SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING MINUTES

August 1995

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Natural Resources
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Erratum for the 1995 Sediment Management Annual Review Meeting Minutes:

Please note that in Appendix A (Post-SMARM Comments and Responses), page 3, Part 2 of the response to Question 5 states "While the PSDDA program includes 2-methylnapthalene in the LPAH group, the SMS Rule does not." The resolution paragraph includes a recommendation that "PSDDA drop 2-methylnaphthalene from their LPAH group", but goes on to say that the "PSDDA agencies will no longer require testing for and reporting of 2-methylnaphthalene with submittal of PSDDA characterization data."

This latter statement is incorrect. As 2-methylnaphthalene is included in the SMS Rule and has apparent effects thresholds calculated for it, there is no reason to drop it from the list of PSDDA chemicals of concern. Therefore, the PSDDA agencies will continue to require testing for and reporting of 2-methylnaphthalene, but will no longer include it in the sum for the LPAH group.

TABLE OF CONTENTS

SMARM MINUTES

SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING MINUTES

The Sediment Management Annual Review Meeting (SMARM) was held on 3 and 4 May, 1995 at the Saint Helens Conference Center, Tacoma, Washington. The SMARM combined both the Puget Sound Dredged Disposal Analysis (PSDDA) Annual Review Meeting and the Sediment Management Standards (SMS) Triennial Review Meeting. The meeting was hosted by the Washington State Department of Ecology (Ecology), and was facilitated by the U.S. Army Corps of Engineers (USACE) on the first day and Ecology on the second day. The meeting agenda and list of attendees are provided as Attachments 1 and 2, respectively.

3 May 1995

1. Brian Applebury, Chief, Operations Division, Seattle District gave opening remarks and introduced Mary Riveland, Director, Washington State Department of Ecology.

2. Mary Riveland greeted the participants and discussed the decade of dredged material management in Puget Sound and the importance of managing and monitoring disposal sites before problems occur. She spoke of Ecology's environmental indicators report which shows whether or not progress has been made concerning environmental issues. The report stated that the major urban bays in Puget Sound contain contaminants which are toxic to the native biota. She pointed out that while the volumes of clean dredged material being disposed in the Sound are high, there is some contaminated material that requires management. A multi-user confined disposal site needs to be established soon. She mentioned the PSDDA agencies' cooperative agreement, and Ecology progress in establishing Sediment Management Standards (SMS) and rules for cleaning up contaminated sediments. The SMS triennial review process allows for a review of the standards, and for comments concerning the rules to be implemented. The meeting also allows for a chance to refine the PSDDA process and guidelines. She emphasized the need for public involvement.

3. Brian Applebury then introduced the panel of agency representatives: David Kendall, USACE, Seattle District; John Malek, Environmental Protection Agency (EPA), Region 10; Keith Phillips, Ecology; and Phil Hertzog, Washington Department of Natural Resources (DNR).

4. Brian Applebury reviewed the objectives of the joint meeting, including both PSDDA activities and the SMS triennial review process.

Ovrhd 1-1: Objectives
Ovrhd 1-2: SMARM

5. David Kendall reviewed the conclusions of the sixth annual review meeting and the actions taken in response to comments and requests by the public. He summarized the commitments and accomplishments of the ARM including the evaluation of the future capacity of the PSDDA disposal sites, re-examination of cost impacts, suspension of use of the saline Microtox bioassay,

decision to combine the ARM with the Sediment Management Triennial Review, elimination of the abnormality performance standard for the sediment larval test, and reconsideration of the use of biological effects assessment tools and alternatives in the monitoring of disposal sites. He also discussed debris disposal at the PSDDA sites, and expressed some concern about the ability to monitor the disposal of debris at the sites.

Ovrhd 2-1: Summary
Ovrhd 2-2: Commitments and Accomplishments
Ovrhd 2-3: Commitments and Accomplishments (continued)

6. Stephanie Stirling, USACE, reviewed the 1994 PSDDA project and testing activities. She provided an update on the number of projects for which ranking and suitability determinations were made, the number of projects and dredged material management units (DMMUs) which exceeded the PSDDA screening level or bioaccumulation trigger, and the volume of material disposed. Ms. Stirling also indicated that the PSDDA agencies are increasingly more involved in other areas including Grays Harbor/Willapa Bay, Columbia River, and federal superfund projects.

Ovrhd 3-1: PSDDA Project and Testing Activities
Ovrhd 3-2: PSDDA Evaluation Activities
Ovrhd 3-3: Project Definitions
Ovrhd 3-4: DY94 Projects
Ovrhd 3-5: DY94 Project Initial Ranking
Ovrhd 3-6: DY94 Sampling Plans
Ovrhd 3-7: DY94 Chemical Testing
Ovrhd 3-8: DY94 Biological Testing
Ovrhd 3-9: DY94 Suitability Determinations
Ovrhd 3-10: DY94 Disposal
Ovrhd 3-11: DY95 Projects
Ovrhd 3-12: Other Evaluation Activities

7. Deborah Lester, DNR, gave an overview of the 1994 PSDDA disposal site tiered full monitoring in Port Gardner. Ms. Lester reviewed the monitoring framework, explained the tiered full monitoring approach used, and described the modifications to the plan including benthic infauna collection changes, the use of *Ampelisca* in bioassay amphipod tests, and analysis of mercury and volatiles at all stations sampled. She then discussed the results of the sediment vertical profile survey (SVPS), chemical and biological testing, and the evaluation of the monitoring data. She expressed the difficulties in comparing the baseline data with current data (due to differences in sample analysis methods), and provided recommendations for statistical procedures used to evaluate the data.

Ovrhd 4-1: Presentation Agenda
Ovrhd 4-2: PSDDA Monitoring Framework
Ovrhd 4-3: Tiered Full Monitoring Approach

Ovrhd 4-4: Monitoring Stations
Ovrhd 4-5: Port Gardner Sampling Stations
Ovrhd 4-6: Additional Modifications
Ovrhd 4-7: Findings
Ovrhd 4-8: Sediment Vertical Profile System (SVPS)
Ovrhd 4-9: SVPS Map
Ovrhd 4-10: Sediment Chemistry
Ovrhd 4-11: Phenol Results
Ovrhd 4-12: Sediment Bioassays
Ovrhd 4-13: Evaluation of 1994 Monitoring Data - A
Ovrhd 4-14: Evaluation of 1994 Monitoring Data - B
Ovrhd 4-15: Evaluation of 1994 Monitoring Data - C
Ovrhd 4-16: Evaluation of 1994 Monitoring Data - D
Ovrhd 4-17: Recommendations
Ovrhd 4-18: 1993 Report Conclusions
Ovrhd 4-19: Statistical Procedures Recommendation
Ovrhd 4-20: Statistical Procedures Recommendation (continued)

8. Public Comments and Questions

Eric Johnson of the Washington Public Ports Association asked for more information concerning the Columbia River guidelines and policies, and the PSDDA program level of involvement.

Stephanie Stirling responded that coordinated management is beginning to be discussed for this area. The PSDDA agencies and the Portland District are cooperating to develop a regional plan in order to implement the Inland Testing Manual for this area. They expect to have a cooperative management approach, which may not necessarily include a PSDDA type screening level approach.

BREAK

9. Brett Betts of Ecology gave an overview of SMS implementation and the triennial review. He discussed the background of the SMS rules, and described current development and review needs. Mr. Betts indicated the SMS rules will be revised where appropriate in order to be consistent with PSDDA guidelines, and listed the joint PSDDA/SMS issue papers and issues for which revisions have been made or have been proposed. These included revisions for bioassay tests, freshwater sediment criteria, holding times for bioassay testing, human health criteria, net pen infauna studies, and chemical summing for HPAHs and LPAHs. He encouraged public comment on the proposed revisions (3 May to 30 June), and conveyed that comments should be sent to him.

Ovrhd 5-1: SMARM and SMS Implementation and Triennial Review
Ovrhd 5-2: Purpose of SMS and SMARM and SMS Rule Background
Ovrhd 5-3: Review of Latest Scientific Knowledge and PSDDA/SMS Joint Papers

Ovrhd 5-4: SMS Rule Background: Key Issues and Intent
Ovrhd 5-5: Current SMS Development/Review Needs
Ovrhd 5-6: SMARM Triennial Review and Post SMARM SMS Activities

10. Teresa Michelsen of Ecology presented the status of the regional cleanup activities. In her discussion of the implementation of the State's Sediment Management Standards, she expressed a need for freshwater cleanup standards, because there are more cleanups being conducted than expected in freshwater areas, and for estuarine areas such as the Duwamish and Snohomish River channels. She gave the status of current site activities, indicating that many have moved to the Remedial Investigation/Final Study (RI/FS) stage. For characterization of a site, she indicated that bioassays are often run first at petroleum contaminated sites, and chemistry archived pending the outcome of the bioassay tests. This differs from the tiered testing approach of the PSDDA program in which bioassays are typically triggered by the chemistry results. Various cleanup technologies such as natural recovery, capping, recycling, dredging, and habitat enhancement and restoration were reviewed. Current and future actions for the SMS implementation were also described such as completing technical guidance and sampling and analysis documents, and increasing technical assistance and sediment staff.

