLES | | | | | | | | | | |
| Benzoic acid (1) | | | | | | S u | M u | S u | | |
| Benzyl alcohol (1) | | | | | | S u | M u | S u | | |
| Dibenzofuran (1) | | S | S | | | S | S | M | | |
| Hexachlorobutadiene | | | | | | S u | S u | S u | | |
| N-Nitrosodiphenylamine | | | | | | S u | S u | S u | | |
| VOLATILES | | | | | | | | | | |
| Ethylbenzene | | | | | | S u | S u | | | |
| Tetrachloroethene | | | | | | S u | S u | | | |
| Total Xylene (1) | | | | | | S u | S u | | | |
| Trichloroethene | | | | | | | | | | |
| PESTICIDES AND PCBs | | | | | | | | | | |
| Aldrin (2) | | | | | - | | | | | |
| Chlordane (2) | | | | | - | S u | S u | S u | | |
| Dieldrin (2) | | | | | - | | | | | |
| Heptachlor (2) | | | | | - | | | | | |
| Lindane (2) | | | | | - | | | | | |
| Total DDT | S | | | | - | S d | S d | S | | S |
| Total PCBs | | S | S | | S | | | | | S |
| BIOASSAYS | | | | | | | | | | |
| Amphipod | X | | - | - | - | XX | | XX | X | |
| Sediment Larval | | | - | - | - | QC | QC | QC | | |
| Juvenile Infaunal Mortality | - | | - | - | - | XX | | XX | - | - |
| Juvenile Infaunal Biomass | | - | - | - | - | - | - | - | | |
| Microtox | | | - | - | - | | | X | | |
| PASS/FAIL | P | P | NA | NA | NA | F | F(C) | F | P | P |
| HIGHEST RANKING: | LM | LM | LM | LM | LM | H | H | H | LM | LM |

## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | USACE Everett Full Characterization | | | US Navy Everett Homeport - Element II Round 1 | | US Navy Everett Homeport - Element II Round 1 | US Navy Everett Homeport - Element II Round 2 |
|---|---|---|---|---|---|---|---|
| | C4 | C8 | C11 | C1 | C5 | C6 | S5 |
| METALS | | | | | | | |
| Mercury | | | | | | | |
| Antimony | | | | | | | |
| Arsenic | | | | | | | |
| Cadmium (1) | | | | | | | |
| Copper (1) | | | | | | | |
| Lead (1) | | | | | | | |
| Silver | | | | | | | |
| Zinc (1) | | | | | | | |
| LPAH | | | | | | | |
| 2-Methylnaphthalene (1) | | | | | S | | |
| Acenaphthene (1) | | | | | | | |
| Acenaphthylene (1) | | | | | | | |
| Anthracene (1) | S | | S | | | | |
| Fluorene (1) | | | | | | | |
| Naphthalene (1) | | | | | | | |
| Phenanthrene (1) | | | | | | | |
| Total LPAH (1) | | | | | | | |
| HPAH | | | | | | | |
| Benzo(a)anthracene (1) | | | | | | | |
| Benzo(a)pyrene | | | | | | | |
| Benzo(g,h,i)perylene (1) | | | | | | | |
| Benzofluoranthenes (1) | | | | | | | |
| Chrysene (1) | | | | | | | |
| Dibenzo(a,h)anthracene (1) | | | | | | | |
| Fluoranthene | | | | | | | |
| Indeno(1,2,3-c,d)pyrene (1) | | | | | | | |
| Pyrene (1) | | | | | | | |
| Total HPAH (1) | | | | | | | |
| CHLORINATED HYDROCARBONS | | | | | | | |
| 1,2,4-Trichlorobenzene (1) | | | | | | | |
| 1,2-Dichlorobenzene | | | | | | | |
| 1,3-Dichlorobenzene (2) | | | | | | | |
| 1,4-Dichlorobenzene | | | | | | | |
| Hexachlorobenzene | | | | | | | |

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## APPENDIX C - DY92/93 EVALUATION GUIDELINE EXCEEDANCES

| Project: | USACE Everett Full Characterization | | | US Navy Everett Homeport - Element II Round 1 | | US Navy Everett Homeport - Element II Round 1 | US Navy Everett Homeport - Element II Round 2 |
|---|---|---|---|---|---|---|---|
| | C4 | C8 | C11 | C1 | C5 | C6 | S5 |
| PHTHALATES | | | | | | | |
| Butyl benzyl phthalate (3) | | | | | | | |
| Di-n-butyl phthalate (2) | | | | | | | |
| Diethyl phthalate (3) | | | | | | | |
| Dimethyl phthalate (2) | | | | | | | |
| PHENOLS | | | | | | | |
| 2 Methylphenol (1) | | | | | | | M |
| 2,4-Dimethylphenol (1) | | | | | | | M |
| 4 Methylphenol (1) | | S | | | | | S |
| Pentachlorophenol | | | | | | | |
| Phenol | | | | | | | |
| MISCELLANEOUS EXTRACTABLES | | | | | | | |
| Benzoic acid (1) | | | | | | | |
| Benzyl alcohol (1) | | | | | | | |
| Dibenzofuran (1) | | | | | | | |
| Hexachlorobutadiene | | | | | | | |
| N-Nitrosodiphenylamine | | | | | | | |
| VOLATILES | | | | | | | |
| Ethylbenzene | | | | | | | |
| Tetrachloroethene | | | | | | | |
| Total Xylene (1) | | | | S | | S | |
| Trichloroethene | | | | | | | |
| PESTICIDES AND PCBs | | | | | | | |
| Aldrin (2) | | | | | | | |
| Chlordane (2) | | | | | | | |
| Dieldrin (2) | | | | | | | |
| Heptachlor (2) | | | | | | | |
| Lindane (2) | | | | | | | |
| Total DDT | | | | | | | |
| Total PCBs | | | | | | | |
| BIOASSAYS | | | | | | | |
| Amphipod | | QC | | | | | |
| Sediment Larval | | | | | XX | | |
| Juvenile Infaunal Mortality | - | - | - | - | - | - | - |
| Juvenile Infaunal Biomass | | QC | | | | | |
| Microtox | | | | | | | |
| PASS/FAIL | P | P | P | P | F | P | F(C) |
| HIGHEST RANKING: | LM | LM | LM | LM | H* | LM | H |