Puget Sound Dredged Disposal Analysis: Management Plan Assessment Report

Dredged Material Management Year 1990

March, 1991
91-13

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Dear Interested Reader:

I am pleased to transmit to you a copy of the Puget Sound Dredged Disposal Analysis Management Plan Assessment Report for Dredged Material Management Year 1990 (June 16, 1989 - June 15, 1990).

The Puget Sound Dredged Disposal Analysis (PSDDA) program requires the Washington Department of Ecology to annually prepare a summary evaluation of the performance of the PSDDA Management Plan and recommend topics for consideration during the PSDDA annual review process. After opportunity for public review, these topics may result in changes to the PSDDA Management Plan.

The Management Plan Assessment Report summarizes:

- o recent dredged material testing results and dredging activity for Puget Sound
- o PSDDA disposal site conditions, and
- o topics with potential implications to the PSDDA Management Plan.

Many of the topics identified in the report will be discussed at the upcoming PSDDA annual review meeting, which is scheduled to occur on May 2, 1990 (and May 3, as needed). This meeting is being announced separately by the U.S. Army Corps of Engineers.

If you have questions regarding this report or other issues related to Ecology's role in the PSDDA Program, please contact Tom Gries (206/438-7706) of my staff.

Sincerely,

Greg Sorlie

Greg Sorlie
Program Manager
Central Programs

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List of Acronyms

AET	Apparent Effects Threshold
ARM	Annual Review Meeting
AVS	Acid Volatile Sulfides
BT	Bioaccumulation Trigger
CLP	Contract Laboratory Methods
COC	Chemical of Concern
Corps	U.S. Army Corps of Engineers
cm	centimeter
cy	cubic yards
DMEAR	Dredged Material Evaluation Application Report
DNR	Washington Department of Natural Resources
DW	dry weight (Basis)
DY	Dredging Year, or Dredged Material Management Year
EPA	U.S. Environmental Protection Agency
GC	Gas Chromatograph(y)
HPAH	High Molecular Weight Polynuclear Aromatic Hydrocarbon (Compound)
LOD	Limit of Detection
LPAH	Low Molecular Weight Polynuclear Aromatic Hydrocarbon (Compound)
MCLP	Modified Contract Laboratory Method
mg/l	milligrams per liter
ML	(PSDDA) Maximum Level
MS	Mass Spectrometer/Spectrometry
NEPA	National Environmental Policy Act
NPDES	National Pollution Discharge Elimination System
PCB	Polychlorinated Biphenyl
ppb	parts per billion
ppm	parts per million
PSDDA	Puget Sound Dredged Disposal Analysis (Program)
PSEP	Puget Sound Estuary Program
PSWQA	Puget Sound Water Quality Authority
QA	Quality Assurance
QC	Quality Control
SEDQUAL	Sediment quality database (Ecology)
SEPA	State Environmental Policy Act
SIM	Selected Ion Monitoring
SL	(PSDDA) Screening Level
SVPS	Sediment Vertical Profile Sampler
TOC	Total Organic Carbon (Basis)
VOC	Volatile Organic Compound
WPPA	Washington Public Ports Association

CHAPTER 1

INTRODUCTION

1.1 Puget Sound Dredged Disposal Analysis

PSDDA is an interagency program for the management of unconfined, open-water disposal of dredged material into Puget Sound, Washington. The PSDDA program was developed jointly by the U.S. Army Corps of Engineers (Corps) Seattle District, the U.S. Environmental Protection Agency (EPA) Region 10, the Washington Department of Natural Resources (DNR) and the Washington Department of Ecology (Ecology). The Management Plans (7,8) for the PSDDA program identify disposal sites, describe dredged material evaluation procedures, and establish site monitoring and management practices. The plans also commit the agencies to a cooperative annual review process which evaluates disposal site use and conditions, dredged material testing results, and new scientific information, in order to determine if changes to the evaluation procedures and/or disposal site management practices are needed.

1.2 PSDDA Annual Review Process

The PSDDA annual review process currently involves preparation of various annual reports by the PSDDA agencies (Corps, DNR, EPA, Ecology), an annual review meeting (ARM), and a public notice of program changes resulting from the annual review.

The process calls for the following annual reports to be prepared:

- a report by DNR summarizing the dredging activity and site use (16a, 16b);
- a report by the Corps summarizing dredged material sampling, testing, and application of disposal guidelines (4a, 4b);
- a report by the Corps describing the results of disposal site physical monitoring (10);
- a report by DNR describing the results of disposal site chemical and biological monitoring (11);
- a report prepared by Ecology summarizing the results of disposal site environmental monitoring[1]; and
- a report by Ecology summarizing potential issues and changes to the PSDDA Management Plan (6 and this report).

The Corps announces the ARM by letter, accompanied by Ecology's annual Management Plan Assessment Report and any key program issue papers. Comments on the report, issue papers and any changes to the PSDDA Management Plan which the public deem appropriate are specifically requested. The latter must be submitted in writing and may be briefly presented at the ARM.

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[1] PSDDA agencies agreed there was no need for this summary report after this first year of monitoring.

After the ARM, PSDDA agencies consider all of the agency and public comments, summarize the ARM and report on any changes to the PSDDA Management Plan. This summary is usually prepared and mailed to interested parties in May or June.

1.3 Results of Dredging Year (DY) 1989 Annual Review Process

The following is a summary of results of the DY 1989 annual review meeting, held spring 1990 (9). The progress made during DY 1990 toward addressing continuing work is summarized in Chapter 4.

DY 1989 Clarifications to the Management Plan

- An interim schedule was set for laboratories performing PSDDA analyses to become accredited by Ecology.
- Subsurface sampling guidelines were relaxed to allow best professional judgement with supporting documentation.
- Analysis of conventional parameters for all bioassay reference samples became a requirement.
- Measurement of sulfide and ammonia in water during all bioassays became a requirement.
- The saline extract Microtox test became an additional requirement for small projects.
- New clarifications to the Microtox test were adopted, including a) the requirement to run a separate reference sample for each new "batch" of test bacteria, b) the interpretation of increased luminescence over reference as a neutral response, and c) the interpretation of a "hit" as when the highest test dilution had significantly lower luminescence than the same-batch reference.
- The 10-day *Neanthes* acute mortality test became a required PSDDA bioassay after January 11, 1990.
- PSDDA project data was required to be transmitted to the Corps in standard formats.
- A PSDDA chemical of concern equaling the screening level (SL) would be interpreted not to exceed the SL.
- The SL for pentachlorophenol was raised to 100 parts per billion (ppb) dry weight (DW) from 69 ppb DW.
- PSDDA agencies agreed to attempt a pattern analysis examining appropriateness of certain SLs.

DY 1989 Issues Resulting in No Clarifications to the Management Plan

- Proposed changes to Puget Sound Estuary Program (PSEP) protocols would not likely affect PSDDA evaluation procedures, but the agencies would track those changes.
- Newly drafted EPA/Corps ocean disposal guidance would likely not have immediate implications for the PSDDA program, but the agencies would follow the development of the guidance.
- Analysis of individual congeners of polychlorinated biphenyls (PCBs) would not replace Total PCBs as a requirement, but PSDDA agencies would follow research on the topic.
- Compliance inspection procedures would not be changed.

DY 1989/1990 Continuing Work

- Ecology would continue review and revision of the PSDDA "User's Manual," anticipating completion during early DY 1991.
- The PSDDA agencies would examine ways of better defining when and how PSDDA would require sampling and testing for polychlorinated dibenzodioxins and dibenzofurans.
- PSDDA agencies would continue their objective review of all bioassay methods and interpretations.
- The PSDDA agencies would conduct various studies, analyze new data, and sponsor a workshop on reference areas toward preventing problems associated with identification of suitable reference areas and reference sample bioassay performance.
- PSDDA agencies would conduct final studies on the "*Neanthes* biomass" test and work towards a decision on potential use of that test as one of the required suite of PSDDA bioassays.
- PSDDA agencies would work with the Washington Public Ports Association to examine recent data for significant patterns or trends, chemical exceedances, and biological effects.

1.4 Purpose and Organization of the Management Plan Assessment Report

This document constitutes Ecology's annual Management Plan Assessment Report (MPAR) for DY 1990 (June 16, 1989 - June 15, 1990). It summarizes the results of the previous year's annual review process, and all the activities of the current DY related to PSDDA (for example, volumes of dredged material tested, disposal site use, site monitoring and management issues, etc.). It discusses and recommends clarifications and/or PSDDA program changes to be considered at the upcoming ARM. Organization of the MPAR is described below.

Chapter 2 summarizes Puget Sound dredging activity, disposal site use, dredged material testing, PSDDA project costs, and sources of new sediment data for DY 1990.

Chapter 3 summarizes the current conditions at disposal sites and compares them to those documented by the PSDDA baseline studies (1,2). When a sufficient number of monitoring events or other studies have occurred, this chapter will also examine any chemical or biological trends evident over time at the disposal sites.

Chapter 4 summarizes the topics which were identified and/or addressed during DY 1990 that PSDDA agencies believe have potential implications to the PSDDA Management Plan.

Concluding observations about the DY 1990 PSDDA program and recommended topics for discussion at the ARM are contained in Chapter 5.

The references section, noted by a number enclosed in parentheses, follows Chapter 5.

Appendix A contains all the clarifications to protocols and other PSDDA program requirements which PSDDA agencies propose. Appendix B contains six issue paper proposals, authored by the various PSDDA agencies, which could result in more significant changes to the PSDDA Management Plans. Appendix C, containing the results of a reevaluation of PSDDA sediment quality values (MLs and SLs), is being prepared and will be made available separately.

CHAPTER 2

SUMMARY OF DREDGED MATERIAL MANAGEMENT YEAR 1990

This chapter summarizes for DY 1990 all dredged material testing, the cost associated with PSDDA testing, and the volume of material which passed PSDDA guidelines (4a). It then summarizes the use of unconfined, open-water disposal sites during the same period (16a). Findings from DY 1990 are compared to those from DY 1989. A summary of sediment quality data sources of interest to the PSDDA program and new technical information concludes the chapter.

2.1 Dredged Material Tested during DY 1990

There were eleven projects, representing 1,716,325 cy of dredged material, which underwent PSDDA tiered testing during DY 1990[2,3] (Table 1). This represented an increase in the number of projects from DY 1989 (Table 2), a "trend" expected to continue in the foreseeable future. The volume tested also increased from DY 1989, but this was principally due to one unusually large volume project, the Navy Homeport Everett (Element I) project. Without this one project, the volume represented increased only 3% from DY 1989.

Two of these eleven projects subsequently withdrew their permit applications (METRO West Point Emergency By-Pass and U.S. Coast Guard Pier 35). While these projects are included in the total volume tested, the material could not be dredged and disposed until re-applying for a permit.

2.2 Volume of Dredged Material Passing PSDDA Guidelines

Almost 99 percent of the volume tested during DY 1990, about 1,695,225 cy, was determined to be suitable for open-water disposal. This was very similar for both dredging years. Nearly 98% of the DY 1989 volume of dredged material tests passed PSDDA guidelines. This was probably due to:

- a continued predisposition for dredgers to propose open-water disposal and conduct sampling in areas suspected to be relatively clean (having mostly "Low" to "Moderate" initial area rankings); and

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[2] The number of cy from the Port of Skagit County/La Conner project was "tested" or evaluated only in the "Tier 1" or "reason-to-believe" sense (no testing was required). This was because it was located in an area having a "Low" area ranking and was a "small project" according to PSDDA guidelines (5).

[3] A single planning study (Port Townsend Harbor Expansion project), conducted preliminary and limited sampling and analyses, but its 300,000 cy was not included in this total.

PROJECT NAME/APPLICANT	Volume Tested (cy) *a*	Volume Passing (cy)
U.S. Navy Homeport Everett Element I	975,000	975,000
Port of Bellingham Blaine Marina	358,000	358,000
U.S. Navy Manchester Fuel Pier	181,825	181,825
Duwamish Operations & Maintenance (O&M)	126,325	110,325
METRO West Point Emergency By-pass	48,775 *b*	48,775
Pope & Talbot	11,100	6,400
Port of Skagit Cty/La Conner	6,600 *c*	6,600
U.S. Coast Guard Pier 35	5,100 *b*	2,700
Morton Marine	4,000	4,000
Lonestar Northwest	1,600	1,600
TOTAL VOLUME TESTED	**1,718,325**	**1,695,225**

Table 1. Dredged material testing in Puget Sound during DY 1990 (June 16, 1989 - June 15, 1990). (4a)

a All units of measure are cubic yards (cy) and are rounded to the nearest 25 cy.

b Metro West Point Emergency By-pass and U.S. Coast Guard Pier 35 project applications have been withdrawn.

c The Port of Skagit/La Conner project was not tested beyond Tier 1 because of small volume and "Low" initial area ranking.

	DY 1989	DY 1990
Number of Dredging Projects Tested Under PSDDA	5	11
Dredged Material Volume Tested Under PSDDA	719,975	1,718,325 *a*
Number of Suitability Decisions Made	5	10 *a*
Volumes of Dredged Material Suitable for PSDDA Disposal and Percent of Tested Volume	703,675 97.7%	1,695,225 98.7%
Total Volume of Dredged Material Suitable for Confined Disposal	403,425	78,925
Total Volume Disposed at Open-Water Disposal Sites (Without Navy Homeport Project Volume)	144,400 *b*	1,121,625 (170,900)

Table 2. Comparison of Dredging Years 1989 and 1990.

a The volume of material tested for the Port Townsend Harbor Expansion planning study (300,000 cy) is not include here because it undertook only limited sampling and analyses.

b This included one large volume project, 138,300 cy, disposed at approved non-PSDDA unconfined open-water site. Otherwise, only 6,090 cy was disposed to one PSDDA site.

- several larger projects which involved collecting and testing samples representing large volumes of deep, native sediments (for example, Navy Homeport Everett, Port of Bellingham/Blaine Marina).

2.3 PSDDA Testing Results

Chemical Testing Results

There were a total of 99 samples tested from the ten DY 1990 projects listed in Table 1. Nearly one-half of the samples tested (44/99) either had detectable levels of one or more COCs in excess of the current PSDDA SL or remained undetected at analytical detection limits greater than the screening level (SL). PSDDA considers the latter to have exceeded SLs.

COCs Exceeding the PSDDA SL

A total of 49 of the 60[4] PSDDA COCs were actually detected at concentrations greater than SL in at least one sample. The ten COCs most frequently found to exceed the SL were:

- Indeno(1,2,3-c,d)pyrene (25 samples > SL);
- Fluoranthene (15 samples);
- Total PCBs (13 samples);
- High Molecular Weight Polynuclear Aromatic Hydrocarbons (HPAHs) (8 samples);
- Benzofluoranthenes (7 samples);
- Anthracene (6 samples);
- Benzo(a)anthracene (6 samples);
- Dibenzo(a,h)anthracene (6 samples);
- Low Molecular Weight Polynuclear Aromatic Hydrocarbons (LPAHs) (6 samples); and
- Phenanthrene (6 samples).

COCs Exceeding ML

Only 2 of the 99 samples exceeded the PSDDA maximum levels (ML). These samples, both from the U.S Coast Guard/Pier 35 project, contained 11 COCs which exceeded the current PSDDA ML. Most exceedances were for LPAHs -- 2-methylnaphthalene, acenaphthene, anthracene, fluorene, naphthalene, phenanthrene and Total LPAHs. Also exceeded were the MLs for dibenzofuran, fluoranthene, tetrachloroethene and Total DDT. Eight other COCs were found undetected but at levels of detection greater than the PSDDA SL (see section below on data quality assurance).

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[4] This number includes Total LPAHs and Total HPAHs.

COCs Exceeding Bioaccumulation Trigger Levels

The same two samples from the U.S Coast Guard/Pier 35 project which demonstrated exceedances of MLs were also the only ones with COCs exceeding the bioaccumulation trigger level (BT). Three BTs were exceeded (ethylbenzene, fluoranthene, and Total DDT) and 8 other COCs remained undetected at analytical detection limits greater than the BT. Bioaccumulation testing was not undertaken because the same sample material, having exceeded at least one ML, was required to be disposed of at upland, confined disposal sites.

Comparison to Initial Area Ranking

The initial area ranking according to the Evaluation Procedures Technical Appendix (5) and the Management Plan Reports (7,8) tended to be conservative for DY 1990 projects. Two exceptions to this observation were the U.S. Coast Guard Pier 35 and U.S. Navy Manchester projects, where initial ranking appeared to be appropriate.

When initial area rankings were compared to results of chemical analyses, many areas of most projects appeared to be candidates for future down-ranking. PSDDA agencies will consider downranking specific areas of dredging after collection of more data over the next several dredging years.

Quality Assurance Results

Analytical QA/QC was generally improved during DY 1990. Chemical holding time restrictions prescribed by PSDDA were usually met. However, the Corps closely examined other PSDDA QA measures and made suggestions for modifications to analytical warning and action limits. These included matrix and surrogate spikes, recovery of certified reference materials, and precision (as measured by relative per cent difference). These clarifications are presented in Appendix A.

Laboratories continued to have some difficulty during DY 1990 meeting the sample limits of detection (LOD) required by PSDDA (less than SL). Eight of eleven projects, 41 of 99 samples and 21 of 60 PSDDA COCs analyzed showed an LOD greater than the SL.

Eleven of the 13 detection limits which were difficult to achieve during DY 1989 remained so in DY 1990: 1,2,4-trichlorobenzene, 2-methylphenol, 2,4-dimethylphenol, benzoic acid, benzyl alcohol, N-nitrosodiphenylamine, 1,2-dichlorobenzene, hexachlorobutadiene, 1,4-dichlorobenzene, pentachlorophenol, and hexachlorobenzene. Chlordane and mercury were the two COCs in DY 1989 which apparently were not a problem in DY 1990.

During DY 1990, sample detection limits lower than the SL were also difficult to attain for ten additional COCs. These were apparently not difficult to attain during DY 1989. The COCs were acenaphthylene, 1,3-dichlorobenzene, diethylphthalate, dimethylphthalate, 4-methylphenol, phenol, tetrachloroethene, aldrin, lindane and Total PCBs. However, most of these latter analyses came from just two sediment samples from one particularly contaminated project, U.S. Coast Guard Pier 35, whose application was subsequently withdrawn.