Ovrhd 6-1: Implementation of the State's Sediment Management Standards
Ovrhd 6-2: Current Site Activities
Ovrhd 6-3: Characterization and Cleanup Technologies
Ovrhd 6-4: Future Actions for SMS Implementation

11. Brenden McFarland provided an update on the source control group activities. He discussed the source control process, including transport modeling once the sediment and effluent quality are assessed. Program development included the Sediment Source Control Standards User Manual (SCUM1), the Water Quality Analysis Simulatory Program (WASP), and sampling and analysis plan guidance. Results of sediment contaminant transport modeling in Bellingham Bay were used as an example of development activities. Mr. McFarland discussed the evaluation of sediment monitoring and modeling results, and he indicated that there was a weak link between the screening process and the modeling results. Their current goal is to incorporate a revised equation to bridge the gap between the screening process and model predictions.

Ovrhd 7-1: Sediment Source Control Update
Ovrhd 7-2: Source Control Process
Ovrhd 7-3: NPDES Permits and Sediment Quality Issues Prior to 1993
Ovrhd 7-4: Sediment Source Control Process
Ovrhd 7-5: Program Development
Ovrhd 7-6: Contaminant Transport Process
Ovrhd 7-7: WASP/ARC INFO Modeling at Georgia Pacific and Bellingham
Ovrhd 7-8: Program Implementation
Ovrhd 7-9: Technical Assistance for Source Control
Ovrhd 7-10: Sediment Monitoring and Modeling Results
Ovrhd 7-11: Lessons Learned
Ovrhd 7-12: What Next?

12. Public Comments and Questions

Eric Johnson asked about the status of plans for allowing sediment impact zones.

Brenden McFarland responded that two are currently being worked on for locations where they are needed, although none are being issued at this time. A few questions need to be resolved first.

Eric Johnson noticed that two grids overlapped in the figure of the regions modeled in Bellingham Bay. He asked how that overlap area was modeled.

Brenden McFarland answered that the overlapping grids represented two different studies, and were modeled separately. They did not model them together because the discharges were of two different contaminants. It is possible for them to expand the model so that it can incorporate multiple discharges, although it was not necessary in this case.

Eric Johnson then asked if they were comfortable with distinguishing the Post Point Sewage Treatment from other effects.

Brenden McFarland conveyed that previous modeling did not indicate there were any problems with the Post Point effluent and should not have interfered with other effects.

Eric Johnson inquired what the distinction was between enhanced natural recovery and capping.

Teresa Michelsen replied that capping isolates the contaminants. Initially, infaunal organisms present are smothered/killed and recovery of the community is a slow process. They must rely on recolonization of the site. With enhanced natural recovery, the cap is thinner, resulting in dilution with improved benthic colonization and recovery via bioturbation. In this instance, the existing community is not eliminated.

Eric Johnson wondered if they had explored prepayment agreements for marine sediments.

Teresa Michelsen indicated that they were considering that, and are looking at cost recovery and prepayment systems.

Kris Holm who represents the Northwest Pulp and Paper Association, had a question concerning one of the cleanup approaches. The questioned concerned bioaccumulation studies that look at ecological considerations. She assumed that meant sediment toxicity to birds primarily.

Teresa Michelsen stated that bioaccumulation studies for ecological considerations were primarily for birds, or organisms higher in the food chain.

Kris Holm mentioned that wildlife protection criteria has not come up as something that is accomplished through the Sediment Management Standards. She asked Ms. Michelsen if she could explain how their cleanup approach ties in with the sediment management regulations.

Teresa Michelsen replied that wildlife protection has not been tied to the SMS. It is under the Model Toxics Control Act (MTCA) rules for ecological risk assessment. They have conducted bioaccumulation work where there could be an ecological impact, such as in wetlands, and also where there may be an effect on natural resources.

Kris Holm asked whether they were not then looking at sediment chemistry at each site and trying to determine if there is an ecological impact to wildlife.

Teresa Michelsen clarified that they were not, and were looking at impacts on wildlife only when wildlife issues are very obvious. One example was a wetland site contaminated with PCBs, but which had no pathway to humans, and for which there were not the toxicity issues they generally deal with at a marine site.

Kris Holm then asked how this ties back in with the regulations. Will they look at wildlife issues on a case by case basis?

Teresa Michelsen concurred that they would.

Kris Holm also questioned if Ecology has identified future NPDES permit requirements and cost impacts for potential requirements.

Brenden McFarland responded that there are potential triggers and there is the screening and modeling process, although it is vague how it will work with respect to regulatory requirements.

Kris Holm asked if modeling is performed and no impact is predicted, are there other requirements that must be met?

Brenden McFarland responded that it is possible that if modeling is performed and no impact is predicted, they may give it a "clean bill of health" (i.e. no further evaluation required). This is provided that they are satisfied with the modeling effort.

Lincoln Loehr of Heller, Ehrman, White & McAuliffe discussed an example of enhanced natural recovery at sites in which sediment contaminants can be correlated to an outfall. If the outfall is still in operation and no longer contaminated, it could be used to deliver clean materials which cover the contaminated material, reducing the toxic effects and aiding in natural recovery. The problem of increased suspended sediment may be an issue however, and relaxation of total suspended solids (TSS) regulations may be necessary. He asked if there was a mechanism in the NPDES permits for allowing this?

Both Brenden McFarland and Teresa Michelsen responded that it was an interesting thought. There have been some instances when the sediment materials from outfalls covering contaminated materials have been much cleaner. However, they were not aware of a mechanism in permits to allow for this possible enhanced recovery.

Teresa Michelsen also added a comment concerning her discussions as a response to Kris Holm's questions. She said that the Toxics Cleanup Program (TCP) is developing a set of guidelines for when ecological considerations should be studied at a site. The issue has been addressed in the past, and under current legislature they have been directed to look at ecological standards.

LUNCH BREAK

13. Justine Barton, EPA, replaced Brian Applebury as coordinator for the afternoon session. She introduced the next speaker.

14. Deb Lester presented an update on the status of PSDDA disposal site shoreline permit renewals. All permits have been renewed. To this date, no unanticipated impacts have occurred at any of the disposal sites. Ms. Lester then discussed the amendment to the permit rule concerning costs of disposal. She gave an overview of PSDDA revenues and expenditures and indicated that the fee increase would not solve revenue problems for long-term monitoring. The PSDDA agencies need to evaluate other alternatives. Ms. Lester informed the participants that the monitoring in Commencement Bay would be full monitoring this year and a partial monitoring in 1996. This was a correction to the status report included in the mailing, which indicated partial monitoring would occur in 1995.

Ovrhd 8-1: Status Update
Ovrhd 9-1: PSDDA Revenues and Expenditures

15. Stephanie Stirling discussed cost relief for small projects. She gave an overview of PSDDA testing and sampling costs for small projects ($3.06 per cy) as compared to an overall average cost for PSDDA projects ($0.49 per cy). Proposed modifications to the program to reduce costs for small projects were presented including increasing the volume of material for which testing is not required, eliminating the QAII data requirement on small projects, piggy backing small projects with larger projects or joint action, and a case by case elimination of some chemicals of concern for small projects.

Ovrhd 10-1: Small Project Cost Relief
Ovrhd 10-2: Current Small Project No Test Guidelines
Ovrhd 10-3: Cost Data for Small Projects from DY91 to DY93
Ovrhd 10-4: Proposed Program Modifications
Ovrhd 10-5: Small Projects Cost Data

16. Justine Barton presented a proposed federal rule for reference area standards for dredging projects in inland waters, including Puget Sound. Reference area selection and comparisons according to the proposed rule are consistent with current PSDDA requirements. The final rule is scheduled for completion in July.

Ovrhd 11-1: EPA Proposed Rule: Reference Sediment Approach and Definition
Ovrhd 11-2: Definition

17. David Kendall discussed the need for congener specific PCB analysis. Current methods of analysis used for the PSDDA program only distinguish the various PCB Aroclors. Because some of the PCB congeners are quite toxic (as are specific dioxin congeners), it is important to consider analyses which distinguish the individual congeners. This would require analysis for the individual analytes, which is expensive. At this time, the agencies need to further evaluate the methodology, QA/QC requirements, and interpretation of the results (e.g., unacceptable levels or regulatory triggers). It will be the subject of a future proposed action and issue paper. To alleviate cost problems, one possible action would be to perform PCB congener-specific analysis in low PCB areas only if the PCB screening level is exceeded. In areas which are known to have a history of high PCB contamination or are suspected to have high concentrations, they may go directly to congener-specific analysis.

Ovrhd 12-1: Coplaner PCB Congener Analysis
Ovrhd 12-2: Problem Identification
Ovrhd 12-3: Far Side
Ovrhd 12-4: List of the 209 Congeners
Ovrhd 12-5: Toxic Congeners
Ovrhd 12-6: Three Most Toxic Congeners
Ovrhd 12-7: Proposed TEFs for the Toxic Halogenated Aromatics
Ovrhd 12-8: Future Proposed Action/Modification
Ovrhd 12-9: Outstanding Issues PSDDA Agencies Must Resolve

18. Deb Lester presented the suggested refinements to the PSDDA post disposal monitoring. She addressed the issue that guideline values were determined from nonreplicated baseline data, and that the current analysis methods differ from those used for the baseline data. The recommendation was to discontinue use of the guidelines as they currently stand for offsite stations. Ms. Lester also reviewed other recommendations for the program including statistical analysis recommendations and the use of time trend analysis. She said they will be using data collected from Commencement Bay this summer to assess what will be the best methods to evaluate the data as opposed to using the guideline values.

Ovrhd 13-1: 1993 Report Conclusion Regarding Perimeter Chemistry Guidelines
Ovrhd 13-2: Statistical Procedures Recommendations
Ovrhd 13-3: Statistical Procedures Recommendations (continued)

19. Comments and Questions

Lawrence McCrone, PTI asked Stephanie Stirling if the cost data she presented for average costs per cubic yard for small projects and PSDDA projects included the sampling and analysis plan, mobilization, demobilization, sampling, etc. or if it was based strictly on sampling and testing.

Stephanie Stirling stated that the costs included the sampling and analysis plan, mobilization, sampling, testing, report, and other related costs. The information was reported to the PSDDA

agencies by the applicant or consultants performing the studies. It did not include permitting and associated costs.

Lawrence McCrone asked David Kendall if he had thoughts on how the congener data will be interpreted. Will it be used for site specific or human health risk assessments? Will screening and maximum levels be set for each congener?

David Kendall responded that they have not yet had discussions about how the data will be handled. They do not yet have data on it, although some programs do use it. They will be looking at these programs and he expects they eventually will come up with an interim number for the congeners.

Eric Johnson stated that he supports the proposed cost relief for small projects. Concerning the shoreline permit renewal, he asked Ecology if copies of Exhibit B for the Management Plan Report and Shoreline Master Plan recommended language had been sent to the seven or eight local jurisdictions. Have they officially notified the locals that recommended language exists in these documents?

Keith Phillips of Ecology said at one time the language was sent as recommended guidance, although he was not certain if the guidance would be repeated in the new Shoreline Master Program model language that Ecology was preparing.

Doug Hotchkiss, Port of Seattle, supported the cost relief for small dredging projects. He also added that it is possible that the number of small projects and cost relief may have been underestimated. There are projects for which the volume needing to be dredged was so small and the costs so high that they decided not to dredge. Mr. Hotchkiss wondered if PCB congener analysis becomes automatic in high PCB areas, what is the agencies definition of "high"; anything over the screening level?

David Kendall said that they would likely consider anything over the screening level high, or perhaps the bioaccumulation trigger level. They may also use bioassay data in this determination.

Doug Hotchkiss expressed his desire to be kept abreast of developments in requirements, and requested that the dredging community be involved early to be a part of the discussions.

David Kendall responded that it is the agencies intent to involve the dredging community, and that was the purpose of presenting this information (PCB congener issue) at the SMARM.

Doug Hotchkiss expressed his concern over costs and indicated he would like to see a cost analysis for the implementation of PCB congener-specific analysis.

David Kendall responded that they are aware of the cost concerns. It will be dependent on the methods of analysis selected.

Nancy Musgrove, Weston, asked if Ecology is considering PCB coplanar analysis for the Sediment Management Standards as well.

Keith Phillips replied that they will keep concurrent with the PSDDA process of evaluating these analyses and will consider them for the SMS. At this time, discussions have not proceeded.

Brett Betts suggested that the current SMS does not preclude looking at coplanar PCBs. He felt that even though screening levels or AETs have not been set for the toxic congeners, there was no reason the data could not be used in some way to evaluate a site.

Gene Revelas, Striplin Environmental Associates (SEA), asked Deborah Lester how many replicates were collected at each perimeter station.

Deborah Lester informed him that three replicates were collected at perimeter stations.

Gene Revelas pointed out that when performing statistical analyses and comparisons, they should be aware of the power. If you just did three replicates the power may not be sufficient to avoid accepting a null hypothesis that there are no effects, when there actually are. He felt that time trend analysis is a good approach in combination with the other statistics to avoid this situation.

20. Brett Betts presented proposed revisions to the SMS amphipod and juvenile polychaete rules. Currently, the SMS rule only identifies *Rhepoxynius* as a test species. The proposed rule language would include two other species, *Ampelisca* and *Eohaustorius*. Species substitution would depend on the salinity or grain size of the test sediments. Changes to the SMS juvenile polychaete (20 Day *Neanthes*) rule would include adopting the growth rate endpoint, requiring ammonia and sulfide water quality measurements, and possible revisions to reference and control standards. Ecology will coordinate with the USACE concerning the control performance standard revisions.

Ovrhd 14-1:	Amphipod Bioassay
Ovrhd 14-2:	Problem Statement, PSDDA Program Approach, and PSEP Protocol Revision
Ovrhd 14-3:	SMS Recommendations
Ovrhd 15-1:	Juvenile Polychaete Bioassay
Ovrhd 15-2:	Problem Statement and SMS Recommendations

21. Pamela Sparks-McConkey, Ecology, discussed the modifications to the SMS rule for the sediment larval bioassay. Among the proposed changes are revisions to seawater control and test performance standards, the addition of an alternate test species (*Strongylocentrotus droebachiensis*: green urchin), and sulfides and ammonia water quality measurement requirements. Revisions to the reference performance standard are being considered; however, these revisions are not recommended at this time.

Ovrhd 16-1: Larval Bioassay
Ovrhd 16-2: SMS Larval Bioassay Modifications
Ovrhd 16-3: Seawater Control Performance
Ovrhd 16-4: Reference Performance
Ovrhd 16-5: Test Performance
Ovrhd 16-6: Test Species
Ovrhd 16-7: Revisions to Protocol
Ovrhd 16-8: Proposed SMS Modifications

22. Rachel Friedman-Thomas reported proposed revisions to the PSEP bioassay holding time protocol, which will allow for more flexibility in holding times (important for both the PSDDA and SMS program approach). The proposed PSEP protocols will allow for up to 8 weeks holding time, although until the protocols are finalized, it will be assessed on a case by case basis. She stressed that the longer the holding time, the greater the probability of a false positive (i.e., toxic effect). Therefore, if tiered testing is not required for a specific project, PSEP recommends a maximum holding time of 2 weeks.

Ovrhd 17-1: Holding Time Protocols
Ovrhd 17-2: Bioassay Holding Time
Ovrhd 17-3: Proposed Changes
Ovrhd 17-4: Proposed Changes (continued)
Ovrhd 17-5: Ecology's Proposed Actions

23. Public Comments and Questions

Tim Thompson, SAIC, asked what SMS bioassay rules will apply for projects which occur during the interim period, before the revisions are official. How will projects be evaluated?

Keith Phillips responded that there is a provision (Alternate Technical Methods Provision) in the Sediment Management Standards that allows for procedures which may be more appropriate for a specific project yet differ from the what the rules require, provided there is prior approval. Therefore, if the sampling and analysis plan is reviewed by the agencies, it is possible the new procedures could be implemented now.

Tim Thompson concluded that for studies which are ongoing, they should use the rules that were in place when the project began.

Keith Phillips agreed. He said it is possible to submit a change in the workplan, but that is a logistical issue for a lot of projects; they are not suggesting they should back up and revise aspects of a project for the new procedure.

Lawrence McCrone asked if there were modifications in the *Neanthes* test, as there were in the amphipod test, to allow for salinity differences in test locations. For example, using alternate test organisms (as proposed for the amphipod test).

Brett Betts responded that he is not aware of the salinity adjustment issue specific for the *Neanthes* test.

Lawrence McCrone commented that in the *Neanthes* protocol it specifically indicates that *Neanthes* is inappropriate for low salinity test sediments. He said that there are provisions that the test can be modified on a test by test basis, but he wondered if it should also be written into the SMS rule as well.

Brett Betts replied that there are other organisms and tests which they use for freshwater locations. It would probably be more appropriate to use these types of tests and corresponding test organisms as opposed to modifying the *Neanthes* test.

Teresa Michelsen interjected that they have approved modifications in some instances, but in a couple cases there were some unexplained mortalities; the tests did not work as well as they thought it might. She wanted to add a note of caution.

Lawrence McCrone also inquired whether ammonia and sulfides measurements required are from multiple replicates, or if only one replicate was monitored. If multiple replicates are required, there may be a greater charge by the laboratories.

Brett Betts understood it to be every replicate.

Kevin Brix, Parametrix, responded that only one replicate is monitored. Tim Thomspon agreed.

Some attendees thought it was every replicate. Mr. McCrone emphasized that it is an issue because of the costs involved.

Brett Betts said he thought it was every replicate. He said that they need to look at the draft PSEP Protocols and decide whether it is optional or mandatory.