The PSDDA agencies will continue to work closely with any required analytical laboratories to resolve sample limits of detection which remain difficult to meet. The potential to raise the SL for six of the COCs most frequently difficult to analyze with respect to LODs were investigated. Results of the investigation are be presented separately in Appendix C.

Bioassay Testing Results

A total of 73 samples of dredged material from 8 of the 11 projects were tested for biological effects using at least one of four bioassay tests:

- amphipod 10-day mortality bioassay
- sediment larval combined mortality/abnormality bioassay
- Microtox luminescence bioassay
- juvenile infauna 10-day mortality bioassay

Only two projects performed the juvenile infauna bioassay. The Duwamish River Operations & Maintenance project used the newly-adopted *Neanthes arenaceodentata* 10-day mortality bioassay for a single test and experienced no difficulties with it. The Navy Homeport Everett Element I project, in contrast, used the geoduck *Panope generosa*. Some of the geoduck mortality test results were used in conjunction with other bioassay test results to make a suitability decision on the project. However, results were generally not considered to be dependable. Similar test batches did not yield consistent results. Thus, without further development, the test was not recommended for future use in the PSDDA program.

The first three types of bioassays listed above were more frequently used with generally acceptable data quality control and good overall test performance. The amphipod bioassay continued to be a reliable test, posing few problems for labs or regulatory reviewers. Only a single Samish Bay reference sediment sample failed the performance standard for the amphipod 10-day mortality test (METRO West Point Emergency By-pass project). This was inconsequential for test interpretation, however, because test samples did not exceed controls by more than 20%.

All sediment larval bioassays run during DY 1990 used the echinoderm *Dendraster*. These tests were relatively trouble-free, partly as a result of discussion among lab representatives at a June 1990 bioassay workshop sponsored by the Corps. However, several QA problems were noted during DY 1990 for this bioassay. It was suspected that these were caused by high sediment ammonia and sulfides. To address this, the PSDDA agencies are proposing that test beakers for this and other bioassays be aerated when dissolved oxygen falls below 5 ppm or when these two conventional parameters are suspected to be present in high concentrations.

The Microtox test performed less satisfactorily during DY 1990 than the previous two bioassays, but the clarifications to test interpretation made after the DY 1989 ARM (9) improved general test performance over DY 1989. This has been substantiated by recent Microtox results.

Of a total 73 bioassay samples, only six failed the PSDDA unconfined, open-water disposal guidelines. These either came from the U.S. Coast Guard Pier 35 project or the Duwamish Operations and Maintenance project. Samples from the former project were from areas initially

ranked "High" where demonstration of biological effects might have been expected. Samples from the latter project which showed biological effects contained lower concentrations of COCs.

2.4 Pattern Analysis

In response to comments and requests from the Washington Public Ports Association (WPPA) made during the DY 1989 ARM, the PSDDA agencies performed pattern analysis on data gathered during DY 1990. These analyses were designed to examine the PSDDA COCs which have:

- led to greatest number of test failures;
- SL values that were frequently exceeded but which resulted in no or few biological effects (bioassay failures); and
- ML values that were most frequently exceeded.

The PSDDA agencies reviewed DY 1990 data in consultation with the WPPA and reported its results in the DMEAR (4a). There were several COCs found to exceed the SL but which did not demonstrate biological effects. These included fluoranthene, indeno(1,2,3-c,d)pyrene, pyrene, Total PCBs and HPAHs. However, PSDDA agencies believed there were too few data available from a single dredging year to recommend changes to guideline values. For further detail of the results of the agencies' pattern analysis, the reader is referred to the DMEAR (4a, Appendix IV).

2.5 Permit Processing

Based on data from DY 1990 projects, the average time required for an applicant to obtain a permit decision is about one year after project conception. Sampling and analysis planning required 5-6 weeks. The overall PSDDA process, including all chemical and biological analyses, required an average of 20 weeks to complete. To complete an application took 5-6 weeks. Finally, the public interest review, permit analysis and permit decision process averaged 22 weeks (4a, pages 33-38).

Suggestions were made at the DY 1989 ARM and at the January, 1991 protocols/process meeting on how the overall process might be accelerated. The Corps stated at the meeting that they were willing to accept concurrent state and federal processing of Section 10/404 project permit applications after the decision on the suitability of material for open-water disposal was made. Encouraging a joint EIS for both SEPA and NEPA could also speed the process.

2.6 Sampling and Analysis Cost

The DMEAR report summarizes the cost associated with sampling and dredged material testing for the eleven DY 1990 projects (4a). The mean and range of overall project cost associated with field work, chemical and biological testing are included in the analysis. The report also presents unit costs, i.e., the analytical cost per cubic yard of dredged material.

Total project cost was greatest for those projects which either had a "Moderate" to "High" initial

area ranking (1), a large volume of material tested, or a greater dredging depth. The combined cost for all the sampling, testing, and miscellaneous costs associated with DY 1990 PSDDA projects averaged $10,441 per sample analysis (range $4,347 - $17,750). This is approximately 2.5 times greater than the average for DY 1989 ($4,119). This was primarily due to high sampling costs incurred by three projects (METRO West Point Emergency By-Pass, Pope & Talbot and Navy Homeport Everett (Element I)) and the relatively high cost of chemical testing for the two small volume projects (Lonestar Northwest and Morton Marine).

Sampling Cost

Cost of taking sediment samples during DY 1990 ranged from a low of $862 to $12,500 per sample, depending on sample depth, ease of collection, need for and ease of coring, and the degree of sample compositing done. The necessity for using coring technology to obtain subsurface, and especially deep samples (> 20 ft), greatly increased sampling cost. This has led to the PSDDA agencies proposed clarification to allow best professional judgement to sometimes allow collecting a reduced number of deep sediment samples. This clarification appears in Appendix A.

Based on DY 1990 information presented in the DMEAR, projects in the near future can probably expect sampling cost to be in the range of $1,000 - $3,000 per sample if they are <u>not</u> required to collect samples from subsurface depths (>4 ft).

Chemical Testing Cost

DY 1990 projects, excluding two single-sample projects, averaged $1,991 per sample (range $1,611 - $2,289). This was 13% greater than for DY 1989 ($1,762 per sample). Organic chemical analyses still comprised by far the largest share of the chemical testing cost.

Bioassay Testing Cost

Of the three bioassays required by PSDDA, the saline Microtox cost the least per analysis ($162 - $243), followed by the amphipod and sediment larval tests (generally $450 - $650 each). The cost for performing all three PSDDA bioassays ranged from $1,115 to $1,657 per sample, averaging $1,419 per sample. This was about 18% less than the total of three bioassay costs reported for the five DY 1989 projects ($1,736).

Cost per Unit Volume

The overall project cost of sampling and testing dredged material for DY 1990 projects ranged from $0.15 - $8.29 per cy, compared to the DY 1989 range of $0.11 - $1.75. DY 1990's average cost of $1.64 per cy was approximately 2.6 times greater than the average for DY 1989 ($0.63). The cost of samples taken had the greatest influence on the unit cost.

The overall costs of testing were quite different from those experienced during DY 1989, mostly due to the higher sampling cost of three projects: METRO West Point Emergency By-pass, Pope & Talbot and U.S. Navy Homeport Everett (Element I). In contrast to this, the cost of performing the three bioassays most frequently selected during much of DY 1990 decreased.

2.7 PSDDA Site Use Summary for DY 1990

Approximately 1,058,000 cy of the 1,718,325 cy, or 62% of the material determined during DY 1990 to be suitable for disposal at unconfined open-water sites, was actually discharged at two PSDDA sites (Elliott Bay and Port Gardner). These sites also received a total 63,625 cy of dredged material from two projects evaluated and found suitable for disposal at a PSDDA site during DY 1989 (Duwamish Yacht Club and Port of Everett Marina projects). This brought the total PSDDA disposal site use during DY 1990 to 1,121,625 cy (Table 3). The remaining approximately 600,000 cy from DY 1990 will be disposed during DY 1991 and subsequent years.

Port Gardner

Most of the unconfined, open-water disposal which took place during DY 1990 was associated with the Port Gardner site. It received a total of 992,075 cy dredged material in DY 1990. Some 950,725 cy of material from the U.S. Navy Homeport project (Element I) were deposited in 581 dumps between November 1, 1989 and March 13, 1990. This constituted 96% of the site's use. An additional 41,350 cy of material from the DY 1989 Port of Everett Marina project was deposited in 80 dumps at the site between February 21, 1990 and March 14, 1990.

A single site use violation was noted during DY 1990. This violation involved the release of approximately 750 cy of dredged material from the Port of Everett Marina project outside of the target zone. However, the discharge occurred well within the Port Gardner disposal site boundary.

Elliott Bay

The other PSDDA disposal site used during DY 1990 was the Elliott Bay site, which received 129,550 cy. Material from maintenance dredging of the upper Duwamish River contributed 107,275 cy to the site. There were 69 barge loads from this project dumped at the site between February 28 and March 28, 1990. The maintenance dredging performed by the Duwamish Yacht Club contributed 22,275 cy (81 barges) between February 9 and March 23.

Comparison of DY 1989 and DY 1990

The total use of PSDDA sites increased from 6,090 cy in DY 1989 to 1,121,625 cy in DY 1990. However, without the Navy Homeport project volume and including one disposal during DY 1989 to an approved non-PSDDA site, the volume actually discharged to open-water disposal sites only increased from 144,400 cy in DY 1989 to 170,900 cy in DY 1990.

2.8 Upland Disposal Dredging Projects

To put into perspective the significance of the PSDDA program for characterization and management of dredged material in Puget Sound, it is first important to note that some dredged material is placed in upland sites for economic reasons (transport of small volumes of relatively clean dredged material to an unconfined, open-water disposal site is generally uneconomical).

PSDDA DISPOSAL SITE	PERMITTEE	VOLUME cy	BARGE LOADS	DISPOSAL DATES
Port Gardner	U.S. Navy Homeport	950,725	581	11/01/89 - 03/13/90
Port Gardner	Port of Everett *a*	41,350	80	02/21/90 - 03/14/90
Elliott Bay	Corps Duwamish O&M	107,275	69	02/28/90 - 03/28/90
Elliott Bay	Duwamish Yacht Club *a*	22,275	81	02/09/90 - 03/23/90
TOTAL VOLUME		**1,121,625**	790	11/01/89 - 03/28/90

Table 3. Dredged material disposal at PSDDA unconfined, open-water disposal sites during DY 1990 (16a).

a The Port of Everett and Duwamish Yacht Club projects were determined suitable for open-water disposal during DY 1989.

Other dredged material may be found suitable only for disposal at an approved confined/ upland disposal site because it failed the guidelines for disposal at a PSDDA site. Either or both reasons exist for any given project.

During DY 1990, approximately 78,925 cy of material was permitted for upland disposal (Table 4). While some of this material has yet to be dredged and disposed, this volume represents less than 5 percent of the total volume of dredged material tested under the PSDDA program and determined during the same period to be suitable for open-water disposal.

Most upland disposal projects involved maintenance dredging of small, private docks and marinas. The total DY 1990 volume of these small projects was 58,225 cy. Two projects, the Duwamish River Operations and Maintenance and Pope & Talbot, contributed the remaining 20,700 cy which failed the PSDDA disposal guidelines.

The volumes of dredged material cited in this section are based on permit records alone. Records on the exact volumes of materials dredged and placed at upland sites are not readily obtainable.

2.9 Other Sources of Sediment Quality Data

Ecology obtained several sources of Puget Sound sediment data other than the dredging projects listed in Section 2.1. These data sets are listed in Table 5 and included monitoring (ambient and disposal site), NPDES discharge compliance inspections, and special investigation reports.

It is beyond the scope of this document to summarize the findings of these reports. However, they contain data and other information that may be useful to permit applicants and others directly or indirectly involved in the PSDDA program. Information about the location of these data can be used to formulate appropriate sampling and testing requirements for proposed dredging projects.

Additionally, data from these sources were evaluated according to PSDDA QA/QC guidelines. Data meeting those guidelines were entered into SEDQUAL database and Ecology staff are currently in the process of examining what implications, if any, these data sets have for the recalculation of the PSDDA SLs/MLs. Any proposed changes to SLs will be presented as a separate Appendix C to this report.

2.10 Literature Review

One of the components of the MPAR is a review of technical literature published during the dredging year that may affect the PSDDA program. The DY 1989 MPAR summarized the pertinent literature published during the period January 1987 - March 1990. Thus, it covered most of DY 1990. Because of this, Ecology will continue its ongoing search for, and review of, pertinent literature for the period April 1990 through June 1991 and will present the results in the DY 1991 MPAR.

PROJECT NAME/APPLICANT	PERMIT VOLUME (CY)
Duwamish Operations and Maintenance/Corps	16,000 *a*
Weyerhaeuser Company	10,000
Bedford Properties	9,000
Salmon Bay Terminals	8,500
Sundt, Fred and Others	8,000
Daishowa America Company	6,775
Pope and Talbot	4,700 *a*
Lonestar Northwest	4,000
Barbee Mill Company, Inc.	2,000
Port of Port Angeles	2,000
Sundt, Fred	400
Barbee Mill Company, Inc.	200
Hanover, Jack	200
Robison, Merrill	125
Pierce County Public Works	100
Port of Skagit/Anacortes	75
Cossman, Theodore	50
Pearce, John	50
Salmon Bay Steel	50
Smith, Ray	50
Toiga, Richard	50
Total Upland Disposal Volume	**78,925**

Table 4. Upland disposal dredging projects permitted during DY 1990 (June 16, 1990 - June 15, 1991). Volumes all rounded to nearest 25 cubic yards (cy). The total does not include volume data from projects which have withdrawn permit applications for unconfined, open-water disposal. Volumes labelled with "*a*" were from the portions of projects which failed PSDDA guidelines.

DATA SOURCE	PROJECT AREA/LOCATION	CHEMISTRY/ BIOASSAY SAMPLES	REFERENCE
DY 1989 Dredging Projects	Urban Bays	48/27	4b
1989 PSAMP Monitoring	Puget Sound	50/50	12
METRO Studies	Elliott Bay METRO	54/8+	17,18
NPDES Inspections	Urban Bay Discharges	15/8	13
DY 1990 Dredging Projects	Urban Bays	99/73	4a
South Puget Sound Reconnaissance Study	South Puget Sound	12/24	19
1990 PSDDA Disposal Site Monitoring	Elliott Bay Port Gardner	26	11

Table 5. Other sources of sediment quality data for Puget Sound. These have been reviewed for admittance to Ecology's SEDQUAL database and recalculation of PSDDA SLs and MLs. Project, samples number and type (chemical and biological), and reference are shown.

CHAPTER 3

PSDDA DISPOSAL SITE CONDITIONS

Baseline studies of the PSDDA disposal sites located in central Puget Sound (Commencement Bay, Elliott Bay and Port Gardner sites) were conducted in 1988 (1). Baseline studies for the nondispersive PSDDA disposal sites in north and south Puget Sound (Bellingham Bay and Anderson Island sites) were conducted in 1989 (2). These studies described the physical, chemical and biological conditions at and around the sites prior to any actual disposal activity. The baseline conditions are used to evaluate the results of future environmental monitoring at the disposal sites. The need and requirements for nondispersive and dispersive monitoring disposal sites were set out in the PSDDA Management Plan Report (7,8).

Three of the PSDDA nondispersive sites did not require monitoring during DY 1990 because they received no dredged material: Anderson Island, Bellingham Bay, and Commencement Bay. Similarly, none of the PSDDA dispersive sites were used during DY 1990, so those sites were not monitored.

The PSDDA agencies conducted the first post-baseline monitorings of both the Elliott Bay and Port Gardner disposal sites during DY 1990. Additional baseline studies were also conducted at the Bellingham Bay site.

The remainder of this chapter summarizes for each individual disposal site active in DY 1990:

- the baseline conditions at the site;
- the results of 1990 monitoring to those conditions; and
- the site use anticipated during the upcoming dredging year.

3.1 Elliott Bay Disposal Site

Baseline Conditions (1)

Physical baseline studies revealed the potential presence of relict dredged material at three of nine on-site stations, an important fact for interpreting results of any future site monitoring.

Chemical baseline studies indicated that several PSDDA chemicals of concern exceeded SL values, including antimony, copper, lead, mercury, nickel, zinc, dibenzofuran, PAHs, and PCBs. All stations sampled during the baseline studies, both on-site and off-site, exceeded at least one of the PSDDA SL values. Mercury also exceeded the PSDDA ML value at two on-site stations. Tributyltin concentrations found at the Elliott Bay site also exceeded the PSDDA SL value established in 1989 (2).

None of the bioassay results exceeded the PSDDA biological disposal guidelines for nondispersive sites.

Site Use, Monitoring Results and Comparison to Baseline

The Elliott Bay disposal site received approximately 129,550 cy of dredged material during DY 1990 (Table 3). Although the PSDDA Managemnent Plans (7,8) require this disposal volume to trigger consideration of a "full" monitoring, the PSDDA agencies agreed that only a "partial" monitoring was warranted, based on the nature of the material placed at the site.

The partial monitoring addressed two questions as prescribed in the Management Plan (7,8):

- Did the deposited dredged material remain onsite?
- Did dredged material deposited onsite cause biological effects exceeding acceptable site management conditions?

The monitoring program's field investigation was conducted during the spring of 1990. Although the report is not yet final, the following results are not expected to change.

Physical Monitoring Results

SVPS results clearly indicated that all of the dredged material was deposited and remained within the site boundary (11). The thickest deposits of dredged material (9 to >17 cm) were found at the site's center and slightly to its southeast.

On-Site Chemistry Results

Only silver and zinc, in two sample replicates, and Total PCBs in one replicate, exceeded the SL. No sample replicate exceeded the ML, so it was concluded that surface sediment at the disposal site did not exceed disposal guidelines based on chemistry data.

On-Site Bioassay Results

Results of three bioassays performed on the single sample taken from the one on-site station (EBZ01) were compared against biological disposal guidelines. Neither the amphipod nor Microtox bioassays showed significant responses, and while the echinoderm bioassay indicated a statistically significant response (11), it did not exceed biological response guidelines for nondispersive sites.