Mr. McCrone then asked if the revised protocols/guidance documents for bioassays would be released before the end of the comment period so that they can be fully reviewed in order to provide comments.

Brett Betts could not answer that question, but he would bring up the issue with the Ecology representative for the PSEP Protocols. He said that they would attempt to get them out as soon as possible, so that the protocols may be reviewed and commented upon.

Lawrence McCrone's final question was concerning the sediment larval test revisions. He understood that there was to be no performance standard for the reference sediment written into the revised rule at this time. He wanted to verify that he understood that correctly.

Pamela Sparks-McConkey confirmed that a reference performance standard would not be written into the rule. They want to first evaluate the PSDDA guidance with the data in the SEDQUAL

database, prior to making a recommendation for a performance standard.

Desiree Turner, SEA, noted discussion on ammonia toxicity in the *Neanthes* and sediment larval tests, but not for the amphipod test. She asked for Ecology's view of ammonia toxicity in the amphipod bioassay.

Brett Betts could not answer that at the moment, he would have to go back and review what it says in the protocol. He asked if anyone else could respond to her question.

David Kendall conveyed that after reviewing data in the DAIS database, ammonia did not appear to be a big issue for the amphipod bioassay. He said that ammonia has been nationally of concern, particularly on the east coast. The agencies will continue to consider this issue and monitor ammonia results. They may consider adding ammonia measurements for interstitial waters as opposed to the current method of measuring ammonia levels in the water column.

Desiree Turner commented that there is a need for the PSDDA agencies to review the EPA's proposed protocols for ammonia.

John Malek indicated the PSDDA agencies have reviewed the referenced protocols and had determined that the conditions which generated the protocol were a rare occurrence in this region. The PSDDA program will continue to look at ammonia and its potential toxicity for projects in this area before any specific protocol is set in place.

Ms. Turner then asked if the ammonia and sulfides measurements included in the proposed revisions to the *Neanthes* and sediment larval tests were for interstitial waters or for the water column.

Dave Kendall said the current PSDDA approach is for the water column.

Desiree Turner asked if this was true also for the SMS.

Brett Betts replied that he would have to look at the PSEP protocol. That is what the SMS will follow.

Tim Thompson mentioned that EPA nationally funded a study on interstitial toxicity of ammonia for all amphipods used in toxicity testing. He added that there are also numbers in the literature for interstitial waters for other studies. He could refer her to some of those documents. One could look at the numbers and get some indication as to whether there may be a false positive as a result of ammonia. He said amphipods exhibit a toxic response only at very high ammonia concentrations. Desiree Turner felt the interstitial ammonia studies were not applicable to the sediment larval test, and Tim Thompson agreed.

David Kendall said that responses to ammonia they have seen have been at very high levels of ammonia (unionized).

Dr. Arthur Whitely, University of Washington, inquired whether the sediment larval bioassay using *Strongylocentrotus droebachiensis* would be run at 12°C, and if the endpoint would be at 48 hours.

David Kendall referenced the current 15°C requirement.

Dr. Whitely felt 15°C was inappropriate for *S. droebachiensis*. This species does not develop well at that temperature, it is too high.

Tim Thompson disagreed. He has successfully grown them at 15°C.

The issue was referred to Paul Dinnel. He indicated that originally he recommended 12°C for sea urchins when *S. droebachiensis* was being used. He pointed out that when the temperature was raised from 12°C to 15°C, *S. purpuratus* instead of *S. droebachiensis* was being used in the tests. They had problems at 12°C for *S. purpuratus* because it did not always fully develop within the 96 hr limit. The 15°C temperature was accepted and a shorter test period defined (48 hr). This temperature was acceptable for the other organisms used in the sediment larval bioassay. He said he was not certain whether 15°C was acceptable for *S. droebachiensis* or not.

Kevin Brix had a question concerning the proposed *Neanthes* control growth endpoint performance standard of 0.72 mg/individual/day (issue paper not presented). He wondered why the average of the control results was used for the performance standard.

Therese Littleton described the methods used to derive the proposed standard by looking at Waterways Experimental Station (WES) studies and bioassay results in the DAIS database. The studies indicated there could be reproductive effects at low growth rates. The mean growth rates determined from data in DAIS were 0.72 mg/individual/day. They want the labs to continue to perform as they have, instead of having a lower target such as the current 0.65 mg/individual/day performance standard.

However, Kevin Brix felt that if they used an average criteria, half of the tests would have failed to meet the 0.72 mg/individual/day control growth endpoint performance standard.

Therese Littleton distinguished average from median. She contended that most of the growth rates were close to the average.

David Kendall reiterated that reproductive effects may occur when the somatic growth rate is below 0.45 mg/individual/day. Therefore, there is a strong concern that the bioassay laboratories have good growth rates. At this time, the 0.72 mg/individual/day growth rate performance standard for controls will be an interim guideline that the labs should strive to achieve. It is not a hard and fast criteria, but a level that the labs should strive to achieve for the control.

Kevin Brix was not certain if the number of replicates on which ammonia and sulfides water quality data are taken was clarified. He said the standard was one replicate.

Therese Littleton wanted to clarify, in case there was some confusion about the Neanthes growth rate requirement and endpoint interpretation, that the growth rate of 0.72 mg/individual/day is the performance standard for the control.

BREAK

24. Kathy Bragdon-Cook gave a review of the SMS rules for chemistry detection limits and TOC normalization. She addressed the problem of meeting appropriate detection limits for the chlorinated hydrocarbons and when TOC concentrations are low. There is a need for the laboratories to coordinate TOC and organic analyses in order to obtain an acceptable detection limit (at least as low as the SMS chemical criteria). She gave suggestions for reducing the detection limits. There may be instances in which laboratories are unable to meet the SMS required detection limit. In this case, they should report the problems they had meeting the detection limits and the measures taken to alleviate the problems. Given justification, Ecology will accept the lowest detection limits in SCUM1. In cases where low TOC (<0.5%) are expected or measured, she suggested that Ecology's regional expert or the sediment management unit be contacted to determine on a site specific basis whether sediment toxicity should be evaluated using the SMS TOC normalized criteria or the dry weight LAET (Lowest Apparent Effects Threshold) criteria.

Ovrhd 18-1: Sediment Management Standards Triennial Review
Ovrhd 18-2: Chemical Group Sums
Ovrhd 18-3: Chemical Group Constituents
Ovrhd 18-4: Current SMS Chemical Summing Method
Ovrhd 18-5: Chemical Summing Method Options
Ovrhd 18-6: Chemical Summing Method Options (continued)
Ovrhd 18-7: Send Input

25. Kathy Bragdon-Cook pointed out various methods have been used to calculate the chemical groups sums for LPAHs and HPAHs including the method described in the SMS rule. She presented these methods and requested comments (to be sent to her) on the best way to sum these chemical groups. This issue will be evaluated including the comments she receives as a potential modification to the rule.

Ovrhd 19-1: SMS Detection Limits
Ovrhd 19-2: 1988 AET for Selected Chemicals (TOC normalized)
Ovrhd 19-3: 1988 AET (dry weight normalized)
Ovrhd 19-4: SQS Criteria
Ovrhd 19-5: Common TOC Range in Puget Sound
Ovrhd 19-6: TOC Distribution in Puget Sound
Ovrhd 19-7: Wet to Dry Weight Normalization and TOC Normalization

Ovrhd 19-8: When TOC Normalization is Inappropriate
Ovrhd 19-9: Chlorinated Hydrocarbons
Ovrhd 19-10: Dry Weight DLs Needed to Meet Criteria at 0.5%, 1%, and 2% TOC
Ovrhd 19-11: Suggestions for Reducing Detection Limits (DLs)
Ovrhd 19-12: Chlorinated Hydrocarbon Group
Ovrhd 19-13: All Nonionizable Organics and Low TOC

26. Jim Cubbage gave an update on developments for the freshwater sediment quality standards and bioassays. He related that the goal is to develop criteria and biological testing procedures for contaminants in freshwater sediments. Progress to date included creating a freshwater sediment database, reviewing bioassay test results and evaluating test organisms, calculating AETs and defining hits, and determining the measures of sensitivity, efficiency, and reliability of the proposed criteria. There is currently a draft report for the freshwater sediment quality standards, for which he requested public review and comments.

Ovrhd 20-1: Freshwater Sediment Criteria Development
Ovrhd 20-2: Acknowledgements
Ovrhd 20-3: Goal
Ovrhd 20-4: Methods
Ovrhd 20-5: Review Criteria
Ovrhd 20-6: Create Freshwater Sediment Database
Ovrhd 20-7: Stations with Bioassay Testing
Ovrhd 20-8: Review Other Candidate Bioassays
Ovrhd 20-9: Develop Apparent Effects Thresholds (AETs)
Ovrhd 20-10: Bioassay Results
Ovrhd 20-11: *Hyalella* AET for Copper
Ovrhd 20-12: Test Sensitivity and Efficiency
Ovrhd 20-13: Type I Error
Ovrhd 20-14: Type II Error
Ovrhd 20-15: SQ Values Compared to Hit/No-Hit Data
Ovrhd 20-16: Conclusions

27. Pamela Sparks-McConkey discussed the status on developing the SMS Net Pen Sediment Criteria as was directed by a 1993 legislative mandate. Progress to date includes an evaluation of the net pen sediment technical data and an informal Assistant Attorney General Opinion from reviewing federal and state regulations on biological effects restrictions for authorizations of mixing zones. She concluded the presentation with the statement that Ecology will be proposing the SMS Rule Amendment in August 1995.