The benchmark station EBB03 experienced failures for both the amphipod and the echinoderm bioassays. However, chemistry obtained during the baseline studies contained high levels of HPAHs and exhibited low benthic abundance, indicating this site has been, and probably continues to be, affected by other sources. This benchmark station is valuable because it provides information on the effects of sources in Elliott Bay that may influence the disposal site.

Perimeter Chemistry Results

PSDDA agencies agreed prior to monitoring to revise the perimeter station guideline values (see Chapter 4). This was done for two reasons. First, the original guideline values were set at 1.25 times the baseline value found at each given station because there was no knowledge of station variability. Subsequent sampling programs, however, noted a within-station chemical variability

that could easily exceed that factor for organic chemicals. Thus, natural sample variability was expected to cause some exceedances of baseline chemistry. Second, PSDDA guidance did not cover how to compare monitoring from a new perimeter station not sampled during baseline.

New guideline value factors for organic chemicals were developed and proposed for use by the PSDDA agencies on an interim basis (11). These guideline values were based on measures of the chemical variability observed among eleven triplicate monitoring samples. Using this approach, samples would be predicted to contain organic COCs no more than 1.47 times the baseline values due to variability. This interim perimeter chemistry guideline value for organic COCs accomodated the observed natural and laboratory variability.

When monitoring results were compared to the proposed interim guideline values, there were eleven samples which contained concentrations of PSDDA COCs above the guideline values. These included four organic COCs and two metal analytes:

- PCB-1260 (3 of 11 perimeter stations);
- bis(2-ethylhexyl)phthalate (2 stations);
- naphthalene (1 station);
- phenol (1 station);
- antimony (2 stations); and
- silver (1 station).

PSDDA agencies investigated and discussed these results. The average loading of COCs from the two sources of dredged material to the site was calculated (3). The mass load of contaminants from the source dredged material could not account for observed increases in perimeter station chemistry. In addition, field sample replicates that exceeded guideline values varied widely (for example, the concentration of PCB-1260 in two replicate samples from Elliott Bay station EBP01 were four times greater than the third replicate).

For these reasons, the PSDDA agencies concluded that perimeter station chemistry increases were not significant.

Future Site Use

The Lonestar Northwest project discharged approximately 1675 cy of dredged material to the Elliott Bay disposal site early in DY 1991. The U.S. Navy Manchester project is expected to put approximately 80,000 cy of additional dredged material at disposal site during DY 1991. This volume is insufficient to warrant a repeat monitoring.

3.2 Port Gardner Disposal Site

Baseline Conditions (1)

The sediments in and near the Port Gardner disposal site consist of clean, fine-grained material. There were no chemicals which exceeded ML values during baseline monitoring. Only nickel and diethylphthalate exceeded SL values.

Results of the amphipod bioassay test indicated that the PSDDA biological disposal guidelines (for nondispersive sites) were only exceeded at one benchmark station. This was also the station where the diethylphthalate SL value was exceeded. Benthic abundance was lower at this station, and the species composition was different from the other Port Gardner stations.

Some chemicals were detected in field tissue samples. Of the organics, only benzoic acid and phenol were detected. Metals were present in all samples, including arsenic concentrations which exceed human health disposal guidelines.

Site Use, Monitoring Results and Comparison to Baseline

The Port Gardner site received 992,075 cy of dredged material during DY 1990, nearly all from the Navy Homeport Everett Element I project. This volume necessitated conducting a "full" monitoring of the site (7,8), which was planned and carried out during the spring of 1990. Results are summarized below.

Physical Monitoring Results

Physical monitoring using SVPS commenced soon after cessation of DY 1990 disposal activities (April 1990). Results indicated that dredged material was present at 30 of the 65 SVPS stations. Seven stations outside the site boundary (four perimeter, one transect and two central cross stations) exhibited recent deposits, mainly to the north, west and southwest. Deposits at six of these stations exceeded the 3 cm trigger depth, requiring further review by PSDDA agencies.

An investigation was conducted to ascertain why this material was found off the site (10). This distribution was not the outcome predicted by original modeling performed to establish the original disposal site boundary (20). It was found that the same model, when run using actual sediment conventional data on the material dredged by the Navy and a 10 cm/sec tidal current velocity, predicted a 50% greater spread of dredged material, relative to their initial assumptions.

Thus, it appeared that the large volume of material coupled with tidal current and the dense nature of the silty material (high per cent solids content) was responsible for the unexpected pattern of deposition. Despite this, only an estimated 3.5% of the total volume was found outside the site boundary.

On-Site Chemistry Results

None of the PSDDA chemicals of concern measured at the five on-site stations exceeded the SL, indicating no exceedance of chemical disposal guidelines (MLs).

On-Site Bioassay Results

None of the on-site stations exhibited adverse effects; there were no bioassay failures. Nondispersive site disposal guidelines were therefore not exceeded.

One benchmark station, located outside the influence of the PSDDA disposal site, exhibited significant biological effects. Station PGB02 exceeded nondispersive guidelines for both the amphipod 10-day mortality test and the echinoderm test.

Perimeter Chemistry Results

Results of perimeter chemistry analyses indicated five stations exceeding the interim guideline values for antimony, bis(2-ethylhexyl)phthalate and zinc. As with the results for the Elliott Bay site, the exceedances were not considered significant because the calculated mass loading from the dredged Navy material, as performed for the Elliott Bay site, could not account for the uncertain increases in the three COCs at perimeter stations (3). Three of the five perimeter station exceedances occurred at stations shown not to have received any dredged material.

Off-Site Benthic Abundance

Benthic infaunal analyses demonstrated a decrease in the abundance of all major taxa and total abundance at Port Gardner transect stations and the benchmark station PGB01. Because the decreases in major taxa at the benchmark station were at least 50% of the decreases at transect stations, it was concluded that the changes probably reflect Puget Sound influences other than dredged material disposal (11).

Off-Site Bioaccumulation Analysis

To examine whether there were off-site biological effects as a result of Port Gardner disposals, bioaccumulation in *Molpadia* was measured. Results indicated that *Molpadia* had minimally bioaccumulated several of the PSDDA metals, including arsenic, cadmium, copper, lead, nickel, and zinc. A strict application of the PSDDA guidelines would thus result in concluding an increase has occurred in the chemical body burden of benthic infauna (11).

However, this conclusion could not be made with any certainty for two reasons. First, the pattern of bioaccumulation increased away from the site, indicating a source of metals other than the disposal site. Second, *Molpadia* body mass from the 1990 monitoring, an important determinant in the degree of chemical body burden, could not be compared to baseline bioaccumulation data because specimen size was not recorded during baseline investigations (11).

On-site Bioaccumulation.

In addition to investigating possible off-site biological effects by measuring bioaccumulation in *Molpadia*, the PSDDA agencies examined whether chemicals of concern to human health had the potential to bioaccumulate. This was done as a one-time affirmation of the human health assessment performed in the PSDDA Final Environmental Impact Statement (21) and in response to comments made by the Tulalip Tribe at the DY 1989 ARM (9).

Sediments from three on-site stations were composited into one test sediment sample and a 30-day bioaccumulation test was conducted using the deposit-feeding clam *Macoma nasuta*. Animals were also exposed to control and background sediments. Tissues from each experimental unit were analyzed for the chemicals of concern to human health. Although a few metals and organic compounds were observed in the tissues exposed to the test sediment, their concentrations were similar to those found in the tissues exposed to the control and reference sediments. None of the concentrations approached the PSDDA human health guidelines.

3.3 Bellingham Bay Site

The PSDDA agencies conducted additional baseline investigations of the site during DY 1990. The purposes of the investigations were to estimate natural population densities of the commercially important Dungeness crab (*Cancer magister*) and to measure baseline levels of bioaccumulation of contaminants in those crabs.

Population density of crabs was estimated from fifteen trawl samples collected at, adjacent and surrounding the site during April 1990 (22). Low densities were found at the site itself (7 crabs per hectare) and near the site (0-40 per hectare). Populations were most dense at 18 to 20 meters depth (28-221 crabs per hectare). The numbers and size distribution of crabs caught were similar to those reported in 1987 (22).

Bioaccumulation of various COCs (4 metals, several pesticides and Total PCBs) in both crab muscle and hepatopancreas tissue was measured for one composited on-site sample, four trawl samples taken near the site and one crab pot sample taken from near a suspected source of contaminants (22).

No tissue sample demonstrated bioaccumulation of Aldrin, DDD, DDT, Dieldrin, Heptachlor, Lindane or Total PCBs. The COCs which were detected in tissues (arsenic, cadmium, lead, mercury, Chlordane and DDE) were found at quite low levels. As might be expected, they were primarily found in the tissue having the greater lipid content: hepatopancreas.

Disposal Site Use

Following completion of baseline chemical and biological studies, a shoreline permit for the Bellingham Bay unconfined, open-water disposal site was issued on November 5, 1989. The Management Plan prescribed no monitoring of the Bellingham Bay site during DY 1990 because no dredged material was deposited at the site. No disposal of dredged material is anticipated to take place at the Bellingham Bay site during DY 1991 and so the site will not require monitoring.

3.4 DY 1991 Monitoring Requirements

Neither the Bellingham Bay nor the Commencement Bay sites were used during DY 1991. The PSDDA agencies did report that approximately 82,000 cy of dredged material was disposed at the Elliott Bay site, and 17,250 cy was disposed at the Port Gardner site. But, neither of the sites required monitoring in spring 1991. Only the Rosario Strait dispersive PSDDA site will be monitored in spring/summer 1991 as a result of dredged material disposal from the British Petroleum Oil and Swinomish Channel projects.

CHAPTER 4

POTENTIAL IMPLICATIONS TO THE PSDDA MANAGEMENT PLAN

One purpose of this Management Plan Assessment Report (MPAR) is to present topics which arose during DY 1990 (or earlier) that were discussed by the PSDDA agencies and may have implications to the PSDDA Management Plan. These topics warrant further discussion during the annual review process, either in this report and/or at the upcoming annual review meeting (ARM).

Depending on its nature, a discussion topic may be presented as a clarification or as one of two types of issue papers. A clarification is an adjustment to an existing PSDDA requirement which needs to be restated or clarified. DY 1990 clarifications are included in Appendix A of the MPAR. There is no formal presentation of a clarification at the ARM unless specifically requested. However, comments on a clarification may be submitted prior to or at the ARM.

The first type of issue paper is one which reports progress and/or presents the current status of an important ongoing area of work. The second type of issue paper is for any topic which proposes a significant change in a PSDDA requirement. For either type, issue papers address a topic whose importance is of sufficient magnitude to warrant a more extensive discussion at the ARM. An issue paper is usually included in the MPAR itself, thus allowing public review prior to the meeting. DY 1990 issue papers are provided in Appendix B, and will also presented orally at the ARM.

The topics for discussion in this Management Plan Assessment Report and/or at the Annual Review Meeting concern evaluation procedures (testing, disposal guidelines and/or data management), disposal site management (including environmental monitoring), and other related PSDDA program features. All topics considered during DY 1990 are discussed below.

4.1 Evaluation Procedures Topics

Sampling Guidelines

PSDDA requires certain dredging projects to conduct subsurface sampling and analysis of deep (for example, native) sediments (7,8). Sampling deep sediments by coring usually costs appreciably more than sampling shallower sediments. Because the potential for deep sediments to contain appreciable COCs is very low, and deep sediments are seldom found to exceed PSDDA SLs, the additional cost of sampling and analysis of deep sediemnts may not be justified.

The PSDDA agencies propose relaxing the requirement to always sample to the maximum depth of the dredging prism. A coordinated PSDDA agency decision to require less sampling will be made on a case-by-case basis where deep native sediments can be adequately documented.

This clarification to allow relaxing sampling and analysis of deep sediments appears in Appendix A of this report. It pertains especially to sampling sediments greater than 20 feet in depth.

Chemical Testing Guidelines

Container/Equipment Decontamination Guidelines

The PSDDA agencies sponsored a January 24, 1991 workshop, hosted by the Corps, to discuss laboratory analytical protocols, problems achieving adequately low limits of detection, and other measures of quality assurance, and streamlining permit processing.

One topic discussed was contamination and cross-contamination of PSDDA samples. Lab representatives cited the following evidence of such occurrences:

- high levels of certain COCs in method blanks;
- occasional unexpected occurrences in Puget Sound samples of acetone, methylene chloride and other COCs used as container cleaning solvents in the lab; and
- possible sample cross-contamination seen in the frequent detection of bis(2-ethylhexyl)phthalate.

At least one laboratory representative stated that PSEP/PSDDA protocols and/or guidelines allow substantial variation between labs in the methods used for cleaning containers or field equipment before or during sampling activities.

Although this topic may deserve more discussion in the future, the PSDDA agencies do not propose a clarification pertaining to equipment and container cleaning and decontamination at this time. Current protocols adequately address the topic.

Chemical Holding Times

The PSEP protocols do not provide guidance on acceptable holding times for unfrozen (4°C) sediments sampled for mercury, metals, total solids, total volatile solids and total organic carbon.

It was stated at the January 1991 workshop described above that samples collected for metals analysis other than mercury could be held at 4° C for six months with no negative implications.

The PSDDA agencies present this and other clarifications to other PSDDA-required chemical holding times in Appendix A of this report.

Measurement of Conservative Metals

The concentration of one or more conservative a metals, i.e., those which do not readily undergo major chemical or biological transformations in the environment, can be useful in determining the origin of soils or sediments. PSDDA agencies discussed the potential value of requiring analysis of one or more conservative metals, such as aluminum. Such data might aid in the interpretation of site monitoring results.

PSDDA agencies agreed to continue to examine the possible benefit and the associated cost of requiring the measurement of aluminum, for example, in routine dredged material and/or site environmental monitoring samples. No clarification is proposed at this time.

Conversion of Strong Acid Digest Method Values to Total Acid Digest Method Values

PSDDA has recommended use of the total acid digest (TAD) method for analyzing metals (8). However, some dredged material data are submitted using the strong acid digest (SAD) method, introducing some uncertainty in the application of disposal guidelines. The PSDDA agencies discussed the need and current ability to determine the quantitative relationship between the two methods so such analyses could be compared in the future.

The PSDDA agencies concluded that there is insufficient data to allow a reliable, direct comparison of TAD to SAD results at this time. As future data allow, the agencies will attempt to quantitatively determine the relationship described.

Selected Ion Monitoring (SIM) versus Gas Chromatography (GC) Methods

It was stated at the January 1991 PSDDA protocols and QA/QC workshop that dual column gas chromatographic methods may be more appropriate or sensitive for analysis of certain organic COCs than the SIM method. Consequently, laboratories will be encouraged to continue to use their professional expertise to select the most appropriate analytical methods to achieve limits of detection less than the SL (from among the accepted PSEP protocols). No clarification is prepared at this time.

PSDDA Requirements for Dioxins and Furans[5]

The high potency of some forms of dioxin (especially 2,3,7,8-tetrachlorinated dibenzo-p-dioxin (TCDD)) have made it a chemical contaminant of growing concern in many regulatory programs. EPA and Ecology are actively pursuing source control actions which may ultimately lead to eliminating by 1993 bleaching processes that create the compounds at the industrial sources.

PSDDA currently requires a laboratory bioaccumulation test and tissue analysis for dioxin when a dredging area could contain these compounds, that is, when the project is located "in the near vicinity of" the wastewater outfalls from chlorine bleaching "kraft" pulp mills or if there is other "reason to believe," that dioxins may be present in the sediment.

As a result of the DY 1989 annual review process, PSDDA agencies were requested to better define "in the near vicinity of" and "reason to believe" or more specifically when they would require dioxin sampling and analysis. It was agreed that PSDDA agencies would:

- keep abreast of regional and national developments in testing for dioxin;
- closely coordinate with each other and other Pacific Northwest groups on dioxin-related activities and projects (e.g., Columbia River and Grays Harbor management planning);

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[5] "dioxin" will herein be used to refer to both polychlorinated dibenzodioxins and polychlorinated dibenzofurans.

- seek staff training on ecological and human health risk assessments involving dioxin; and
- consider sponsoring a technical workshop to discuss "state-of-the-art" knowledge of dioxin in the environment.

Since the DY 1989 ARM, PSDDA agencies have remained in close communication on topics related to dioxin, coordinated on projects which involve dioxin issues, continued work on dioxin source control strategies, held an interagency workshop on dioxin risk assessment, and conducted health risk assessments involving dioxin.

Ecology is currently conducting a modeling analysis which will estimate the areal extent of detectable dioxin contamination of sediments "in the vicinity of" a known source in Everett, Washington. The Corps is assisting in this work by conducting hydraulic modeling for the source area of concern. Both of these efforts attempt to address the need to define when the PSDDA Management Plan should require dioxin sampling and testing.

PSDDA agencies will review at the ARM what progress was made during DY 1990 on the topics related to dioxin in the environment discussed above. These include efforts to:

- identify sources of dioxin;
- reassess the toxicity and bioaccumulation potential of dioxin;
- identify the routinely achievable limits of detection for dioxin in sediments together with the precision and costs of the analysis;
- alternative approaches to assessing human and environmental risk associated with dioxin in dredged material and tissues; and
- the relationship between those approaches to other ongoing dioxin control strategies.

PSDDA Chemical Quality Assurance Limits

The Corps closely examined the chemical quality assurance for the PSDDA program during DY 1990. As a result, several clarifications to PSDDA analytical warning and action limits were put forward at the January 1991 protocols and process workshop. These included minor revisions to the limits associated with analytical precision (measured as relative percent difference), matrix and surrogate spike, and recovery of certified reference materials. For example, one recommendation was to change the PSDDA warning limit for recovery of VOCs from a surrogate spike sample from 50% to 85%. These clarifications are discussed in more detail in Appendix A. PSDDA agencies will adopt some or all of these clarifications, depending on comments received in the current annual review process.

Carbon Normalization of the Bioaccumulation Trigger for PCB

When normalizing the measured concentration of any COC to the total organic carbon (TOC) content of a sample, the normalized concentration becomes larger as sample TOC decreases. Samples containing very low organic carbon can more easily exceed the PSDDA carbon-normalized bioaccumulation trigger (BT) level for Total PCBs even when PCB concentrations are below SL values and below detection levels. This occurred for several samples from the DY 1990 METRO West Point Emergency By-pass project.

The PSDDA agencies discussed one solution to this difficulty: to allow best professional

judgement in reviewing data from samples containing less than 0.5 ppm Total Organic Carbon. However, it was decided that more information, and perhaps bioaccumulation data, were needed before all options could be properly evaluated and one could be recommended.

Biological Testing

Bioassay Sediment Holding Times

There have been instances of bioassay test samples being held slightly beyond the maximum 6 week time allowed under current PSDDA guidelines. PSDDA agencies will consider formally allowing up to eight weeks holding time, with the applicant's understanding that the longer holding time increases the chance of test failure due to the potential for increased toxicity. This clarification is made in Appendix A.

Bioassay Reference Area Samples

A key concern related to conducting PSDDA biological tests is the identification of suitable reference sediments. Reference sediments need to be accessible for sampling, be of a similar grain size, and contain no or low concentrations of chemicals of concern or other parameters such as ammonia and/or sulfides which might interfere with the bioassays. While PSDDA agencies have identified general areas (i.e., bays) where reference sediment may be found, specific station location, grain size, and chemical characterization data are either missing, not consolidated or not readily available. This can result in a poor match between reference and test sediments, inappropriately affecting bioassay test results.

Various reports have compiled available data on potential reference areas in the Puget Sound. Based on these results, EPA and Ecology, through the Puget Sound Estuary Program, undertook a field study to fill key data gaps for selected reference areas. When the study is completed, PSDDA agencies also could use the results to develop and improve general performance standards (maximum chemical concentrations and bioassay responses) for Puget Sound reference areas. Better characterization of Puget Sound reference areas and presentation of resulting data in readily usable format would likely improve routine performance of the PSDDA bioassays.

As a result of the DY 1989 ARM, Ecology agreed to:

- continue work on characterizing reference areas;
- continue investigating the potential for creating an artificial but grain size-matched reference sediment by mixing two sediment samples from known and acceptable reference areas;
- complete the ongoing reference area study discussed above; and
- consider convening a reference area workshop to present results and discuss their ramifications.

Ecology did not convene a reference area workshop in DY 1990 because the results of the reference area study initiated in DY 1990 will only become available in April, 1991. A PSDDA representative will present a status report at the upcoming ARM on results of the reference area study, and the need for convening a workshop focusing on reference areas and performance standards at the upcoming ARM.

Aeration of Bioassay Test Containers

PSDDA agencies have sometimes observed high mortalities in the reference samples of sediment larval bioassays. This effect has most often been ascribed to the presence of very fine grained sediments or to the toxic effects of sediment conventionals such as high ammonia or sulfides content of the test container. The PSDDA agencies present in Appendix A a clarification to the sediment larval bioassay interpretive guidelines which allows best professional judgement to determine if and when test containers should be lightly aerated.

Reburial Data Collection for the Amphipod 10-Day Mortality Bioassay

The endpoint for the amphipod 10-day mortality test in PSDDA is the number of dead organisms after a ten day exposure. The amphipod bioassay in the revised PSEP protocols also specifies use of a "non-reburial" endpoint. As a result, the PSDDA agencies will require collection of data on the number of amphipods in each bioassay chamber which fail to rebury within one hour of test termination. This will help the agencies to remain consistent with new PSEP protocols. It will also enable the agencies to evaluate which test endpoint is best. The evaluation will be one topic in the work plan addressing PSDDA bioassay performance (see below and Appendix B).

Echinoderm Embryo Sediment Bioassay Protocols

The PSDDA agencies sponsored a sediment bioassay workshop in July 1990 which was hosted by the Corps. The agencies learned of several minor clarifications to the echinoderm sediment bioassay which were needed. Clarifications were recommended for test temperature (15° C), duration (at least 48 hours), interpretive endpoint (when at least 90% of the the pluteus larvae are well developed), and termination protocol. These are presented in Appendix A.

Technical Review of Dredged Material Bioassays

At the time of program implementation, the PSDDA agencies agreed to conduct a technical review of the PSDDA bioassay requirements after several years of experience had been obtained in their application to dredging projects. The purpose of the review is to assess bioassay performance, to revisit the suitability of the bioassays for evaluation of potential dredged material effects at unconfined open-water disposal sites, and to determine the need for any changes in program biological testing requirements.

At the DY 1989 ARM, the PSDDA agencies agreed to conduct this review in preparation for the DY 1990 ARM. In response to public requests heard at the DY 1989 ARM, the PSDDA agencies sponsored the July 1990 Bioassay Workshop. The workshop provided regional testing laboratories with detailed instructions regarding PSDDA modifications to bioassay testing requirements. The labs were also provided with an opportunity to identify other bioassay performance issues.

To ensure that the results of the bioassay improvements and workshops are considered prior to making substantial changes to program requirements, the PSDDA agencies agreed to extend the technical review through 1991. This will allow time for additional bioassay results using the modified requirements to be included in the review.

The process for the ongoing technical review and the issues to be addressed for each bioassay are described in a DY 1990 issue paper contained in Appendix B.

Technical Review of the *Neanthes* Biomass Test

The PSDDA program has relied on several bioassays which measure acute toxicity to assess biological effects in sediments (7,8). The program has heretofore not adopted the use of a chronic effects test because none have been considered adequately developed.

However, more recent studies to develop a *Neanthes* biomass test protocol, to research the relation between juvenile growth and long-term reproductive success, and to assess best interpretive guidelines for the test have indicated that the test has a high potential for successfully evaluating the chronic effects of dredged material disposal.

As a result of the DY 1989 ARM, PSDDA agencies agreed that they would:

- summarize technical research findings
- convene a meeting to determine the scope of remaining research needs;
- arrange for that research to be conducted by the end of 1990;
- sponsor a panel or workshop for experts to discuss research results and options for interpretation; and
- present a status report on progress at the DY 1990 ARM.

During DY 1989, the PSDDA agencies reviewed the technical findings related to the Neanthes growth test and its potential for future use in the PSDDA program. Although few technical questions remained unresolved, the PSDDA agency interpretations of test results for regulatory decision-making require more discussion.

A work plan was recently proposed as a means to resolve all remaining issues related to adopting the *Neanthes* biomass test as a PSDDA bioassay. This work plan is presented in Appendix B of this report. Briefly, it includes:

- a review of technical requirements of the test, including:
  - a summary of the recent research,
  - the validity/repeatability of the test,
  - the interpretation of test results, and
- a process by which the agencies will decide on whether and how the test could be incorporated into PSDDA program.

PSDDA agencies will summarize at the upcoming ARM the results of previous studies, results of final research projects related to technical issues, and their assessment of any remaining field experience needs. The agencies will also present a time schedule for completing the work plan objectives and the PSDDA agencies' commitment to adopt an improved method for the evaluation of chronic/sublethal effects of dredged material disposal by the DY 1991 ARM.

Regulatory Review of Bioassays

The PSDDA agencies have agreed to undertake a programmatic review of the regulatory bioassay tests and biological disposal guidelines used by the PSDDA program. The main purpose of this review is to update the existing regulatory framework by integrating recent technical findings on bioassay testing methods and incorporating improvements to PSDDA evaluation procedures to better assess potential chronic/sublethal effects of dredged material disposal.

The issues to be addressed during this regulatory review, and the proposed review process, are summarized in an issue paper presented in Appendix B.

Disposal Guidelines

Changes to the PSDDA Screening and Maximum Level (SL/ML) Values

The PSDDA Management Plan requires an annual reevaluation of numerical sediment quality values (SLs/MLs). To this end, analytical results from dredging projects during DY 1989 and DY 1990 which required both sediment chemistry and biological testing were reviewed for adherence to additional PSDDA quality assurance/control (QA/QC) requirements[6]. Additional projects and sources of data which contained both types of data were also checked for appropriate QA/QC. These sources of sediment quality data are listed in Table 5.

Projects which resulted in either chemical or biological data, but not both, were assigned lesser priority because they would not contribute to a recalculation of SLs/MLs. These data are currently under QA/QC review and will be added to the database, as appropriate.

The results of sediment quality value recalculations will be presented in a Appendix C of this report. It will contain:

- the results of quality assurance review of newer data sets;
- a summary of the data admitted to the SEDQUAL database;
- methods for recalculating PSDDA SLs/MLs;
- recommendations for changes to SLs/MLs (if any); and
- the associated predictive reliabilities.

This will be a separate appendix. If PSDDA agencies propose new sediment quality values, Appendix C will be distributed to interested persons in advance of the ARM. If no changes are proposed, the appendix will be made available at the ARM itself.

Reanalysis of Specific Chemical Screening Levels.

Some laboratories that test Puget Sound dredged material during both DY 1989 and DY 1990 found that for some samples of dredged material it was difficult to detect certain organic COCs

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[6] PSDDA requires a strict level of data quality assurance for regulatory suitability decision-making ("QA1") and additional QA ("QA2") for calculating sediment quality values.

at levels below the PSSDA SL value. For this reason, PSDDA agencies were requested at the January 1991 protocol/process workshop to consider raising the SL for selected PSDDA COCs.

The six COCs suggested by DY 1990 project data, include 1,2,4-trichlorobenzene, 2-methylphenol, 2,4-dimethylphenol, benzoic acid, benzyl alcohol, and nitrosodiphenylamine. The review will be based on apparent analytical capabilities of surveyed laboratories and the relative reliability of the current versus the proposed SLs. Results of this review will also presented in Appendix C of this report, bound separately, and described at the upcoming ARM.

Data Management

PSDDA Quality Assurance/Control Data Submittals

Few DY 1990 dredgers submitted all the data required by PSDDA for Ecology's data quality assurance review ("QA2") (25). These include, for example, a portion of the individual chromatographic results from organic analyses. The QA2 data are required in addition to those required for making decisions on the suitability of dredged material for disposal at a PSDDA site. (The latter data were required to be submitted on standard LOTUS spreadsheets as a result of a DY 1989 ARM clarification.)

The PSDDA agencies clarify in Appendix A the existing requirement for the submittal of QA2 data. This will be accomplished by including the QA2 data along with those submitted to the Corps, who will then relay them to Ecology.

4.2 Disposal Site Management Topics

Environmental Monitoring

Accelerated SVPS Site Monitoring

The team responsible for the 1990 Site Monitoring recommended that an accelerated schedule for SVPS sampling be adopted. SVPS sampling should occur as soon as possible after the cessation of dredged material disposal each spring, instead of being simultaneous with other sampling. This would minimize the degree to which bioturbation of surficial dredged material could obscure monitoring results.

The PSDDA agencies make this clarification to environmental monitoring guidelines in Appendix A.

Recommended Changes to Benchmark Station

The Port Gardner disposal site benchmark station PGB02 was found to have grain size characteristics different from those near the site itself. In addition to this fine grained material, both ammonia and sulfide may have contributed to bioassay failures. The benthic communities also differed from those found on-site.

The PSDDA agencies agreed on the need to replace station PGB02. A new benchmark station

is needed near to the Port Gardner disposal site but beyond the influence of any dredged material discharged at the site.

Efforts are now underway to sample and analyze potential benchmark sediments prior to June 15, 1991, the onset of the 1992 DY. The agencies detail this need and effort in a clarification to the environmental monitoring guidelines contained in Appendix A.

Chemical Analyses at Benchmark Stations

The original environmental monitoring program called for archiving benchmark station samples for subsequent chemical analysis.

PSDDA agencies propose that, in the future, sediments collected for analysis of sulfides and volatile organic compounds will be analyzed immediately instead of being archived. This proposal is made in Appendix A as a clarification to the environmental monitoring guidelines.

Measurement of Acid Volatile Sulfides

The toxicity of certain metal species in soils or sediments has been successfully related to the presence and concentration of acid volatile sulfides (AVS). Others have used AVS data to improve the ability of co-occurring metals data to predict biological effects.
AVS analyses were performed during the 1990 monitoring program at all stations where biological analyses were conducted and there may be utility in collecting AVS data for future disposal site monitoring and/or routine samples of dredged material.

The PSDDA agencies agreed to measure AVS in future monitoring efforts. However, they also agreed to follow for another dredging year the research on the significance of this chemical species, the methods for its measurement, its incremental analytical cost and potential benefit to predicting the biological effects measured by the PSDDA bioassays.

Disposal Site Monitoring Issues Work Plan

As a result of the 1990 Site Monitoring Report, numerous issues have arisen which the PSDDA agencies have agreed to examine in detail over the course of the next one or more dredging years. The issues fall into the following three categories.

- Interpretation of perimeter chemistry data.
- How to best interpret benthic community data.
- Bioaccumulation measurement and interpretation.

The first issue area will examine:

- newly proposed perimeter station chemistry guidelines;
- field variability and the analytical chemistry limits of quantitation; and
- the weight-of evidence approach to PSDDA (monitoring) sample/data collection strategy and interpretation as opposed to an approach based more on statistical significance.

The PSDDA agencies present in Appendix B a PSDDA interagency work plan and schedule for reaching consensus on monitoring plan issues. PSDDA agencies will then propose any resulting changes as individual issue papers at the DY 1991 ARM.

Site Use Guidelines

The 1990 monitoring of both the Elliott Bay and Port Gardner disposal sites was summarized in Chapter 3. As a result of monitoring findings, the PSDDA agencies will recommend minor changes to disposal site use practices to ensure that all dredged material discharged at the site remains within the designated disposal area. For the Port Gardner site:

- all disposal will be required to occur at the center of the site; and
- a review of the physical characteristics of the dredged material will be required prior to disposal.

For the Elliott Bay site, all material will be discharged in the center of the southern quadrant of the target area which is located in the disposal zone. New positioning coordinates will be:

- 47°35.92′ N x 122°21.38′ W (1927 North American Datum); or
- 47°35.91′ N x 122°21.45′ W (1983 North American Datum).

The PSDDA agencies make these clarifications in Appendix A.

4.3 Other PSDDA Program Topics

Laboratory Accreditation

Ecology presented during the DY 1989 ARM a summary of:

- o the legal authority to establish a laboratory accreditation program (RCW 43.21A.230 (1987));
- o the purpose in establishing such a program;
- o the state rules which establish such a program;
- o the early progress in program implementation; and
- o how the accreditation program affects the PSDDA program and dredging projects.

A handout was also provided which outlined an approach to phasing in lab accreditation for labs performing analyses for PSDDA projects.

Since the DY 1989 ARM, the lab accreditation program made great progress. Most commercial labs were accredited for water chemistry analyses. However, labs were only accredited for water and not sediment chemistry analyses. Ecology will therefore extended its interim deadlines for accreditation as outlined below and will facilitate this process with a special mailing targeted for April, just prior to the DY 1990 ARM. The new deadlines are described in Appendix A.

PSDDA User Manual Update

The PSDDA Management Plans (7,8) called for Ecology to prepare a "User's Manual" in cooperation with the other PSDDA agencies. The User's Manual is to describe all current PSDDA requirements and procedures, and serves as a comprehensive guide for regulators and dredging project proponents. The final manual will allow for easy update in response to revisions to the PSDDA Management Plan.

Since the DY 1989 ARM, a second draft of the "PSDDA User's Manual" was reviewed by PSDDA agency staff and then revised. A third or "working" draft will be available at the ARM and subsequently mailed to regulators, dredgers and other users. Ecology will request critical review of the manual at that time.

Biennial Reporting and Annual Review Meeting Schedule

PSDDA agencies discussed during DY 1990 the need to reconsider the number and format of the PSDDA annual reports, as well as the frequency and format of the annual review meetings. It was suggested that three annual reports could serve to present the same information now presented in seven (see Chapter 1, Section 1.2).

PSDDA agencies have suggested that major program review meetings be held every two years with briefer meetings, designed mainly as forums to make clarifications or exchange information, in alternate years. Because the reports and ARMs have been fairly well established, and project proponents have become accustomed to their frequency and timing, the agencies will present their reasons for these changes in Appendix B of this report and also discuss this issue at the upcoming ARM.

EPA/Corps Ocean Disposal Guidance Manual Status

EPA and the Corps published national guidance for dredged material evaluation relative to disposal in ocean waters. The guidance includes a tiered testing approach that is very similar to the approach used in the PSDDA evaluation procedures.

The EPA will present a brief report on the status of the national guidance and any implications to the PSDDA Management Plan.

PSDDA and the Sediment Management Standards

During DY 1990, Ecology was developing a new state rule establishing sediment quality standards and addressing the application of these standards to source control (e.g., wastewater discharge permits) and sediment cleanup programs. Under the current schedule, the Sediment Management Standards (SMS) rule will become legally effective prior to the May 1991 PSDDA Annual Review Meeting.

The SMS rule will establish procedures and environmental criteria that are generally applicable to all sediments, as well as to dredging activities. However, the rule as proposed explicitly recognizes established dredged material management programs, including PSDDA, and defers

specific technical requirements to these established programs. It also requires coordination with other federal and state agencies when establishing requirements for dredging actions.

The PSDDA agencies have discussed the eventual application of the SMS rule to the PSDDA disposal sites and to dredging activities. Ecology will use a combination of water quality certifications and administrative orders under state water quality laws to implement the new rule.

The approved PSDDA disposal sites will be recognized under the new rule via issuance of administrative orders by Ecology. These orders will incorporate the currently established PSDDA evaluation procedures and disposal site management requirements. Consequently, the SMS rule will not conflict with, or alter, any of the PSDDA program requirements.

For other dredging and dredged material disposal actions, the SMS rule would be applicable in cases where the dredging action exposes buried contaminated sediments to surface waters, or where the dredging or disposal action redistributes contaminated sediments to cleaner areas. For these cases, Ecology would establish appropriate requirements via the project-specific water quality certification. The SMS rule will also establish standards for the quality of capping sediments to be used in confined aquatic disposal projects.
Chemical and biological testing requirements in the SMS rule are similar, though not identical, to those used in the PSDDA program. Most of the differences are associated with different interpretations of sediment bioassay tests. As part of the upcoming program review of the PSDDA regulatory bioassays (Appendix B), the PSDDA agencies will review these SMS rule features to determine if any changes to the PSDDA program are appropriate. If needed, these PSDDA program changes could be made during the annual review process in early 1992.

CHAPTER 5

RECOMMENDATIONS AND CONCLUSIONS

This chapter lists those topics presented in Chapter 4 which clarify program requirements or are recommended for more extensive presentation and discussion at the annual review meeting. Concluding observations on Dredging Year 1990, the second year of PSDDA implementation, are also provided.