Ovrhd 21-1: Status of Marine Finfish Rearing Facilities Rule Development
Ovrhd 21-2: Purpose
Ovrhd 21-3: 1993 Legislative Mandate
Ovrhd 21-4: Status
Ovrhd 21-5: Status on Issues: Technical

Ovrhd 21-6: Status on Issues: Legal Analysis
Ovrhd 21-7: Status of SMS Rule Studies
Ovrhd 21-8: SMS Rule Amendment Schedule

28. Laura Weiss reported on the status of the development of human health sediment criteria for Puget Sound. Using the SEDQUAL database, chemicals of concern that bioaccumulated, have toxicity values, and occur in greater than 5% of urban bay sediments were identified as Group 1 chemicals of concern. She described the methods and approach in the development of biota-sediment accumulation factors (BSAFs), and how those BSAFs will be used in conjunction to standard risk assessment methods to develop human health sediment criteria.

Ovrhd 22-1: Human Health Sediment Criteria Development
Ovrhd 22-2: Why Develop Health Based Sediment Criteria?
Ovrhd 22-3: What and Where? Health-Based Sediment Criteria
Ovrhd 22-4: Figure Denoting Process Schematic
Ovrhd 22-5: Human Health Chemicals of Concern (Group I Organics)
Ovrhd 22-6: How Will Health-Based Criteria be Developed?
Ovrhd 22-7: Options for Development of Biota-Sediment Accumulation Factors
Ovrhd 22-8: Derivation of Risk-Based Sediment Quality Criteria for Carcinogens
Ovrhd 22-9: When Will Health-Based Criteria be Developed?

29. Public Comments and Questions

Doug Hotchkiss, speaking for himself, Eric Johnson, and the Ports, commented on the Human Health Rule. He and the Ports were concerned about the implications of the rule and the scientific validity on which the rule is based. He hopes those developing the rule are certain of the science involved in the development of the criteria, before moving ahead with the rule. He pointed out that it has taken years to develop the SMS rule and it is still being revised, there are not defined sediment impact zones for any site yet, and reference sediment station data exceed the draft criteria numbers. He urged the agencies to not rush into making decisions on the rule.

Dave Hericks, Beak Consultants, asked if an impact statement on the implications of adopting the Human Health Criteria Rule and its potential impacts would be written, and would it be completed before the rule is finalized.

Keith Phillips responded that an economic impact statement is a requirement for any rule adoption process. They do have an economic impact statement planned at this time. It has not been decided yet whether they will need to supplement the existing environmental impact statement, although they will have to look at the environmental side.

Dave Hericks had some comments and suggestions concerning the detection limits the laboratories must meet. He expressed that there has been considerable effort to standardize methods in sampling and analysis in Puget Sound, so that data from different studies will be comparable. One comment was concerning the TOC normalization starting to drive the detection

limits which must be achieved. Based on his experience and discussions with different laboratories, varying methods are used to obtain lower detection limits (e.g., some labs use a standard sample size, perform several extracts and combine the extracts; other labs use a larger sample size with a single extraction). He is concerned that although the laboratories are achieving a lower detection limit, the protocols for achieving that lower detection limit differ.

Dave Hericks' second issue was concerning the dry weight values in the SCUM1 document. He spoke with one laboratory to get their opinion on whether they could achieve the numbers in the document. They indicated they could not according to current method protocols. He urged the laboratories to take a look at the SCUM1 detection limits and provide comments to Ecology as to whether or not they are realistically achievable.

Kris Holm was speaking for a few people concerning the proposed Human Health Criteria. She said that when the general public looks at the implications of the proposed criteria, people will ask where the mandate is for the new set of standards. She said that she was not so certain that the Puget Sound Water Quality Act and other regulations are as direct as the agencies would like in specifying that Human Health Criteria are required for sediments. She emphasized that before the agencies draw those ties, the public would like to see the language out of those statutes which expresses where the mandate for the criteria is derived.

Kris Holm's second question was concerning the net pens policy issues. She asked when the Net Pen Sediment Criteria will be finalized or when the policy issue will return to the implementation committee.

Pamela Sparks-McConkey responded that it should be a quick process, but there were more reviews by workgroups needed prior to submittal to the implementation committee. An estimated time was not given.

Tim Thompson mentioned that one of the recommendations which came out of the fish tissue workshop a year ago was that they should develop criteria to regulate the fish flesh itself. He indicated that he has not seen any development on those lines to date.

Laura Weiss responded that a contractor recently prepared a paper on the use of fish tissue criteria options, entitled "Fish Tissue Regulatory Options", and that this paper is available. They are still reviewing how to use the fish tissue data, but they expect to use it in some manner. She said the rule may take a stepwise approach: first look at the sediments and then look at the fish tissues to see if they confirm what would be predicted from the sediments, and then from there they would look at more site specific information.

Tim Thompson recommended that as part of the rule they should give the applicant the option of proceeding to the fish (or clams or oysters) tissue first (eliminating the sediment step). This would get at the carcinogen and human health issues right away, and would be more cost effective for the applicant.

Doug Hotchkiss added that the cost of doing the research that Ecology should be doing now is put on the future applicants after they are hit with a rule that is not founded on science.

Keith Phillips pointed out that it is possible to go directly to fish tissues if you have existing conditions to try to assess what to do about them. He said it is not possible to do that when permitting a discharge situation, particularly in an area previously uncontaminated or which could have human impact. When trying to determine whether a discharge should be allowed, modeling would be appropriate.

Tim Thompson agreed with those situations. He still felt that when you want to know if human health is a concern, the applicant should be given the option of going directly to the tissue analysis and bypass the sediment criteria.

Keith Phillips said that one of the premises may be whether or not the chemistry information serves other purposes: for dredging decisions or looking at ecological numbers. You may not know right away that fish tissues are of concern, until looking at the fundamental characterization of the site. However, if you do know they are an issue, you may be able to go directly to the fish tissues.

Lincoln Loehr had a comment concerning the Human Health Criteria and its purpose of protection of human health. He felt that the risk numbers of levels of 10^{-6} do not really provide the public with the balanced information they need to make informed decisions. He said that if numbers are set where people discern that since the sediments are contaminated and consequently so are the fish, the public will avoid eating those fish. The public should have a reality check to compare the risk of eating those fish versus other sources of protein they may use. They possibly may be better off eating the fish than red meat. He concluded that the primary beneficiary of the "scare tactic" (too low risk numbers) might be the fish.

Bob Chandler, City of Seattle, stated that his assumption is that the Sediment and Human Health Criteria would be applied across the board. He felt they may not be applicable in certain situations, particularly when there is not a ready pathway between the sediments and human consumption (e.g., urban estuaries). He hopes that there will be some consideration given that the criteria may not be universally applicable to all areas.

Lawrence McCrone, PTI, asked if the method of summing groups of compounds (LPAHs, HPAHs) according to the SMS rule is revised, will Ecology revisit the AETs and LAETs (which were based on the SEDQUAL database which may have been based on a different method of summing).

Brett Betts replied yes, if the method of summing is changed, the AET values would be revised accordingly.

Lawrence McCrone indicated that it would only drive the AETs lower. He added that the same would be true if they added 2-methylnapthalene to the sum, that it may be necessary to revisit the AETs.

Brett Betts agreed.

30. Meeting adjourned for the day.

4 May 1995

1. D.J. Patin gave the opening remarks and moderated the 4 May 1995 session. She discussed the objectives of the day, which included public input to changes in the SMS rule and PSDDA via issue papers and public comment, and joint PSDDA/SMS status reports.

2. Eric Johnson presented an issue paper concerning the involvement of the proposed Northwest Straits Marine Sanctuary in the PSDDA program. He expressed his concern about the level of involvement of the National Marine Sanctuary (NMS) in the PSDDA program, particularly with regards to dredging permit decisions, in suitability determinations, or in monitoring and management of open-water dredged material disposal sites. It could create many problems if the NMS is involved with these aspects of the program, and that it would be more appropriate if the NMS is involved only through the annual review process.

3. Lincoln Loehr gave a presentation on his issue paper, "The validity of bioassay protocols and the historical bioassay data as representing toxicity of sediments in Puget Sound". He discussed the issue that apparent effects thresholds were based on toxicity tests performed on disturbed sediments under conditions that were more representative of a static environment, as opposed to a flow-through system as occurs in the real world. He expressed that the AETs may be overly conservative. When determining AETs, we need to allow for confirmatory testing more representative of the ambient environment; insufficient physical data were used in the development of the AETs. Performing bioassays on disturbed sediments may not be representative if ambient sediments are not disturbed. In addition, the effects of pore water salinity should be taken into account. He postulated that the SMS may have been based on data where some hits may have been due to low salinity; however, there is no way of knowing this because salinity measurements were not taken.