As stated in Chapter 1, the PSDDA annual review process and meeting encourage public comment on any topic identified in this report. The public is also invited to identify any other topic that could possibly result in improvements to the PSDDA Management Plan.

5.1 Recommendations

As discussed in Chapter 4, the PSDDA agencies have prepared program clarifications on the following topics:

- Subsurface Sampling Requirements
- Environmental Lab Accreditation
- Changes to Chemical Holding Times
- Submittal of Quality Assurance Data
- PSDDA Analytical Chemistry Warning/Action Limits
- Aeration of Bioassay Test Beakers
- Collection of Reburial Data for the Amphipod Test
- Sediment Echinoderm Testing Protocols
- Clarifications of Environmental Monitoring Requirements, including
  - Accelerated SVPS Sampling of Disposal Sites
  - Establishing a New Port Gardner Benchmark Station
  - Analysis of VOCs and Sulfides before Archiving Benchmark Samples
  - Analysis of Acid Volatile Sulfides in Site Monitoring Samples
- Adjustments to Disposal Site Management for Port Gardner and Elliott Bays

These clarification papers are included as Appendix A of this report.

PSDDA agencies prepared Issue Papers with detailed proposals for changes to the Management Plan covering the following topics:

- PSDDA Program Review Reports and Meetings
- PSDDA Bioassay Holding Times
- Technical Review of Dredged Material Bioassays
- Technical Review of the *Neanthes* Biomass Test
- Regulatory Review of Bioassays
- Disposal Site Monitoring Review Work Plan

These issue papers appear in Appendix B of this report.

Also at the upcoming ARM, the PSDDA agencies will present the status of ongoing work for the following topics:

- Results of SL and ML Recalculations
- Dioxin: PSDDA Agency Findings and Process
- Results of the Reference Area Study
- Results of DY 1990 Disposal Site Monitoring
- Status of the Ocean Disposal Guidance Manual
- Application of Sediment Management Standards to the PSDDA Program

5.2 Conclusions

During DY 1990, the PSDDA agency staff have successfully expanded their program activities to encompass additional project review, increased compliance activities, continued refinement of program requirements, educational workshops with testing laboratories, and varied disposal site monitoring events. Despite the diversity of tasks, the PSDDA program is functioning smoothly and as designed in the Management Plan.

PSDDA program activities during DY 1990 were largely focused on environmental monitoring of two of the PSDDA disposal sites. These monitoring activities represented the first "partial" and "full" monitoring events conducted at the PSDDA sites. PSDDA agencies spent much time and effort evaluating the monitoring results and discussing program adjustments warranted by these results.

Experience gained through physical monitoring at the Port Gardner site will result in even closer PSDDA agency scrutiny of disposal requirements for future large projects. Requirements for release of dredged material at the Port Gardner and Elliott Bay sites (within the optimal "target zone") were also adjusted to ensure that material is deposited within the disposal site boundaries.

The chemical and biological monitoring requirements will undergo some minor program refinements. The PSDDA agencies are evaluating the need to collect additional baseline monitoring information at the nondispersive sites (stations unaffected by dredged material). This effort will ensure future interpretability of the environmental monitoring data. During the coming year, the PSDDA agencies will also undertake a broader review of the methods and guidelines used in the environmental monitoring program to address technical observations resulting from the DY 1990 monitoring (Appendix B).

Implementation of the PSDDA program continues to be a human resource-intensive activity for the PSDDA agencies. Day-to-day management of dredging projects includes review of applications, evaluation of dredged material testing requirements and results, data management and inspections to ensure permit compliance. In addition to these responsibilities, PSDDA program requirements to address ongoing issues (e.g., development of improved tests) and to prepare annual reports are now combined with the need to assess and respond to the results of disposal site environmental monitoring.

To ensure optimum use of available resources, the PSDDA agencies are evaluating program

changes (Appendix B) in the annual reporting schedule contained in the PSDDA Management Plans (1,2). The shift to biennial reporting for some aspects of the program should allow better dedication of resources to program services. To ensure better progress in resolving key ongoing program refinement issues (e.g., assessment of chronic/sublethal effects), more detailed and date-specific work plans are proposed.

The PSDDA agencies, and in particular the Corps, have dedicated substantial effort to the disciplined implementation of the PSDDA quality assurance program. Through the development and application of standard reporting formats, and by conducting several laboratory practitioner workshops, the PSDDA agencies have obtained improvements in laboratory performance and in the quality of guidance provided by the agencies to the labs. While improved, the agencies have agreed that persistent quality assurance/quality control issues with reported dredged material testing data will merit continued outreach and communication with dredging applicants and testing laboratories.

During DY 1990, federal and state agency cooperation and consensus management remained the trademarks of the PSDDA program. As issues surfaced and program demands peaked, the agency staff worked together to ensure consistent execution of regulatory services, while ensuring the underlying protection of human health and the environment.

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Appendix A

PSDDA Annual Review

Clarifications for Dredged Material Management Year 1990

CLARIFICATION

MODIFICATIONS TO SAMPLING REQUIREMENTS FOR DEEP NATIVE SEDIMENTS

Prepared by David Fox (Corps, 206/764-3768) for PSDDA agencies.

INTRODUCTION

PSDDA provides guidelines for calculating the number of field samples and laboratory analyses which must be used in the characterization of proposed dredged material. These guidelines are based on the project area ranking and volumes of surface (0-4 feet) and subsurface (>4 feet) material to be dredged.

PROBLEM IDENTIFICATION

Under current PSDDA guidelines, the entire volume of material to be dredged is included in calculating the number of field samples and laboratory analyses required. This includes deep sediments in native soils. The problem is that sampling costs for deep sediments may be appreciably higher than those associated with shallower sediments. In the case of deep native sediments, the potential for chemicals of concern to be present is very low and the additional cost associated with sampling deep sediments seems unjustified. Unnecessary costs associated with PSDDA testing must be controlled to maintain the purpose and viability of the PSDDA process.

PROPOSED CLARIFICATION

At the second PSDDA annual review meeting it was determined that for native materials best professional judgement should be applied in determining the number of samples and analyses to be required. When the existence of large volumes of native material could be substantiated through exploratory testing or from site-specific historical dredging records, then testing requirements could be relaxed.

Volumes of native material could be substantiated through exploratory testing or from site-specific historical dredging records, then testing requirements could be relaxed. It is proposed that on a case-by-case basis, where deep native sediments exist and can be similarly substantiated, the requirement to sample to the maximum depth of the dredging prism may be relaxed by a collective decision of the PSDDA agencies after applying and documenting best professional judgment considerations.

CLARIFICATION

ENVIRONMENTAL LABORATORY ACCREDITATION

Prepared by Tor Gries (Ecology, 206/459-7706) for the PSDDA agencies.

INTRODUCTION

Ecology presented at the DY 1989 Annual Review Meeting a summary of:

- o the legal authority to establish a laboratory accreditation program (RCW 43.21A.230 (1987));
- o the purpose in establishing such a program;
- o the state rules which establish such a program;
- o the early progress in program implementation; and
- o how the accreditation program affects the PSDDA program and dredging projects.

A handout was also provided at the DY 1989 ARM which outlined a phased approach to lab accreditation for those labs performing analyses for PSDDA projects.

PROBLEM IDENTIFICATION

The lab accreditation program has made great progress since the DY 1989 ARM. Most commercial labs were accredited for water chemistry analyses. A few were accredited for various bioassay methodologies. Approximately 40 additional labs submitted applications for accreditation and a similar number of others were sent accreditation applications but have yet to return them. All told, it appeared Ecology will eventually accredit several hundred labs.

However, labs were only accredited for water chemistry analyses. While most of the labs performing analyses for PSDDA projects were accredited before the January 1, 1991 interim deadline proposed at the DY 1989 ARM, they did not specify and so were not accredited for PSEP/PSDDA-accepted sediment chemical or bioassay methods.

PROPOSED CLARIFICATION

Ecology therefore will extend the interim deadlines for accreditation as outlined below.

> By July 1, 1991, labs must resubmit their applications for accreditation, as already required by rule. Labs should state that their analyses include sediments/dredged material and specify the PSEP/PSDDA protocols for which they desire accreditation.

By January 1, 1992, all labs conducting analyses for the PSDDA program, and submitting results to Ecology via the Corps, will be required to be accredited for appropriate PSEP/PSDDA protocols prior to sampling and analysis plan approval. (This requirement will not affect sampling plans approved before January 1, 1992.)

Ecology is prepared to facilitate the sediment methods accreditation process with a special mailing targeted for April, just prior to the DY 1990 ARM.

CLARIFICATION

MODIFICATIONS TO HOLDING TIMES FOR PSDDA CHEMICAL ANALYSES.

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

INTRODUCTION

PSDDA chemical analyses must be performed within specified time limits. These time limits are called "holding times" and have been established to ensure that chemical testing results reflect the in-situ conditions at the dredging site. Natural processes, such as oxidation, biological degradation, speciation and volatilization, can alter the chemical composition of a sediment if proper storage conditions and holding times are not met.

PROBLEM IDENTIFICATION

The Puget Sound Estuary Program (PSEP) protocols for sediment storage conditions and holding times have been used by PSDDA since implementation. The PSEP protocols are a combination of EPA guidelines and suggested guidelines in those cases where no EPA guidance exists. Attachment 1 includes current PSEP guidelines. These guidelines are provided to dredging applicants and become part of their sampling and analysis plans (SAP).

The problem is that in many cases the PSEP protocols suggest holding times frozen at -18°C for certain chemical groups. For example, semivolatiles may be stored for one year at this temperature, and metals may be stored for 2 years. In reality, most, if not all, sediments have been delivered to testing laboratories on ice, but unfrozen. Laboratories do not routinely freeze sediment samples due to lack of freezer space and the difficulties involved with having to thaw frozen sediments before analysis. Reports from dredging consultants and investigations by PSDDA agencies have corroborated the lack of freezer space with documentable -18°C capacity. The PSEP protocols do not give any guidance relative to holding times for unfrozen (4°C) sediment samples for mercury, metals, total solids, total volatile solids and total organic carbon analyses.

The reality of current practices must be resolved with the need for proper storage conditions and holding times. This issue was raised at the PSDDA QA/QC workshop held on January 24, 1991. A practical set of guidelines which also protects the chemical integrity of sediment samples needs to be adopted.

PROPOSED CLARIFICATION

Attachment 1 includes recommended holding times for chemical analysis of unfrozen sediments which are practicable for use in the PSDDA program and as consistent as possible with the limited guidance provided in the PSEP protocols. Since several analytes or groups of analytes have holding times of seven days specified in PSEP for unfrozen sediment, and since laboratories are already processing sediments within that time, it seems reasonable to adopt seven days for other analytes when no other guidance is available. This would include mercury, total solids, total volatile solids and total organic carbon. For metals, other than mercury, the general

consensus at the PSDDA QA/QC January 1991 workshop was that a holding time of six months at 4°C should not be a problem. All other holding times specified by PSEP would be retained. The holding times included in Attachment 1 will be adopted for use by PSDDA.

Attachment 1. PSEP and PSDDA recommended holding times.

Variable	Container	Puget Sound Estuary Program		Recommended PSDDA Guidelines	
		Holding Time at 4 degrees C	Holding Time at -18 degrees C	Holding Time at 4 degrees C	Holding Time at -18 degrees C
Metals (except mercury)	P,G	no guidance	2 years	6 months	2 years
Mercury	P,G	no guidance	28 days	7 days	28 days
Semivolatiles, Pesticides and PCBs	G	7 days (1)	1 year (1)	7 days	1 year (1)
Volatiles	G	14 days	not applicable (2)	14 days	not applicable (2)
Particle Size	P,G	6 months	not recommended (3)	6 months	not recommended (3)
Total Solids, Total Volatile Solids and Total Organic Carbon	P,G	no guidance	6 months	7 days	6 months
Total Sulfides	P,G	7 days	not applicable	7 days	not applicable
Ammonia	P,G	7 days	not applicable	7 days	not applicable

(1) until extraction; extracts must be processed within 40 days.

(2) freezing these samples will likely cause breakage of the sample container because no airspace for expansion is provided.

(3) samples must not be frozen or dried prior to analysis, as either process may change the particle size distribution.

CLARIFICATION

MODIFICATIONS TO THE CHEMICAL TESTING QUALITY ASSURANCE GUIDELINES

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

INTRODUCTION

Chemical data submitted to characterize dredged material proposed for open-water disposal at a PSDDA site must be quality-assured before it may be used for regulatory decision-making. Guidelines were established for this quality assurance (QA) review at the inception of PSDDA implementation. Attachment 1 includes all QA elements and the guideline values currently in use. This level of review is known as QA1.

PROBLEM IDENTIFICATION

Most laboratories doing PSDDA chemical analysis use modified Environmental Protection Agency Contract Lab Program (EPA CLP) methods. These methods have their own QA "control" limits for precision, matrix spike recovery and surrogate spike recovery, which have been established through interlaboratory testing. Laboratories rely on the CLP control limits to determine when data quality may be inadequate and corrective action is necessary.

In addition to the CLP limits in common use, the Puget Sound Estuary Program (PSEP) has established both "warning" limits and "action" limits for these same QA parameters. PSEP defines warning limits as "numerical criteria that serve to alert data reviewers and users to possible problems within the analytical system. When a warning limit is exceeded, the laboratory is not obligated to halt analyses, but the reported data may be qualified during subsequent QA/QC review." Action limits are defined as "numerical criteria that, when exceeded, require specific action by the laboratory before data may be reported. Action limits are intended to serve as contractual controls on laboratory performance." The terms "action limit" and "control limit" are similar and used interchangeably.

The QA limits established for use by PSDDA for QA1 purposes have been termed "control limits", the same term used by EPA CLP. The problem is that the PSDDA control limits are a mix of PSEP warning and action limits. A detailed analysis of laboratory QA/QC performance during DY 1990 was presented in the Corps' Dredged Material Evaluation Application Report (DMEAR). Since CLP limits are typically used by laboratories as control limits, the QA1 limits were treated in the DMEAR report as *warning* limits to assess their efficacy in that capacity. As warning limits, the PSDDA QA1 limits were not totally effective in screening data. The function of a good warning limit is to provide a quick check on data. To perform this function adequately the warning limits should be exceeded before any control or action limits are reached. The DMEAR analysis, comparing the number of exceedances of PSDDA limits to that of CLP limits, produced many inconsistencies for DY 1990. In numerous cases, the CLP control limits were exceeded while the PSDDA limits were not. Under these circumstances the possibility exists of overlooking exceedances of control limits because the warning limits were not restrictive enough.

Sufficient data was generated during DY 1990 to make adequate comparisons to other objective standards, such as EPA CLP. A more rational system of QA warning and action limits is needed to ensure proper evaluation of chemical testing data. Warning limits need to be established which provide effective screening mechanisms for quick checks of data sets. Inconsistencies with the PSEP protocols and EPA CLP control limits need to be rectified.

PROPOSED CLARIFICATION:

Attachment 1 includes recommendations for establishing QA limits which are as consistent as possible with both PSEP and CLP. A system of warning and action limits, similar to PSEP, is adopted. In most cases, PSEP quantitative levels have been adopted as well.

For matrix spike and surrogate spike recoveries, independent warning limits were established for volatiles, semivolatiles and pesticides. These limits meet the PSEP definition of warning limits and screen data effectively relative to the EPA CLP control limits. The chemical-specific EPA CLP control limits were adopted for use as action limits for surrogate spike recoveries and for a basis of evaluation in the application of best professional judgement for matrix spike recoveries. Where certified reference materials are available for either metals or organics, the interlaboratory-derived 95% confidence interval should be used as an objective evaluation tool. This alternative is endorsed by PSEP. The recommended warning and action limits listed in Attachment 1 will be adopted for use in PSDDA QA1 evaluations.

Attachment 1 Interstandard QA Limit Comparisons

QA Element	Current PSDDA QA1 "Control" Limits	Puget Sound Estuary Program		EPA CLP Control Limits	Recommended PSDDA Limits	
		Warning Limits	Action Limits		Warning Limits	Action Limits
Precision:						
Metals:	20% RPD or COV	none	20% RPD	20% RPD (1)	none	20% RPD or COV
Organics	100% COV	35% COV	50% COV (or a factor of 2 for duplicates)	Chemical-specific recovery limits	35% RPD or COV	50% COV or a factor of 2 for duplicates (2)
Matrix Spikes:						
Metals:	75-125% recovery	none	75-125% recovery	75-125% recovery	none	75-125% recovery
Organics:	50% recovery	50-150% recovery	Project Manager decision (3)	Chemical-specific recovery limits		Best professional judgement (4)
Volatiles:				Range of minimum recoveries = 59-66%	70-150%	
Semivolatiles and Pesticides:				Range of minimum recoveries = 11-46%	50-150%	
Reference Materials:						
Metals:	80-120% recovery	none	80-120% recovery (5)	Not applicable	none	95% CI if specified for a particular CRM; 80-120% recovery if not.
Organics:	95% confidence interval for certified reference material	95% confidence interval if certified	Project Manager decision	Not applicable	none	95% CI for CRMs. No action limit for uncertified RMs.
Surrogate Spikes:						
Organics:	50% recovery	50% recovery (6)	Follow EPA CLP guidelines (6)			EPA CLP chemical-specific recovery limits
Volatiles:				Range of minimum recoveries = 59-84%	85% recovery	
Pesticides:				Minimum recovery = 60% (advisory only)	60% recovery	
Semi-volatiles:				Range of minimum recoveries = 18-30%	50% recovery	

(1) Based on matrix spike duplicates
(2) Chemical-specific precision limits may be utilized for those chemicals used for matrix spike duplicates under CLP.
(3) Zero percent spike recovery requires rejection of data
(4) Based on comparison to EPA CLP control limits; less than 10% recovery may be cause for data rejection (PSDDA QA/QC workshop, January 24, 1991).
(5) Other recovery limits may be accepted if they are specified for a particular CRM
(6) Except when using the isotope dilution technique

CLARIFICATION

SUBMITTAL OF PSDDA QUALITY ASSURANCE/CONTROL (QA/QC) DATA

Prepared by Tom Gries (Ecology, 206/438-7706) for the PSDDA agencies.