Ovrhd 23-1: EPA SAB July 1989: Physical Factors
Ovrhd 23-2: EPA SAB July 1989: Bioassays
Ovrhd 23-3: Stability and Disturbance
Ovrhd 23-4: EPA Office of Marine and Estuarine Protection

4. Lincoln Loehr presented a second issue paper, "The validity of bioassay protocols and the historical data as representing toxicity of sediments in Puget Sound when ammonia has not been considered". Similar to the salinity issue, he proposed that some of the standards may have been driven by hits which may actually have been due to ammonia toxicity, particularly when sediments were highly organic. He provided copies of a paper written by Anne Jones-Lee and G. Fred Lee: "Toxicity of ammonia in aquatic sediments and its implications for sediment quality evaluation and management".

5. <u>Agency Comments on Issue Papers</u>

Phil Hertzog expressed his concerns about the involvement of the National Marine Sanctuary/NOAA in the PSDDA process. The agencies need to evaluate any benefits which may

be derived from the involvement of the NMS, and determine what other players (e.g., bureaucracy) will be added. At this time, the PSDDA agencies do not have a management agreement with NOAA in place.

6. Public Comments and Questions

Doug Hotchkiss commented that additional study on ammonia in interstitial waters is needed. Some of the toxicity results for bioassay tests may have been a result of the ammonia and sulfide concentrations as opposed to contaminants in the sediments. The agencies should consider including measurements of ammonia in interstitial waters, along with the overlying water measurements (as currently performed), in the test protocols. He pointed out that the concentrations of ammonia in the interstitial waters must be very high in order to measure it in the overlying water.

Mel Oleson commented on Lincoln Loehr's discussion concerning disturbed sediments and agreed that the current toxicity testing methodology tends to have a very conservative artifact. One issue is concerning the suspension of sediments which allows for the organics to enter into the water column, so that a toxic water effect as opposed to a sediment effect is actually measured. The other issue is that the tests do not take into account the ambient conditions of the site where test sediments were collected. For example, the Duwamish River has strong currents and freshwater input effects. He feels the agencies should review the bioassay testing methods and make sure they are representative.

Teresa Michelsen pointed out that when commenting on disturbed vs. undisturbed sediments in the tests, we should consider the logistics of obtaining undisturbed sediment. There may be a problem in the collection of undisturbed sediments. In addition, a disturbed condition may actually be more representative of the environment from which the sediments are collected, particularly in shallower areas. She asked this to be taken into consideration when writing comments on disturbed sediments.

Doug Hotchkiss added a comment on Lincoln Loehr's presentation on disturbed vs. undisturbed sediments and salinity concerns in pore waters. He agreed that measurement of interstitial salinity is important particularly in areas where there may be freshwater or groundwater effects (e.g., in shallower areas such as lower intertidal areas and nearshore disposal sites).

Lincoln Loehr mentioned that once there is a situation in which the pore water salinity is less than 25 ppt, there are no numbers yet in the Sediment Management Standards to evaluate these data. The data in the SMS address sediments that have higher salinities.

BREAK

7. Pamela Sparks-McConkey gave the status of the establishment of reference area performance standards and an evaluation on revisions to the benthic effects criteria. Objectives were to evaluate endpoint sensitivity in assessing benthic community effects, evaluate statistical analyses

used in identifying adverse community effects, and to define reference conditions for Puget Sound. Studies conducted to evaluate these issues included compiling synoptic data sets of sediment chemistry, sediment type, biological community, and sediment quality, and developing reference values and indices. The efficiency of benthic indices in identifying degrees of biological impact effects were also evaluated. Ecology is currently determining the manner in which this information will be used for PSDDA and SMS regulatory decisions.

Ovrhd 24-1: Status of the Benthic Infauna Studies
Ovrhd 24-2: Purpose, Study Objectives
Ovrhd 24-3: Approach
Ovrhd 24-4: Establish Habitat Categories
Ovrhd 24-5: Development of Reference Values
Ovrhd 24-6: Evaluating Benthic Indices
Ovrhd 24-7: Recommendations
Ovrhd 24-8: Purpose
Ovrhd 24-9: Approach - Statistical Analyses
Ovrhd 24-10: Approach - Multivariate Analyses
Ovrhd 24-11: Recommendations
Ovrhd 24-12: Status on Recommendations

8. Therese Littleton discussed the status of the Microtox test for PSDDA and the SMS. Because the saline extract test was questionable (inability to clearly interpret results, performance standard problems), the use of the test for suitability determinations had been suspended until more data were reviewed. Side by side testing of saline and solid phase Microtox tests were planned. However, only one set of tests were performed during the past year for the PSDDA review. Therefore, the PSDDA program is unable to evaluate the tests. The result of the saline vs. solid phase test implied that the solid phase test was more sensitive. The PSDDA program will continue the suspension of the test until more data become available.

Ovrhd 25-1: Evaluation of the Microtox Bioassays
Ovrhd 25-2: Microtox
Ovrhd 25-3: Problem Identification
Ovrhd 25-4: Status of Work
Ovrhd 25-5: Gary Larson Cartoon

9. Tom Gries related the status of new AETs, particularly for amphipod mortality and sediment larval abnormality. He reviewed the background of AET development, the method of calculating the new AETs, and the difference in calculation of AET values. The new AET calculations included some subsurface samples, while the 1988 values were based only on surface sediment samples. In addition, power analysis was used in the calculations for the echinoderm test. Amphipod mortality AET values generally remained the same with some increasing over the 1988 values. Dry weight normalized echinoderm abnormality AETs were often lower than corresponding 1988 oyster values, while the carbon normalized echinoderm abnormality AETs were sometimes higher than the 1988 oyster values.

Ovrhd 26-1: Progress Re-evaluating Puget Sound AETs
Ovrhd 26-2: Conclusions
Ovrhd 26-3: Background
Ovrhd 26-4: Background (continued)
Ovrhd 26-5: Objectives
Ovrhd 26-6: Calculating 1994 Puget Sound AETs: General Approach
Ovrhd 26-7: Calculating 1994 Puget Sound AETs: Schematic
Ovrhd 26-8: Calculating 1994 Puget Sound AETs: 1988 Differences
Ovrhd 26-9: SEDQUAL Database
Ovrhd 26-10: Amphipod Mortality - Trace Metals
Ovrhd 26-11: Amphipod Mortality - Dry Weight Organic Compounds
Ovrhd 26-12: Amphipod Mortality - Organic Carbon Normalization
Ovrhd 26-13: Sensitivity of Echinoderm AETs
Ovrhd 26-14: Ratio of 1994 Echinoderm to 1988 Oyster AETs
Ovrhd 26-15: Rank of 1994 AETs Among 5 Puget Sound AETs
Ovrhd 26-16: Reliability of Dry Weight Puget Sound AETs
Ovrhd 26-17: Conclusions
Ovrhd 26-18: Conclusions (continued)
Ovrhd 26-19: Recommendations
Ovrhd 26-20: Volume II Objectives
Ovrhd 26-21: Recommendations

Mr. Gries also recounted accreditation requirements for laboratories, including a review by Ecology of standard operating procedures, analysis of a standard reference material (SRM), on-site system audits of the laboratory's capabilities, and annual requirements for maintenance of accreditation. He stated that some laboratories have let their accreditation lapse, and that everyone should verify that the laboratory with which they work is still accredited.

Ovrhd 27-1: Initial Accreditation Requirements
Ovrhd 27-2: Analogous Water Method
Ovrhd 27-3: Submit SOP Used by Lab
Ovrhd 27-4: Analyze an Appropriate SRM
Ovrhd 27-5: SRM Analysis
Ovrhd 27-6: On-Site System Audit
Ovrhd 27-7: Annual Requirements for Maintaining Accreditation
Ovrhd 27-8: Annual Requirements for Maintaining Sediment Accreditation
Ovrhd 27-9: Accreditation Requirements for Toxicity Testing

10. John Malek provided an update on regional and national issues. He conveyed that little has changed over the past year on the national front. National EPA workgroups have been formed to develop guidance regarding how five draft sediment quality criteria will be used in EPA program areas. The final rule for the five draft criteria should be out in the spring of 1996. The final rule for the reference sediment criteria should be out in July 1995. Public comments are being addressed for the Inland Testing Manual, and the final manual should closely follow

publication of the reference sediment rule. A national QA/QC Manual for Chemical Analysis will be published, and should be released soon after the Inland Testing Manual. A Site Management Plan Guidance document is being developed and should be published soon, and a Site Management and Monitoring Manual is currently at an internal draft stage and should follow the management plan document. A draft of ocean dumping regulations revisions should be complete in the fall or winter, 1995. The EPA and USACE are developing guidance to form national and regional dredging teams. The big issue nationally is bioaccumulation and what it really means. Regional workshops conducted on the east coast have identified a number of research needs. Currently, a Corps/EPA national workshop is planned for August 1995 to discuss bioaccumulation for dredged material. Regional manuals and programs are being put together to standardize procedures so that different programs and districts are coordinated. These include the Inland Testing Manual, Grays Harbor/Willapa Bay program guidance manual, and the Columbia River program. In addition, interagency workgroups are in place including the sediment cleanup, beneficial uses, and the multi-user disposal site (MUDS) workgroups.