INTRODUCTION

The PSDDA Management Plan (7,8) contains requirements for the quality assurance/control (QA/QC) of analytical data to be used in the program. The process and degree of QA/QC of data used for making decisions on the suitability of dredged material for disposal at unconfined, open water sites differs from the QA/QC of data used to calculate PSDDA sediment quality guideline values.

PROBLEM IDENTIFICATION

Dredgers or their agents currently submit analytical and associated quality assurance data to the Corps on standard LOTUS spreadsheets (result of a DY 1989 ARM clarification (9)). However, seldom during DY 1990 did they submit all the QA data necessary for Ecology to evaluate whether the data may be added to the SEDQUAL database and used to calculate sediment quality guideline values.

PROPOSED CLARIFICATION

Data submittals important to performing the latter QA include:

General Sample Data

- Cruise logs with positioning records and observations on sample collections
- Sample summary, including container and field equipment preparation, sample location and depth, sample size, handling procedures and storage conditions, holding time, dilution volume, etc

Chemical Data

- Analytical method used (for example, 625/8270 for semivolatiles)
- Instrument calibration and/or tuning results
- Instrument and method detection limits
- Reconstructed ion chromatograms for GC and/or GC/MS analyses
- Mass spectra of detected targeted compounds, with associated library spectra
- Raw data quantification reports
- Data qualifications
- Anomalies observed or experienced during analysis

Biological Data

- Raw bioassay data necessary to determine if protocols have been followed (for example, appropriate preparation of test chambers, holding conditions, data on control chambers and responses, experimental test conditions, test duration), verify test endpoints and apply PSDDA interpretive guidelines
- Benthic sorting efficiency information

Only some of these are required for making suitability decisions. The other QA/QC information listed above must also be submitted. The PSDDA agencies recommend that dredgers or their agents submit these additional required QA data along with their data submitted to the Corps, who will then relay them to Ecology.

CLARIFICATION

PSDDA REQUIREMENT TO COLLECT AND REPORT AMPHIPOD REBURIAL DATA

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

PROBLEM IDENTIFICATION

The PSDDA program interprets the amphipod bioassay based on the mortality observed after 10 days exposure to the test sediment, and does not utilize the reburial data.

INTRODUCTION

The revised PSEP amphipod bioassay protocol which is soon to be released (April 1991?) specifies a dual endpoint of mortality and the number of amphipods failing to rebury after 1 hour. The current PSDDA interpretation of the amphipod test does not utilize the amphipod reburial data, nor does it require collection and reporting.

PROPOSED CLARIFICATION

The PSDDA agencies will require the collection and reporting of amphipod reburial data along with the rest of the data. This requirement will be revisited during the ongoing technical review of the PSDDA biological testing requirements (see appendix xx). In the meantime, PSDDA should require the collection and reporting of amphipod reburial data in order to be consistent with the 1991 revision of the PSEP protocols for bioassays.

CLARIFICATION

ECHINODERM EMBRYO SEDIMENT BIOASSAY PROTOCOL CLARIFICATIONS

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

INTRODUCTION

At a PSDDA sponsored bioassay workshop conducted on July 10, 1990 it was apparent that for the echinoderm embryo sediment bioassay a number of protocol issues needed clarification. The proposed clarifications ensuing from this workshop will be adopted and implemented by the PSDDA program to insure consistency in the running of this bioassay and the quality of the data for regulatory decision making. The bioassay workshop recommendations on bioassay protocol clarifications were also sent to EPA's Office of Coastal Waters for future PSEP bioassay protocol revisions.

PROBLEM IDENTIFICATION

The following protocol issues requiring better specifications are discussed as follows:

(1) **Temperature.** Due to longer development times required for the echinoderm embryo bioassay at 12 degrees Centigrade, the bioassay temperature specification should be changed to 15 degrees Centigrade. This recommendation was endorsed by the July 10, 1990 bioassay workshop participants. At 15 degrees Centigrade, most labs report that they get pluteus larval development within 48-96 hours.

(2) **Test Duration**. The workshop endorsed adopting a **minimum** test duration of 48 hours, with no maximum test duration specified. Experience in the PSDDA program to date has shown that some echinoderm embryo sediment bioassays may have been terminated prior to full pluteuas larval development in the seawater control. To insure that the tests are not terminated prematurely, a minimum test duration specification of 48 hours is proposed for implementation.

(3) **Test Endpoint.** The workshop recommendation for test endpoint was as follows: monitor seawater control until at least 90 percent (preferably more) of the pluteus larvae are well developed with deeply invaginated preoral arms. Abnormality in the seawater control should not exceed 10 percent. No test should be terminated before 48 hours have elapsed as noted above.

(4) **Test Termination**. Carefully (gently) stir up the water in each test beaker to insure larvae are suspended in the water without disturbing the sediment; the carefully decant up to 95 percent of the water (80-95%) leaving the sediment remaining in the test beaker. The decanted water should be thoroughly mixed to insure uniform distribution of larvae prior to removing up to three 10 ml aliquots, each of which is fixed with buffered formalin. One 10 ml aliquot is then counted, while the other two are archived until counts are assured to be adequate for characterizing test replicates.

PROPOSED CLARIFICATION

The following protocol clarifications will be implemented to insure high quality data for PSDDA program regulatory decisionmaking.

(1) **Temperature**. The temperature specifications for the echinoderm embryo sediment bioassay should be changed to 15 $\pm$ 1 degree Centigrade.

(2) **Test Duration**. Tests should not be terminated prior to 48 hours, and before the pluteus larval development endpoint. Test duration normally should be 48-96 hours at 15 degrees Centigrade, but no upper limit for test duration is specified. Test duration depends on larval development.

(3) **Test Endpoint**. The test endpoint is reached when 90 percent or more of the developing larvae have reached the pluteus larval stage, where the larvae are well developed with deeply invaginated preoral arms in the seawater control. Abnormal pluteus larvae in the seawater control should not exceed 10 percent as a general rule.

(4) **Test Termination**. To terminate the test, the water in test beakers should be carefully (gently) stirred to insure that larvae are in suspension without disturbing the sediment. The water is then carefully decanted so that a maximum of 20 percent of the water remains in the beaker. The decanted water containing generally between 80 to 95 percent of the tested volume is then thoroughly mixed to insure uniform larvae distribution, and three 10 ml aliquots are removed and each fixed with buffered formalin. One 10 ml aliquot is then counted, while the other two remain archived until the counts rendered for the other replicate is assured to be adequate.

CLARIFICATION

AERATION OF SEDIMENT LARVAL/ECHINODERM LARVAL BIOASSAY TEST BEAKERS

Prepared by Pat Cagney (Corps, 206/764-3768) for the PSDDA agencies.

INTRODUCTION

Biological testing results generated during the sediment larval/echinoderm larval test have occasionally been inconclusive. High mortalities for both reference and proposed dredged sediments have many times co-occurred. Although inconsistent results could emanate from a variety of sources, water quality and sediment conventional parameters may have significant influence on test results. These include low concentrations (less than 5 mg/l) of dissolved oxygen in the water column and elevated concentrations of sulfide and ammonia in the test sediments. Detrimental effects encountered from low levels of dissolved oxygen or high concentrations of ammonia and or sulfide may be offset by aeration of test beakers.

PROBLEM IDENTIFICATION

A number of PSDDA projects have experienced difficulty in obtaining interpretable sediment bioassay results. Reference sediments, appropriately matched to test sediments relative to grain-size, have failed to meet performance standards established by PSDDA. (The performance standard for reference sediments is 20 percent, or less, seawater-normalized combined mortality and abnormality.) These difficulties have been correlated with high bulk and aqueous ammonia, and high bulk sulfides. High aqueous sulfides and low DO would be expected to have similar effects but have not been implicated to date; low DO has occurred infrequently and detection limits for aqueous sulfides are generally higher than known action limits.

Increased levels of ammonia and sulfides may have toxic effects on echinoderm test species. False positive errors, associated with elevated levels of ammonia and sulfides in the test beakers, have been reported by other investigators. It is the conclusion of Ankley et. al., and illustrated in their test results concerning the role ammonia toxicity from sediments plays on biological test organisms, that "the presence of ammonia can greatly complicate the interpretation of results of sediment toxicity tests. High concentrations of ammonia in sediments could mask the effects of other toxicants, and even small concentrations may conceivably interact with other sediment-associated contaminants in additive, synergistic or antagonistic fashions." Additionally, tests were conducted locally on the role of sulfides and ammonia toxicity on echinoderms in a recent PSDDA project. There was a statistically significant correlation between echinoderm mortality and bulk sulfide, bulk ammonia and aqueous ammonia.

The PSDDA agencies anticipated potential problems with the sediment and water quality parameters. Sediment conventional data, including bulk ammonia and sulfides, is required of all test and reference sediments. During bioassays, PSDDA requires (along with temperature, pH, and salinity) monitoring of DO on a daily basis and aqueous ammonia and sulfides at the beginning and end of the bioassay.

Four methods have been identified to remove the effects of ammonia, they include: (1) manipulation of pH, (2) removal via cation exchange resins such as zeolites, (3) removal by air-stripping at high pH and (4) allowing ammonia to dissipate through aeration of test beakers. Aeration would provide the most cost-effective and simplest solution. Problems with elevated levels of sulfides and low DO levels would also be ameliorated. The loss of other volatile species is not considered to be a problem since the majority of these are lost during sample handling and preparation for bioassays.

There has been sufficient data generated identifying low dissolved oxygen (< 5 mg/l), bulk and aqueous ammonia, and bulk sulfides as causes of interference in the sediment larval bioassay/echinoderm test, that additional guidance can be promulgated to alleviate these problems.

PROPOSED CLARIFICATION

When performing sediment larval bioassay, dissolved oxygen should continue to be monitored on a daily basis, and ammonia and sulfides at the beginning and end of the bioassay. If the concentration of dissolved oxygen drops below 5 mg/l in the test beaker, aeration of all test beakers within the batch should be initiated. Aeration should also be initiated if bulk ammonia or sulfides are present at elevated levels. Aeration in these cases should be applied using best professional judgment, but certainly in cases where a strong sulfide smell exists in very fine-grained sediments when sediment conventional data has not yet been evaluated, or when water quality monitoring results are above EPA's water quality criteria.

CLARIFICATION

ENVIRONMENTAL MONITORING PROGRAM REFINEMENTS

Prepared by Betsy Striplin (DNR, 206/753-0263) for the PSDDA agencies.

PROBLEM STATEMENT

The first environmental monitoring occurred at two PSDDA nondispersive disposal sites during spring 1990. During program implementation, several issues were raised regarding sample collection, sample processing, and data interpretation. Interim solutions to these issues were developed through technical discussions with the PSDDA agencies and the monitoring program contractor. These solutions enabled the program to continue without substantial delays. The purpose of this paper is to briefly clarify minor changes to the monitoring program.

PROPOSED CLARIFICATIONS

Acid Volatile Sulfides

The U.S. Environmental Protection Agency has determined through intensive laboratory and field investigations that the concentration of acid volatile sulfides (AVS) in sediment affects the bioavailability and toxicity of certain metals. As research and development on the use of AVS continues, the PSDDA agencies recognize the potential utility of collecting AVS data at the disposal sites. AVS analyses were performed during the 1990 monitoring program at all stations where biological analyses were conducted. The environmental monitoring program will continue to analyze AVS in future monitoring events using the U.S. EPA laboratory analysis method, to preserve future program options. The PSDDA agencies will continue following the research on this variable, and may make additional recommendations on its use in future Annual Review Meetings.

Chemical Analyses at Benchmark Stations

The original environmental monitoring program called for the archival of sediments for chemical analysis at benchmark stations. The 1990 monitoring program identified the need for the immediate analysis of sulfides and volatile organic compounds due to short holding time requirements. In the future, sediments collected for analysis of sulfides and volatile organic compounds will be analyzed immediately instead of archived.

Sediment Vertical Profiling System Schedule

The sediment vertical profiling system (SVPS) is used to map the distribution of dredged material at the nondispersive disposal sites. The contractor conducting the 1990 monitoring program recommended that the schedule for the SVPS sampling be accelerated so that this survey occurred as soon after dredging ceased as possible instead of simultaneously with

sediment sampling. This strategy has the advantage of minimizing the period of time over which benthic organisms may bioturbate the sediment, causing a layer of dredged material to become less distinct. Additionally, the resulting data may be used to better select perimeter and gradient stations. The PSDDA agencies agreed to implement this strategy for the 1990 program. As a result, SVPS images were obtained about one month prior to biological and chemical sampling, and were used to select station locations for sediment sampling. The PSDDA agencies will adopt this strategy for all future monitoring because it optimizes mapping dredged material and selecting stations for sediment sampling.

Benchmark Station in Port Gardner

Port Gardner benchmark station PGB02 contains sediment with a substantially different grain size distribution relative to ambient conditions in the vicinity of the Port Gardner disposal site. Hence, the benthic community at PGB02 naturally differs from the baseline benthic community at the disposal site. Furthermore, the station has repeatedly demonstrated high toxicity in the absence of significant chemical contamination. Therefore, this station is not an appropriate benchmark station. A new benchmark station will be identified and sampled for baseline information prior to the start of the next dredging year which begins in June 1991.

CLARIFICATION

MANAGEMENT OF THE PORT GARDNER AND ELLIOTT BAY SITES

Prepared by Betsy Striplin (DNR, 206/753-0263) for the PSDDA agencies.

Port Gardner

Prior to the initiation of disposal operations for the U.S. Navy Homeport Element I dredging project, concern was raised that the large volume of dredged material to be placed at the Port Gardner PSDDA site may cause mounding. To minimize potential mounding, it was agreed that dredged material would be deposited throughout the disposal site's central target area instead of at the center of that area. Contractors for the U.S. Navy followed that guidance.

During physical monitoring of the Port Gardner site in April and May 1990, the dredged material footprint appeared to exceed the disposal site boundary in all directions. Numerical modelling determined that the presence of dredged material outside of the disposal site was primarily the result of the physical characteristics of the material placed at the site.

To minimize the chance for future dredged material that is placed at the Port Gardner site to be located outside of the site boundary, two site management changes are proposed for adoption. First, all efforts will be made to dispose of the dredged material at the center of the disposal site instead of throughout the target area. Second, the physical characteristics of the dredged material will be reviewed prior to disposal to ensure that the material will disperse as predicted through the modelling studies.

Elliott Bay

Results of the physical monitoring studies in spring 1990 showed that dredged material remained within the disposal site boundary. The distribution of this material mirrored the shape of the disposal site by extending to the northwest. This distribution pattern was predicted to occur because the site is located in a submarine valley with relatively steep sides and a downward slope to the northwest (Disposal Site Selection Technical Appendix - Phase I, pg. II-200).

One site management change is proposed for adoption. It is recommended that disposal operations target the southern quarter of the disposal site's target area, resulting in the disposal of dredged material approximately 300' south of the center of the site. By concentrating disposal operations in this area, material will be placed farther up the submarine canyon and will have less chance of moving off the site due to movement down the canyon. The navigational coordinates of the center of the southern quarter of the target area are 47°35.92' and 122°21.38' 1927 North American Datum or 47°35.91' and 122°21.45' 1983 North American Datum. The U.S. Coast Guard's Puget Sound Vessel Traffic Service will guide all barges to these revised coordinates.

Appendix B

PSDDA Annual Review

Issue Papers for Dredged Material Management Year 1990

ISSUE PAPER

PSDDA REQUIREMENTS FOR PROGRAM REVIEW REPORTS AND MEETINGS

Prepared by Thomas Mueller (Corps, 206/764-3495) for the PSDDA Agencies.

INTRODUCTION

The agencies implementing the PSDDA Management Plans are required to annually prepare seven program documents:

- DNR prepares an annual site use report which describes the use of PSDDA disposal sites during the previous Dredging Year.
- The Corps prepares a report now called the Dredged Material Evaluation Application Report (DMEAR). This report contains all the relevant data collected within the previous Dredging Year pertaining to dredged material sampling, testing and disposal guidelines application.
- The Corps prepares a report on the results of any physical monitoring of disposal sites.
- DNR prepares a report on any chemical and biological monitoring of disposal sites.
- Ecology prepares a report which summarizes all environmental monitoring of disposal sites.
- Ecology prepares the Management Plan Assessment Report (MPAR) which assesses the need for changes in dredged material evaluation procedures and disposal site management plans. It includes an analysis of the need for technical changes to sampling guidelines, chemical and biological testing methodologies and disposal guidelines.
- The Corps prepares an Annual Review Meeting (ARM) notice announcing the meeting details and transmitting the issue and clarification papers.

Ecology's MPAR and the Corps ARM notice must be provided to other agencies, tribes, and other interested parties at least one month prior to the ARM.

PROBLEM IDENTIFICATION

Public involvement in the PSDDA annual review process requires active participation to track and integrate information contained in the numerous program reports. While the reporting responsibilities were initially designed to ensure active and equitable involvement from each of the regulating agencies, the net result has been a presentation to the public that is more fractured

than necessary. Improvements in the presentation of annual review materials are needed to enhance public participation in the annual review process.

Though PSDDA agency staff expend substantial effort to ensure that the various reports are consistent and represent an integrated assessment, the current program review structure still results in duplication of information, effort and mailing costs. This additional effort could be applied to day-to-day management of dredging projects, including: review of applications; evaluation of dredged material testing requirements and results; data management; and inspections to ensure permit compliance. Project-specific review will become even more critical to the success of the PSDDA program as the number and complexity of projects increases. Indeed, the experience of DY 1990 (relative to Dredging Year 1989) was that greater effort was required to develop and review sampling and analysis plans (SAPs), conduct quality assurance/quality control reviews on the resulting data, and analyze that data for suitability decisions.

In addition to these responsibilities, PSDDA program requirements to address ongoing issues (e.g., development of improved tests) and to prepare annual reports are now combined with the need to assess and respond to the results of disposal site environmental monitoring. And new significant program changes are becoming less frequent as experience with program implementation is gained.

To ensure effective opportunity for public involvement, the PSDDA agencies are evaluating program changes in the annual reporting schedule contained in the PSDDA Management Plans. Reduced reporting for some aspects of the program would allow better dedication of resources to program services.