Ovrhd 28-1: National and Regional Issues Update
Ovrhd 28-2: National and Regional Issues Update (continued)
Ovrhd 28-3: Regional Issues

11. Rachel Friedman-Thomas discussed recommendations of the sediment cleanup workgroup. She reviewed the development of the cleanup strategy, which involved establishing a sediment cleanup workgroup. The group focused on facilitating cleanup under the existing legal framework, strategies for conducting urban sediment cleanups, agency roles and possible funding sources to participate in sediment cleanup, and the possibility of changing the legal schemes for sediment cleanup. The recommendations of these groups were to manage sediment loading; to coordinate the agencies to work together, pool resources, determine priority issues; to release a sediment contaminated site list for Puget Sound; to institute a bay-wide approach to source control sediment cleanup, dredging disposal, shoreline permits, habitat, and navigation; to focus on hotspots; to reduce barriers to cleanup and provide incentives for voluntary cleanup; and to set in place a multi-user disposal site. Currently the proposed strategic direction for sediment cleanup is to finalize the draft progress report, address the recommendations, and complete a limited number of initiatives.

Ovrhd 29-1: Sediment Cleanup Workgroup Recommendations
Ovrhd 29-2: Interagency/Intergovernmental Agreement
Ovrhd 29-3: Sediment Cleanup Work Group
Ovrhd 29-4: Work Group Charges
Ovrhd 29-5: Consensus Recommendations
Ovrhd 29-6: Consensus Recommendations (continued)
Ovrhd 29-7: Proposed Strategic Direction for Sediment Cleanup

12. Steve Babcock, USACE, reported the status of the Grays Harbor/Willapa Bay special study implementation. The program objectives were to establish publicly acceptable guidelines governing environmentally safe disposal of clean dredged material at established estuarine and

ocean disposal sites. This included dredged material evaluation procedures and development of disposal site management plans. The program, which is a PSDDA-like program, will be reviewed annually at the SMARM. The proposed program has been publicly and agency reviewed, and comments addressed. The program is ready to be implemented. The agencies have a public notice to be issued, and as soon as the agency heads sign off on the program, the guidelines will be available for full distribution.[1]

Ovrhd 30-1: Grays Harbor and Willapa Bay Dredged Disposal Analysis
Ovrhd 30-2: A Cooperative Federal-State Effort
Ovrhd 30-3: Program Objectives
Ovrhd 30-4: Study Framework
Ovrhd 30-5: Status
Ovrhd 30-6: Cover for Final Report

Steve Babcock also reviewed the Puget Sound Multi-user Disposal Site (MUDS) study and the need to establish one or more sites for disposal of contaminated sediments. The agencies are developing an action plan so that a MUDS site can be established. The studies include a reconnaissance phase and a feasibility phase. They hope to have the feasibility phase funded by both a federal and non-federal interest. They are currently at a preliminary stage of scoping the effort, assessing the work that has been done, and getting information to the public in order to get input.

Ovrhd 31-1: Puget Sound Multi-User Disposal Site (MUDS) Study
Ovrhd 31-2: Principal Participating Agencies
Ovrhd 31-3: Action Plan Elements
Ovrhd 31-4: Corps of Engineers Study
Ovrhd 31-5: Reconnaissance Study

13. Public Comments and Questions

Mel Oleson noted that PSWQA was involved in some of the programs, and that there is concern that this agency is under some jeopardy. He wondered how the agencies will handle this with respect to PSWQA's involvement in the programs.

Keith Phillips replied that the agencies are waiting to see what happens with PSWQA. They really have not done anything concerning this yet.

Greg Holman, King County Metro, asked if Ecology is going to suspend use of the Microtox test in the Sediment Management Standards, as PSDDA has currently done.

[1] All agency heads have approved the Dredged Material Management Plan (end of June) for immediate implementation and the final plan will be mailed out to the public by the end of July 1995.

Teresa Michelsen replied that Ecology has used Microtox tests in evaluations of freshwater sites. The test has been useful at sites where sediments were very contaminated. However, they are not satisfied with the saline extract test, and are interested in the solid phase test. Ecology is also looking into the chironomid test, which has multiple endpoints (one is a growth endpoint similar to the *Neanthes* test).

Dr. Kok-Leng Tay from the Halifax, Nova Scotia, Atlantic Region in Canada, conveyed that Canada has similar issues of concern as have been presented at the SMARM (e.g., coplanar PCB analysis, onsite vs. offsite, Microtox testing). He wanted to share some of the knowledge they have obtained. They have run numerous Microtox tests. For the saline extract test, there were no positive results regardless of sediment contamination. Use of the saline extract test has been abandoned. Currently the organic extract and solid phase Microtox tests are in use. The solid phase test was very sensitive. In addition, there exists a bacteria community test which looks at the bacteria community collected from a dump site. The bacteria and solid phase Microtox tests were well correlated. They have also begun to look at ammonia and sulfides, which have correlated well with the solid phase test. However, there was not a correlation with the amphipod test. He concluded with requesting that we not forget them in Canada, and to keep them informed of developments. It would be good to coordinate the various efforts of both countries.

Eric Johnson asked Pamela Sparks-McConkey if the organic enrichment listed on her overhead of environmental stresses was TOC.

Pamela Sparks-McConkey replied that it was.

Eric Johnson had a question concerning the development of the AETs. He was concerned about the anomalous no hit samples that were eliminated from the calculations of the AETs, and wondered if Ecology (Tom Gries) was sure that good data were not being thrown out. He also wondered what the next step would be concerning the AETs, and whether a regulatory workgroup would be set up.

Tom Gries indicated that in developing the AETs the same methodology used in 1988 was followed, which considered subjective and statistically based methods of testing for outliers. He said the subjective methods were chosen, but he was not entirely comfortable with that approach. Statistical tests for outliers would be preferable. He agreed that there is always a hesitancy to throw out data, especially if it could set higher AETs. However, in this instance, most of the anomalous samples which were eliminated seemed to be severe outliers, and he felt comfortable that the values did not belong in the data set. Concerning what the next step is with respect to AETs, the PSDDA agencies are at the technical level of AET development, and need to move on to the policy realm. The PSDDA agencies will likely convene a workgroup, which will discuss the next steps, and eventually release a second report with recommendations.

D.J. Patin asked if there were any comments on the clarification papers not presented at the SMARM (*Neanthes*, reference sample analyzed in each batch). There were no comments.

Kris Holm had some basic questions for which she did not feel she really had answers to pass on to the Pulp and Paper Association and other members of the regulated community: 1) Does she have a contaminated site associated with her discharge, which she should be cleaning up? 2) Are there stable AETs, so that if someone wants to cleanup a site now, and spend a substantial amount of money doing so, it would be with the assurance that it is what they need to do. She would have to tell the regulated community that no, the AETs are changing and there are human health criteria involved. She could not give them a good answer to that question. 3) Are we in agreement with the appropriate cleanup level? 4) Once cleanup occurs, where will the contaminated material be placed? She would have to say that there is no approved disposal site, and that issue still needs to be resolved. She appreciates that the agencies are working on these issues, but it is getting frustrating with the regulated community not to be able to have answers to those questions. She stressed that it is very important that the agencies work well together and continue to talk together. It seemed to her that when issues are elevated to higher levels of management, progress is slowed. She also wondered how the AET developments will be integrated, and how will it affect the public, particularly since the public involvement in the Sediment Management Standards is not every year. She and the regulated community are anxious to see progress with respect to the AETs.

Doug Hotchkiss commented that the Ports are interested in reading the technical papers concerning the development of the AETs and the benthic criteria. The Ports want to be assured that good science is being used to develop the guidelines. He has some concerns about the AETs. From one perspective, it appears that a circular type logic in revising AETs may occur, such that AETs are kept close to the original levels. If the AET changes too much, it makes everyone uncomfortable, particularly if the level was five times higher than initially determined. He is concerned that those determining the AETs may be more likely to call certain data points (which may result in the calculation of a higher AET) anomalous, when this may not be the case. It would be tough to go to the public and say that the AET was much higher than originally thought.

Doug Hotchkiss stated that he also wants to look at the benthic community analyses with respect to reference stations. Are data being truncated when looking only at <150 ft depth communities? When identifying a reference station, will the benthic community present be used as well as grain size and other physical parameters?

Rachel Friedman-Thomas wanted to bring to the public's attention that the State Department of Fish and Wildlife has drafted a proposed rule to restrict the importation of exotic species. It includes specifications to regulate toxicity testing laboratories, and could include the invertebrates used in the PSDDA and SMS bioassay tests. She said that the Department of Fish and Wildlife needs to receive comments by 11 May 1995. She could try to get copies to any interested parties.