BACKGROUND

During its first few years, a new program requires more oversight to implement, to allow public scrutiny, to fine-tune protocols and to make necessary program adjustments. As the program gains experience, less oversight is generally required. The PSDDA program is an excellent example of this.

By the next Annual Review Meeting (spring 1992), the PSDDA agencies expect to have the experience and data to show that the program has completed the initial "fine-tuning" stage, continues to work well, and provides appropriate protection of the environment.

The need for major changes is not expected to occur on an annual basis after DY 1991 (spring 1992 ARM). Therefore, the PSDDA agencies propose altering the reporting and annual review requirements.

In particular, considerable duplication of effort could be avoided by report consolidation. The DNR site use report could be consolidated with the Corps' DMEAR. The three monitoring reports could also be consolidated into one. This would be advantageous because monitoring evaluation requires close coordination among the agencies to ensure that physical, chemical and biological information is integrated before conclusions are reached.

This approach would also reduce the number of reports which the interested public would need to read. Reducing reporting requirements would also reduce the costs of preparing, printing and mailing the various reports.

PROPOSED MODIFICATION

Specific recommendations of the PSDDA agencies are listed below.

1. All of the various annual reports described above will be prepared for DY 1991, to be published in spring 1992.

2. Beginning with DY 1991, DNR's Site Use Report will be consolidated with the Corps' DMEAR Report to be published in spring 1992. The Corps will have the lead to prepare the consolidated report. In addition, Ecology will supply the Corps with a summary of dredging projects that did not use the PSDDA disposal sites for inclusion in the Corps report (rather than the Management Plan Assessment Report).

3. Beginning with DY 1990, the MPAR is consolidated with the issue papers, clarifications and the 30-day Annual Review Meeting notice so that only one package is mailed to the public. This practice will be continued in future reports.

4. After DY 1991, the Corps dredging year report (including the Corps DMEAR, DNR's Site Use information, and Ecology's summary of other dredging projects) and Ecology's Management Plan Assessment Report (including the Corps ARM notice and issue/clarification papers) will only be prepared on a biennial basis, covering a two year period. The first set of these biennial reports would cover DY 1992-1993 and would be published in spring 1994.

5. All three monitoring reports will be consolidated into one and be prepared by spring of the year following site monitoring event(s). The DNR will take the lead to prepare the report, with the Corps providing input for physical monitoring and Ecology providing the summary and assessment of the overall monitoring for inclusion in the consolidated report. The consolidated monitoring report will not be tied to the timing of the other PSDDA reports, but would be tied to actual site monitoring events.

6. Public Annual Review Meetings will be routinely held following preparation of the various consolidated reports (springs of 1992, 1994, 1996, etc., and post-monitoring as appropriate).

   During the springs of the odd numbered years, public coordination will take place as appropriate to the nature and number of clarifications or issues proposed . If there are only a few clarifications/issues and no proposals for "management plan changes," then coordination with the agencies, tribes and other interested parties will be by public notice with a comment period of 30 days. The PSDDA agencies will consider all comments received prior to implementing the clarifications (according to the procedures implemented as a result of the Second Annual Review Meeting). If major plan changes are proposed, then an Annual Review Meeting will be held.

ISSUE PAPER

MODIFICATIONS TO HOLDING TIME FOR BIOLOGICAL TESTING

Prepared by David Kendall and David Fox (Corps, 206/764-3768) for the PSDDA agencies

INTRODUCTION

PSDDA bioassays must be performed within an established time limit. This time limit, or "holding time," has been established to ensure that biological testing results reflect the in-situ conditions at the proposed dredging site. Natural processes, such as chemical and biological degradation, speciation and volatilization, can alter the chemical composition of a sediment if proper storage conditions and holding times are not met. PSDDA currently requires that biological testing be initiated within six weeks of sediment collection. Sediments must be stored at 4°C and if biological testing does not commence within two weeks of sampling, sediments must be stored under a nitrogen atmosphere.

A recommended two-week holding time for bioassay sediment is indicated in the Puget Sound Protocols and Guidelines. However, the Protocols and Guidelines are currently under revision to recognize that regulatory and management programs using a tiered testing strategy will not be able to meet that guideline.

PROBLEM IDENTIFICATION

Under PSDDA guidelines, biological testing may be performed concurrently with chemical testing, or tiered testing may be chosen. Tiered testing generally allows greater economy, as only those sediment samples which exceed chemical screening levels must undergo biological testing. The problem is that chemical testing takes time. Laboratories many times face backlogs of samples to be tested (PSDDA samples comprise only a small fraction of the typical lab's business). Often chemical testing results are not available for 4-6 weeks after sampling has been completed. To provide smooth biological testing, a minimum of two weeks in good weather and three weeks in bad, should be allowed for startup. Organisms must be obtained (and cultured if necessary), conditioned and equilibrated prior to testing. The experimental apparatus must be set up. Reference and control sediments must be obtained. Both chemical and biological testing practitioners feel harried to get their tests completed or started, respectively. In several cases in the past year, dredging consultants were pressed right against the 42 day holding time, trying to get last minute data from chemical labs, while trying to get biological testing geared up. This situation not only produces stress for all involved but drives up costs because dredging applicants are forced to pay premium prices for chemical testing to get a faster turnaround, and biological testing labs charge higher prices due to the uncertainty with the number of samples to be run and the short lead times provided by dredging applicants. These factors reduce the cost effectiveness of tiered testing.

Tiered testing must remain a viable option to keep PSDDA testing costs down. This problem will continue as long as a six week holding time remains in effect. Results from recent studies have provided evidence needed in extending holding times for biological testing.

PROPOSED MODIFICATION

It is proposed that the holding time for sediments undergoing biological testing be extended to eight weeks. Data supporting this change is provided in the following documents. A study prepared for EPA on the effect of holding times on response in the amphipod test, Neanthes biomass test, and the microtox test (B1). The study showed for all three bioassays, there was no observed decrease in toxicity even beyond 8 weeks, and changes when noted were associated with increased toxicity with increasing holding time. These results are further corroborated by a recent study by the Corps's Waterways Experiment Station conducted for the New York District Corps of Engineers (B2). Holding times extending beyond 4 to 8 weeks showed no decrease in toxicity, but did show some evidence of increased toxicity. From a regulatory perspective, an increase in toxicity would be more environmentally conservative, with the increased risk of a sediment sample (i.e., a dredged material management unit) exceeding disposal guidelines for unconfined, open-water disposal being carried by the applicant. In conclusion, these two studies indicate that an increase in holding time for biological analyses to eight weeks is justified.

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ISSUE PAPER

WORKPLAN FOR TECHNICAL REVIEW OF DREDGED MATERIAL BIOASSAYS REQUIRED BY PSDDA

Prepared by Keith Phillips (Ecology, 206/459-6143) for the PSDDA agencies.

PROBLEM STATEMENT

Development of the PSDDA evaluation procedures included substantial work to identify, develop, and refine sediment bioassays for use in the assessment of dredged material suitability for unconfined, open-water disposal. The required suite of biological tests were selected as the best available tools for evaluating potential disposal effects at the time of program implementation. Whil some of these bioassays had been in use for many years, others received their first application to dredged material evaluation via the PSDDA program. The PSDDA agencies have committed to improving dredged material evaluation procedures as new scientific information and/or program experience becomes available.

At the time of program implementation, the PSDDA agencies agreed to conduct a technical review of the PSDDA bioassay requirements after several years of experience had been obtained in their application to dredging projects. The purpose of the review is to assess bioassay performance, to revisit the suitability of the bioassays for evaluation of potential dredged material effects at unconfined open-water disposal sites, and to determine the need for any changes in program biological testing requirements.

BACKGROUND AND STATUS

Prior to and during DY 1990, a number of test performance issues were observed for the various bioassays. As these testing issues were documented, the PSDDA agencies responded by making minor modifications to testing protocols and/or test interpretation, and by conducting training workshops with testing laboratories.

Early program difficulties with control mortalities in the geoduck 10-day mortality bioassay resulted in substituting the polychaete 10-day mortality test as the routine PSDDA bioassay. Performance problems with the sediment larval test resulted in convening an experts workshop in 1989. The experts' recommendations were used in revising the larval test protocols and clarifying the test interpretation requirements. Performance problems also resulted in revised meth[illegible]ocols and interpretation for the microtox test. The PSDDA agencies additionally agreed to consider fine-grain interferences in the interpretation of the amphipod test.

In response to public requests heard at the Second Annual Review Meeting, the PSDDA agencies sponsored the July 1990 Bioassay Workshop. The workshop provided regional testing laboratories with detailed instructions regarding PSDDA modifications to bioassay testing requirements. The labs were also provided with an opportunity to identify other bioassay performance issues.

To ensure that the results of the bioassay improvements and workshops are considered prior to making substantial changes to program requirements, the PSDDA agencies agreed to extend the technical review through 1991. This will allow time for additional bioassay results using the modified requirements to be included in the review.

The PSDDA agencies have continued to document, and participate in, recent developments in biological testing methods. PSDDA agencies updated the current information on biological testing before the Second Annual Review Meeting (April 1990), and made available at the meeting a synopsis of the bibliographic review. During DY 1990, a report entitled "Annotated Bibliography of Bioassays Related to Sediment Toxicity in Washington State" was compiled by Dr. Paul Dinnel of the Fisheries Research Institute at the University of Washington. Also during DY 1990, the Puget Sound Estuary Program drafted a revised version of the bioassay protocols for the "Recommended Puget Sound Protocols and Guidelines," and circulated these revisions for regional and national comment. Additionally, the sediment and water column larval test protocols for the bivalve and echinoderm are currently being considered by the American Society for Testing Materials (ASTM), and a PSDDA representative is involved in the review and voting. The results of these ongoing activities will be incorporated into the technical review of the PSDDA bioassays.

PROPOSED ACTION

The PSDDA agencies will continue their technical review of the bioassay testing requirements through the rest of 1991. The review will include summary of additional data, technical studies, and review by other scientists and the public. The issues to be addressed for each bioassay are listed below.

Amphipod Bioassay

The PSDDA program requires the use of reference sediments as the basis for interpretation of dredged material biological test results. The reference sediment provides information on potential animal response that is due to factors other than chemicals of concern (e.g., grain size). To ensure that reference sediments are relatively clean, bioassay response "performance standards" are established for reference sediments. Amphipod testing has on occasion exceeded the established performance standards. These exceedances may be due either to a high content of fine-grained particles and/or to water quality problems associated with conventional sediment chemicals (e.g., ammonia, sulfides). Because of these problems, and as part of the ongoing technical review, the PSDDA agencies are considering establishment of a default reference value to use in cases where the reference sediment exceeds performance standards.

When conducting amphipod bioassays, the Recommended Puget Sound Protocols and Guidelines require reporting of amphipod reburial data. These data are not currently used by the PSDDA program (see related PSDDA clarification in Appendix A). The technical review will address the potential use of reburial data in the PSDDA program. The review will also consider the results of a recent study reported at the January 1991 Puget Sound Research Conference ("The Effect of Test Stabilization and Disturbance on Acute Sediment Toxicity to the Amphipod Rhepoxinius Abronius" by Word et al.) that indicated an influence of sediment handling methods on amphipod response.

Sediment Larval Bioassay

High larval mortality rates in the reference sediment exposures continue to be a problem for the larval test. Several of the larval experts who attended the 1989 larval workshop noted that entrainment of larvae (larvae settling along with the sediment particles) due to suspended sediment in the test chamber could be the cause of these mortalities. To address this potential, PSDDA instituted requirements for additional test chamber settling time after introduction of the sediment and prior to introduction of the larvae. These requirements went into effect in 1990. Recent data also suggest that toxicity due to conventional water column parameters (dissolved ammonia and/or sulfides) may be partially responsible for the observed mortalities. These water column parameters also reflect the presence of sediment in the test chamber. The PSDDA agencies are evaluating the potential routine use of test aeration as one method to reduce or eliminate these interferences. Another approach that will be examined is to establish an administrative default value for reference sediment larval response for use when performance standards are exceeded.

Removal of the sediment from the test chamber prior to introduction of the larvae is another approach to addressing the solids entrainment and conventionals toxicity problems. However, the influence of removal of the sediments from the test chamber on the test sensitivity and relevance to sediment toxicity will be a key subject of the PSDDA bioassay technical review.

The PSDDA disposal guidelines currently use a combined mortality/abnormality endpoint for the larval test. However, high reference mortalities can obscure the test interpretation. Accordingly, the bioassay technical review will also address whether the test evaluation should be based solely on the abnormality endpoint, or whether the combined endpoint should be continued.

Microtox Bioassay

Early experience with the microtox test indicated that reference sediments often do not show a dose-response relationship. When this occurred, it was not possible to calculate an EC50 value for comparison with dredged material. To address this problem, PSDDA altered the test interpretation to evaluate differences in light output between the highest concentration extracts of the dredged material and the reference sediment. This approach was established in 1990.

In addition to the absence of dose responsiveness, the microtox test has also shown light enhancement in some sediments. This enhancement is currently not being considered in the PSDDA disposal guideline. Further, the saline extract test, as currently required by PSDDA, has been non-responsive to some contaminated sediments, when compared to the response observed in other bioassays. To address these issues, the technical review will summarize the current information on interpretation of the microtox test, including light enhancement, and on the use of saline versus organic extracts. The review will also assess available information relating the microtox test, which uses a sediment extract, to toxicity from whole sediment exposures.

Technical Studies

As a first step in the ongoing technical review, available data on bioassay performance will be summarized. In addition to Puget Sound data, information from the Fraser River bioassay

studies (British Columbia) and NOAA's Boston Harbor microtox bioassay data will be requested for review. The observed relationship between amphipod mortality and grain size will be summarized. An analysis of water quality parameters relative to abnormality, mortality and combined endpoints in the larval test will be prepared. If data are available, comparisons of saline and organic extract response for the microtox test will be summarized. A power analysis will be conducted to evaluate the response of reference sediments to different bioassay endpoints.

Concordance analysis between different bioassays, and between bioassay response and field benthic information, will be performed. To evaluate the potential expansion of the database for concordance analysis, a listing of archived benthic samples for which synoptic bioassay information exists will be prepared. As funding allows, analysis of selected archived samples may be conducted by the PSDDA agencies.

A technical study will be performed to compare the larval response in test chambers containing only sediment elutriates with test chambers containing whole sediment. The study will be conducted in three steps. First, a preferred elutriation method will be selected by comparing test responses between elutriates prepared by centrifuge and decant methods. Second, elutriate and sediment response will be compared over a range of contaminated and reference sediments. And third, the influence of grain size and organic carbon on the comparative response will be investigated.

Public Review

Agency coordination of the technical review will be conducted by PSDDA agency staff beginning in April 1991. The staff will be responsible for scoping and prioritizing the technical studies, securing funding, conducting public review, and documenting the technical findings.

Through discussion and review of this workplan, public review of this work will begin at the May 1991 Annual Review Meeting. At the meeting, a mailing list will be developed for individuals who wish to receive copies of the technical mailings. The workgroup will prepare technical findings in the form of an issue paper describing the workgroup's proceedings and conclusions. The issue paper will be distributed for public review prior to the Annual Review Meeting to be held in spring 1992. Any significant changes to the bioassays, e.g., deletion or addition of a test organism, would be accomplished in accordance with the established PSDDA program change procedures, such that the changes would become effective by June 16, 1992.

In addition, any changes to standard testing methods resulting from this review will be submitted by the PSDDA agencies to the Puget Sound Estuary Program Management Committee for consideration in future revisions to the Recommended Puget Sound Protocols and Guidelines.

SCHEDULE

■ PSDDA Agency Scoping	April, 1991
■ Analysis of existing data and preparation of study scope	May - July, 1991
■ Technical larval studies	July - November, 1991
■ Draft Issue Paper	January, 1992

ISSUE PAPER

WORKPLAN FOR TECHNICAL REVIEW OF THE NEANTHES BIOMASS TEST AS A METHOD FOR EVALUATION OF POTENTIAL EFFECTS OF DREDGED MATERIAL DISPOSAL

Prepared by Keith Phillips (Ecology, 206/459-6143) for the PSDDA agencies.

PROBLEM STATEMENT

The Clean Water Act Section 404(b)(1) Guidelines specify the types of potential adverse effects to the aquatic environment that must be considered when making regulatory decisions on dredged material disposal. These considerations include the persistence and permanence of effects, including the short- and long-term effects on aquatic communities and the potential for sublethal effects such as impairment to animal growth and reproduction. To date, Puget Sound Dredged Disposal Analysis (PSDDA) agencies have relied on sensitive acute indicators or the use of the benthic infaunal abundance information (e.g., benthic sediment quality values) to provide an estimate of the combined effects of acute and chronic exposure to any chemicals of concern that may be present in the dredged material.

The PSDDA agencies have committed to improve the PSDDA evaluation procedures relative to the assessment of potential chronic and/or sublethal effects by no later than June 1992. However, despite continued studies and ongoing research, presently there is no widely accepted regulatory test for the assessment of potential chronic/sublethal effects of dredged material disposal.

BACKGROUND AND STATUS

During Phase I, the PSDDA agencies considered a variety of ways to evaluate potential unacceptable chronic/sublethal effects of dredged material disposal. The "Evaluation Procedures Technical Appendix -- Phase I" (reference B3) states that PSDDA agencies initially considered use of an intrinsic rate of population growth (IRPG) test to address chronic/sublethal effects of dredged material disposal. The IRPG test, which indicates whether the test sediment population is growing at a rate comparable to reference conditions, was not recommended since a suitable test species could not be identified.

In another attempt to develop a useable alternative, PSDDA agencies funded the National Marine Fisheries Service (NMFS) to investigate and, if possible, recommend a chronic sediment test. After completing work with juvenile geoducks and sand dollars, NMFS could not recommend either animal or another test as an alternative for a long-term marine sediment bioassay, at that time. Pending development of an acceptable chronic/sublethal test, and per the NMFS recommendation, PSDDA decided to address potential chronic/sublethal effects of dredged material disposal using existing sensitive acute bioassays and chemical surrogate measures of benthic community effects. These indicators include abnormality in bivalve larvae, sublethal effects in the microtox bioassay, and the chemical disposal guidelines based in part on benthic infaunal abundance.

As part of Phase II, PSDDA agencies funded further test development with two species noted to have a high potential for use as chronic/sublethal indicators, the amphipod *Ampelisca abdita* and the polychaete *Neanthes arenaceodentata* (B4). This work demonstrated that the 20-day juvenile polychaete test, using a biomass endpoint, was dose-responsive to a range of tested sediments, and was the most promising for continued chronic/sublethal development.

As described below, recent work on development of the *Neanthes* biomass test indicates that the test continues to merit strong consideration as a method for evaluation of potential chronic/sublethal effects of dredged material disposal. The chronology of Neanthes biomass test development follows:

- Development work began as a sublethal test demonstration study (B4) for the Corps and the PSDDA program. This test demonstration was conducted concurrently with an EPA study comparing multiple sediment bioassays (B5).

- In February 1989, Ecology funded development of a draft *Neanthes* biomass test protocol (B6) and an experts' workshop to discuss the draft protocol. The experts panel evaluated the draft protocol to determine the information and research that may be needed for further test development. An interim protocol (B7) was developed based on the workshop recommendations. The workshop participants identified eight high priority topics for further test development. Most of these topics addressed how nontreatment factors (e.g., grain size, feeding rate, etc.) could affect test response.

- Ecology also funded an evaluation of growth as a sublethal indicator of sediment quality, the relationship between growth and reproduction, and an assessment of approaches to establish interpretive guidelines for the juvenile *Neanthes* biomass test (B8).

- Seven of the eight high priority *Neanthes* biomass test development topics from the 1989 Ecology workshop were addressed in work funded by EPA (B9). A draft final *Neanthes* biomass test protocol (B10) was developed based on the interim protocol, using the results from the seven experiments.

- Another experiment was conducted under EPA funding to address the eighth *Neanthes* experts workshop topic (B11). This study evaluated the relationship between changes in juvenile biomass (i.e., the critical response criterion in the *Neanthes* biomass test) to other long-term endpoints that are measures of reproductive success.

- An additional study completed by EPA in early 1991 further linked the *Neanthes* biomass endpoint to reproductive impairment and chronic mortality (B12). This study used 108-day exposures with sediments of varying degrees of contamination to investigate effects on several reproductive endpoints. Adverse effects to reproduction were dose-responsive and directly correlated to the 20-day biomass endpoint in the juvenile polychaete.

The work above establishes a strong foundation for future use of the *Neanthes* biomass test in PSDDA evaluations of dredged material for chronic/sublethal adverse effects to the aquatic environment. At this time, there remain issues of field demonstration on dredging projects, interlaboratory evaluation, and regulatory application and interpretation of the *Neanthes* biomass test.

The time required to complete the long-term reproduction studies was longer than anticipated during the 1990 Annual Review Meeting. This delayed completion of the technical and regulatory review needed to determine whether to incorporate the *Neanthes* biomass test into the suite of PSDDA bioassays prior to the 1991 Annual Review Meeting.

PROPOSED ACTION

The PSDDA agencies have agreed that the PSDDA evaluation procedures will be improved relative to the assessment of potential chronic/sublethal effects of dredged material disposal by no later than the 1992 Annual Review Meeting. Pending the results of technical, regulatory and public review, these improvements may include use of the *Neanthes* biomass test or other appropriate tests.

The proposed actions described below address the remaining technical questions associated with the *Neanthes* biomass test. Regulatory interpretation of the *Neanthes* biomass test will be the subject of a separate agency review (see page B-19 in this appendix).

Work remaining with the *Neanthes* biomass test consists of obtaining broader experience with the test as applied to a greater range of marine sediments. The PSDDA agencies will identify project opportunities and other sediment studies during summer and fall 1991 where the *Neanthes* biomass test can be applied (in a non-regulatory mode) concurrently with other bioassays. Broader experience will validate the previously observed range of response, will allow establishment of regulatory interpretation guidelines, and will verify the decisionmaking utility of the test in Puget Sound.

In conjunction with the above work, the agencies will attempt to evaluate test performance as conducted by several regional laboratories. Interlaboratory comparisons will further define response variability and will assist in defining future training needs. The agencies will also summarize any available results from previous work and other studies using the *Neanthes* biomass test (e.g., Vancouver Public Works studies in B.C., Canada).

Agency coordination will be conducted by a PSDDA agency technical workgroup. The

workgroup will be responsible for identifying testing opportunities for application of the *Neanthes* biomass test, scoping the technical review, securing funding, conducting peer and public review, and documenting the technical findings.

Scientific peer review will be conducted in two steps. A scope of work prepared by the agency workgroup will be widely mailed to regional and national scientists requesting review prior to initiation of the studies. After completion of the field application studies, a scientific workshop will be convened to review study results. Experts who participated in the previous *Neanthes* workshop, as well as other regional scientists, will be asked to attend. A summary will be prepared to document the workshop findings.

Through discussion and review of this workplan, public review of this work will begin at the May 1991 Annual Review Meeting. At the meeting, a mailing list will be developed for individuals who wish to receive copies of the technical mailings. The technical workshop summary will be included in these mailings. The workgroup will also prepare technical findings in the form of an issue paper describing the workgroup's proceedings and conclusions. The issue paper will be distributed for public review prior to the Annual Review Meeting to be held in spring 1992.

SCHEDULE

■ PSDDA Workgroup Scoping	Apr 91
■ Analysis of existing data and preparation of study scope	May - Jun 91
■ Peer review of study scope	Jun - Jul 91
■ *Neanthes* application studies	Aug - Nov 91
■ Technical review workshop	Dec 91
■ Draft Issue Paper	Jan 92

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ISSUE PAPER

WORKPLAN FOR REGULATORY REVIEW OF BIOASSAYS

Prepared by Keith Phillips (Ecology, 206/459-6143) for the PSDDA agencies.

PROBLEM STATEMENT

Regulatory evaluation of the suitability of dredged material for unconfined, open-water disposal often includes direct biological testing on the material to be dredged as a means to assess potential adverse effects associated with chemicals of concern present in dredged material. Interpretation of the biological tests requires consideration of both technical and administrative factors, such as bioassay performance, ecological relevance of the bioassay endpoint, integration of the results from multiple bioassays, and a decision on the degree of response that defines whether dredged material is suitable for unconfined open-water disposal.

The PSDDA agencies have agreed to undertake a programmatic review of the bioassay tests and biological disposal guidelines used by the PSDDA program. The main purpose of this review is to update the existing regulatory framework by integrating recent technical findings on bioassay testing methods and incorporating improvements to PSDDA evaluation procedures to better assess potential chronic/sublethal effects of dredged material disposal.

BACKGROUND AND STATUS

Prior to and during DY 1990, the PSDDA agencies have implemented minor changes to biological testing requirements when needed to improve bioassay performance and to clarify interpretation. These testing refinements are previously summarized in the DY 1989 Management Plan Assessment Report and in this report. In combination with other proposed changes being considered, the PSDDA agencies have agreed to conduct a program-level review of the regulatory requirements for biological testing of dredged material.

At the time of program implementation, the PSDDA agencies agreed to conduct a technical review of the PSDDA bioassay requirements after initial experience had been obtained via the dredging program. The purpose of this technical review is to assess bioassay performance, to revisit the suitability of the bioassays for evaluation of dredged material effects, and to determine the need for any changes in program biological testing requirements. This ongoing review is further described in this appendix (see page B-7).

The Clean Water Act Section 404(b)(1) Guidelines specify the types of potential adverse effects to the aquatic environment that must be considered when making regulatory decisions on dredged material disposal. These considerations include the persistence and permanence of effects, including the short- and long-term effects on aquatic communities and the potential for sublethal effects such as impairment to animal growth and reproduction. To date, the PSDDA agencies have relied on sensitive acute indicators or the use of the benthic infaunal abundance information to provide an estimate of the combined effects of acute and chronic exposure to any chemicals of concern that may be present in the dredged material.

The Puget Sound Dredged Disposal Analysis (PSDDA) agencies have agreed to improve the PSDDA evaluation procedures relative to assessment of potential chronic and/or sublethal effects by no later than June 1992. However, despite ongoing research, presently there is no widely accepted regulatory test for the assessment of potential chronic/sublethal effects of dredged material disposal.

The PSDDA agencies and others have worked over the last few years to develop a test that would better assess chronic/sublethal adverse effects. Previous technical work established a strong case for future use of the *Neanthes* biomass test in PSDDA evaluations of dredged material. However, there remain issues of field demonstration on dredging projects, intra/inter-laboratory evaluation, and regulatory application and interpretation of a final *Neanthes* biomass test protocol. Further details on the ongoing and proposed technical work to address the *Neanthes* biomass test are provided in this appendix (see page B-13).

PROPOSED ACTION

The PSDDA agencies will conduct a comprehensive review of the biological tests and biological disposal guidelines used in the PSDDA evaluation procedures. The issues to be addressed during this regulatory review, and the proposed review process, are summarized ...

Bioassay Regulatory Issues

Many regulatory tests have relied on clear endpoints that are relatively easy to interpret (e.g., bioassay animal mortality). For the *Neanthes* biomass test, the PSDDA agencies will need to address the ecological relevance and regulatory interpretation of a sublethal endpoint. The review will also evaluate the relevance of the *Neanthes* 10-day mortality endpoint currently used by PSDDA.

For the amphipod and larval tests, the regulatory review will address the establishment of an administrative default value for use when reference sediments exceed performance standards. Also for the amphipod test, the review will discuss the significance and interpretation of the amphipod reburial endpoint. For the sediment larval test, the use of abnormality and/or mortality alone will be compared to the combined mortality/abnormality endpoint currently used by PSDDA. The PSDDA agencies will also revisit the ecological relevance of the use of a "water column" test animal (e.g., bivalve larvae) as an indicator of sediment toxicity.

For the microtox test, the review will address the regulatory interpretation of light enhancement response and the ecological relevance of the extract test as an indicator of sediment toxicity. The insensitivity of the saline extract microtox for certain types of sediment contamination, and the potential modification to require an organic extract, will also be considered.

A key issue to be addressed during the coming review will be the regulatory integration of biological testing requirements. Ideally, the selected suite of biological tests will provide

ecologically-relevant information on a wide range of potential chemical types and effects, over a range of Puget Sound sediment types and degrees of contamination. Interpreting the results of multiple bioassays will require a determination of the appropriate mix of test species and endpoints. The PSDDA agencies will assess whether the current suite of biological tests remains the most appropriate for dredged material evaluation.

Review Process

The program review will be conducted by a Regulatory Work Group composed of representatives of the PSDDA agencies. Other agencies, tribes and the public will be invited to attend and participate in the Work Group meetings. The Work Group will be responsible for reviewing the test interpretation issues listed above, developing recommendations for needed improvements to the PSDDA evaluation procedures, and obtaining public input on these recommendations. The key steps in the Work Group process will be:

- Development of an initial regulatory framework (a "working hypothesis") based on agency experience — June 1991
- Refinement of the regulatory framework after evaluation of technical data review — August 1991
- Preparation of a report containing preliminary regulatory recommendations for review by PSDDA agency heads — January 1992
- Preparing a annual review issue paper — February 1992

Through discussion and review of this workplan, public review of this work will begin at the May 1991 Annual Review Meeting. At the meeting, a mailing list will be developed for individuals who wish to receive copies of minutes from the Regulatory Work Group meetings. The Work Group's findings report will also be included in these mailings. The issue paper will be distributed for public review prior to the annual review meeting to be held in spring 1992. Any significant changes to the bioassays, e.g., deletion or addition of a test organism, would be accomplished in accordance with the established PSDDA program change procedures, such that the changes would become effective by June 16, 1992.

ISSUE PAPER

WORKPLAN FOR CONTINUED DEVELOPMENT OF THE DISPOSAL SITE ENVIRONMENTAL MONITORING PROGRAM

Prepared by Betsy Striplin (DNR, 206/753-0263) for the PSDDA Agencies.

PROBLEM STATEMENT

The first environmental monitoring occurred at two PSDDA nondispersive disposal sites during spring 1990. During program implementation, several issues were raised regarding sample collection, sample processing, and data interpretation. Interim solutions to these issues were developed through technical discussions with the PSDDA agencies and the monitoring program contractor. These solutions enabled the program to continue without substantial delays.

The issues raised can be divided into two categories: 1) Issues that were addressed though straightforward modifications to the monitoring plan; and 2) Issues that require continued technical development. Issues belonging to the first category are presented in a separate clarification paper within appendix A of this report. The purpose of this issue paper is to present the workplan to address the issues requiring additional technical development so that recommended solutions can be developed and approved prior to the next disposal site monitoring which will occur in spring 1992. A mailing containing the conclusions of the monitoring workplan will be provided to the public during winter 1992.

The following discussion is divided into three sections, one for each technical monitoring issue. For each, a Background and Status section is provided along with the Proposed Action and Schedule.

MONITORING ISSUE: INTERPRETATION OF THE PERIMETER CHEMISTRY DATA

Background and Status

Several issues pertaining to the evaluation of perimeter chemistry data were raised during the 1990 monitoring program. Existing trigger guidelines (1.25 times baseline concentration) were determined to fall within routine field and laboratory variability. An alternative method was proposed that included an assessment of actual field variability. This alternative method was used to modify the trigger guideline for organic compounds from 1.25 to 1.47 times the baseline value. Application of this method to metals data resulted in maintaining the metals trigger guideline at 1.25 times the baseline value.

A procedure was also developed to estimate the baseline concentrations of metals and organic compounds at perimeter stations that had not been sampled during the baseline studies. This procedure involved calculating a mean baseline value from the adjacent two stations that was weighted by the distance from each of those two stations. An uncertainty factor was applied to the weighted mean that related to the distance between the new perimeter station and the closest baseline station.

During discussions among the PSDDA agencies and the monitoring contractor, other approaches to interpreting perimeter chemistry were proposed. Screening levels may be incorporated into an interpretation guideline. Loading calculations may also be helpful, as they were for interpretation of the 1990 monitoring data.

The evaluation of perimeter chemistry data also generated questions concerning the use of undetected values in decision-making, the issue of field variability, and the consequences of conducting a statistical assessment versus a weight-of-evidence assessment of potential changes in contaminant concentrations.

Proposed Action

The PSDDA agencies have agreed that the approach for establishing perimeter chemistry trigger levels requires re-evaluation and the subsequent recommendation of a preferred approach prior to the initiation of monitoring in spring 1992. Points of discussion will include:

1). Consideration of field variability in the establishment of trigger values.

2). Integration of trigger values, loading calculations, and SL values in the site management approach.

3). Consideration of using the weight-of-evidence approach (current PSDDA approach) versus an approach based on statistical significance.

4). Interpretation of trigger values and monitoring data that are qualified as undetected or estimated concentrations.

The cost implications of different approaches will be given appropriate attention. For example, the cost to conduct an assessment based solely on statistical significance will be greater than an assessment using the weight-of-evidence approach that is currently utilized. Accordingly, the long-term costs associated with data requirements for different approaches will be studied.

A workgroup of PSDDA-agency personnel will be tasked to recommend a preferred approach to evaluating perimeter chemistry. The workgroup will review the processes used to establish the original and interim trigger values. Using the 1990 monitoring data as representative of the types of data that will be evaluated, the workgroup will investigate alternative methods for establishing trigger levels.

Schedule

- PSDDA Agency Scoping — May 1991
- Workgroup Meetings — June - October 1991
- Draft Issue Paper — January 1992

MONITORING ISSUE: ASSESSMENT OF BENTHIC COMMUNITIES

Background and Status

The assessment of possible alterations to benthic infauna near the disposal site relies on changes in the abundances of major taxa (i.e., polychaetes, molluscs, crustaceans, total taxa) relative to baseline conditions. Several concerns about the approach to evaluate possible effects to benthic infauna were raised during the 1990 monitoring program. These concerns involved the survey design, sampling methods, and benthic variables for interpretation.

There is a lack of widespread agreement among benthic ecologists in the Puget Sound region on the optimal survey design and data interpretation methods to assess changes in the benthic infauna for regulatory decisionmaking. Methods provided in the benthic chapter of the Puget Sound Estuary Program protocols generally concern field and laboratory processing of samples.

Proposed Action

The Puget Sound Estuary Program has proposed convening an expert's workshop to address many of the benthic issues pertinent to the PSDDA program. The PSDDA agencies will participate in that workshop, and will later review the findings to assess their suitability for the PSDDA program. In the event that some issues remain unresolved, the PSDDA agencies may choose to convene a workgroup of regional benthic experts to address certain issues specific to the PSDDA program.

The benthic expert's workshop is tentatively scheduled for summer/early fall 1991. The PSDDA agencies will meet not later than one month following that workshop to discuss how the workshop results may be used for the PSDDA program. In the event that a workgroup of regional experts is needed, then that workgroup will be convened during fall 1991. If changes to the PSDDA monitoring plan are recommended, then an issue paper containing the recommended changes will be prepared. These changes will be adopted on an interim basis until the spring 1992 annual review meeting.

Schedule

■ PSEP Benthic Expert's Workshop	August 1991
■ Evaluation of Workshop Results	September 1991
PSDDA Workgroup Meeting, If Needed	November 1991
■ Draft Issue Paper	January 1992

MONITORING ISSUE: BIOACCUMULATION

Background and Status

During the 1990 monitoring program, the lack of specific protocols for collecting organisms for bioaccumulation analysis was identified as a problem. There is a growing body of literature that shows the positive relationship between organism size and contaminant concentrations in organism tissues. The existing baseline data do not include measures of organism size, making the interpretation of monitoring data difficult.

Proposed Action

The PSDDA agencies propose to collect additional data on the effect of size on the concentrations of PSDDA chemicals of concern in the tissues of the sea cucumber Molpadia intermedia and the clam Compsomyax subdiaphana. The Molpadia data will be collected from areas of Port Gardner that monitoring results showed did not receive dredged material. Data for Compsomyax will be collected from the vicinity of the PSDDA disposal site in Bellingham Bay (which has not received any dredged material). These data will be used to reassess the monitoring bioaccumulation trigger guidelines of two times the baseline value for metals and five times the baseline value for organic compounds.

Results will be presented in a technical report. An issue paper containing the new trigger values will be prepared, and the results presented at the annual review meeting in spring 1992.

Schedule

- Fieldwork — May 1991
- Draft Technical Report — August 1991
- Final Technical Report — December 1991
- Draft Issue Paper — January 1992