Maria Peeler added another comment concerning the above draft. She said that the proposed rule is more extensive than previously presented. It would have an impact on imported test

organisms such as amphipods and *Neanthes*, and that a laboratory would have to get a permit each time it imports test organisms.

Pamela Sparks-McConkey responded to Doug Hotchkiss's comments on the benthic reference indices. Locations which were less than 150 ft water depth were selected for the development of the reference indices, but the indices will not be applied throughout the water depths found in Puget Sound.

Doug Hotchkiss thanked her for the response and added that it will help when he can look at the technical paper, that it will clarify items which may not have been in the summary.

BREAK

David Kendall reviewed the comments received and issues to which PSDDA and the SMS group will respond before the next annual review meeting. He remarked that written comments concerning the SMARM meetings must be submitted to the PSDDA agencies and SMS group by 18 May 1995 for consideration. Triennial Review comments should be submitted to Ecology by 30 June 1995.

(See Appendix A for public comments and issues, and agency responses to comments.)

14. D.J. Patin closed the meeting and reminded the participants that the comments should be submitted by 18 May 1995.

ATTACHMENT 1

Agenda

Sediment Management Annual Review Meeting
Jointly Sponsored by the
Puget Sound Dredged Disposal Analysis (PSDDA) Program
and the
Department of Ecology-Sediment Management Standards (SMS) Group

Location: Saint Helens Conference Center, Tacoma, WA

Final Agenda

MORNING SESSION (May 3, 1995)

Coffee (8:30-9:00am):

Introduction and Overview (9:00-9:30am):

Greeting: Mary Riveland, Director, Washington State Department of Ecology

Joint Meeting Objectives: Brian Applebury, Chief, Operations Division, Seattle District

PSDDA Program Overview (9:30-10:15am)

- ☞ Conclusions of Previous PSDDA Annual Review Meeting, Actions Taken (David Kendall, Corps)
- ☞ Overview of PSDDA Project/Testing Activities (Stephanie Stirling, Corps)
- ☞ Disposal Site Monitoring Overview (Deborah Lester, DNR)

Discussion and Public Comment on above topics (10:15-10:30am)

Break (10:30-10:45am)

SMS Overview (10:45-11:30am):

- ☞ SMS Implementation and Triennial Review (Brett Betts, Ecology)
- ☞ Regional Cleanup Activities (Teresa Michelsen, Russ McMillan, Ecology)
- ☞ Source Control Activities (Brendan McFarland, Ecology)

Discussion and Public Comment on above topics (11:30-11:45am)

Lunch (11:45-1:00pm):

AFTERNOON SESSION (May 3, 1995)

Presentation of PSDDA Status Reports and Issue Paper (1:00-2:15pm):

- ☞ PSDDA disposal site shoreline permit renewals (Deborah Lester, DNR)
- ☞ DNR Site Use Fee Increase (Deborah Lester, DNR)
- ☞ Small Project Cost Relief (Stephanie Stirling, Corps)
- ☞ Reference Area Standards for Dredging (Justine Barton, EPA)
- ☞ Congener Specific PCB Analysis (David Kendall, Corps)
- ☞ Issue Paper: Refinements to PSDDA Post Disposal Monitoring Guidelines (Deborah Lester, DNR)

Discussion and Public Comment on above topics (2:15-2:30pm)

Break (2:30-2:45pm)

Presentation of SMS Triennial Review Papers (2:45-4:30pm)

- ☞ Amphipod Bioassay (Brett Betts)
- ☞ Juvenile Polychaete Bioassay (Brett Betts)
- ☞ Larval Bioassay (Pamela Sparks-McConkey)
- ☞ Holding Time Protocol (Rachel Friedman-Thomas)
- ☞ Chemical Summing Protocol (Kathy Bragdon-Cook)
- ☞ Detection Limits and TOC Normalization (Kathy Bragdon-Cook)
- ☞ Freshwater Sediment Quality Standards/Bioassays (Jim Cubbage)
- ☞ Net Pen Infaunal Studies (Pamela Sparks-McConkey)
- ☞ Human Health Criteria Development Status (Laura Weiss)

Discussion and Public Comment on above topics (4:30-5:00pm)

Adjournment for Day (May 3, 1995)

SMS Triennial Review Public Hearing (7:00-9:00pm)

MORNING SESSION (May 4, 1995)

Coffee (8:30-9:00am):

Introduction and Objectives Overview (9:00-9:05am) (D.J. Patin, Ecology)

Presentation of Issue Papers by the Public (9:05-9:50am)

- ☞ Involvement of the proposed Northwest Straits Marine Sanctuary in the PSDDA Program (Eric Johnson, Washington Public Ports Association)

- ☞ Validity of bioassay protocols and the historical bioassay data as representing toxicity of sediments in Puget Sound (Lincoln Loehr, Heller, Ehrman, White & McAuliffe)

- ☞Validity of bioassay protocols and the historical bioassay data as representing toxicity of sediments in Puget Sound when ammonia has not been considered (Lincoln Loehr, Heller, Ehrman, White & McAuliffe)

Discussion on Public Issue Papers (9:50-10:15am)

Break (10:15-10:30am)

Joint PSDDA / SMS Status Reports (10:30-11:45am)

- ☞ Benthic Issues: Status on the establishment of reference performance standards, and the evaluation on revisions to the biological effects criteria (Pamela Sparks-McConkey, Ecology)

- ☞ Microtox status for PSDDA and SMS (Therese Littleton, Corps)

- ☞ Status of new AETs: (New MLs/SLs, SQSs/CSLs/)(Tom Gries, Ecology)

- ☞ Regional and national issues update (John Malek, EPA)

- ☞ Sediment cleanup workgroup recommendations (Rachel Friedman-Thomas, Ecology)

- ☞ Grays Harbor/Willapa Bay Special Study Implementation Status (Steve Babcock, Corps)

Discussion and Public Comment on above topics (11:45-12:00pm)

Public Comment on the PSDDA Clarification Papers mailed out to public with meeting invitation (12:00-12:15pm)

Summary and Closing (12:15-12:30pm)(Greg Sorlie, Ecology)

- ☞ Issues to which PSDDA agencies will respond before the next annual review meeting.
- ☞ Issues to which SMS group will respond before the next annual review meeting.
- ☞ Written comments may be submitted on the SMARM proceedings, but must be submitted to the PSDDA agencies and SMS group by May 18, 1995 for consideration.
- ☞ Triennial Review comments should be submitted to Ecology by June 30, 1995.

ATTACHMENT 2

List of Attendees

SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING
Attendee List

Name	Organization	Address	Phone #
Doug Hotchkiss	Port of Seattle	P.O. Box 1209 Seattle, WA 98111	206-728-3192
Yzp Chun	Hart Crowser	1910 Fairview E Seattle, WA	206-324-9530
Phyllis Varner	City of Bellevue Utilities	P.O. Box 90012 Bellevue, WA	206-455-7683
Paul Benko	City of Bellevue Utilities	P.O. Box 90012 Bellevue, WA	206-451-7240
Brenden McFarland	Ecology	P.O. Box 7703 Olympia, WA 98502-7703	360-407-6913
Carl Samuelson	WDFW	Olympia, WA	360-902-2563
Eric Johnson	WA. Public Ports Association	P.O. Box 1518 Olympia, WA 98507	360-943-0760
Nancy Musgrove	WESTON	700 Fifth Avenue, Ste 5700 Seattle, WA 98104-5057	206-521-7600
Dena Hughes	WESTON	700 Fifth Avenue, Ste 5700 Seattle, WA 98104-5057	206-521-7600
Rick Haley	NCASI	1900 Shannon Pt. Road Anacortes, WA	360-293-4748
Karen Stash	WESTON	700 Fifth Avenue, Ste 5700 Seattle, WA 98104-5057	206-521-7600
Tuan Vu	Ecology	P.O. Box 7600 Olympia, WA 98504-7600	360-407-7449
Russ McMillan	Ecology	Olympia, WA	360-407-6254
Gene Revelas	Striplin Environmental Associates	6541 Sexton Drive Olympia, WA	360-866-2336
Tom Gries	Ecology	Olympia, WA	360-407-7536
John Virgin	EMCON	Bothell, WA	206-485-5000
Dana Walker	METRO	322 W. Ewing Street Seattle, WA	206-684-2357
Paul Dinnel	Dinnel Marine Res.	9205 126th NE Kirkland, WA	206-822-4460

SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING
Attendee List (Continued)

Name	Organization	Address	Phone #
Lawrence McCrone	PTI	15375 SE 30th Place Bellevue, WA 98007	206-643-9803
Dave Slater	Analytical Technologies	560 Naches Avenue SW, #101 Renton, WA 98055	206-228-8835
David B. Hericks	Beak Consultants, Inc.	12931 NE 126th Place Kirkland, WA 98034	206-823-6919
Sharon R. Brown	Ecology	P.O. Box 47703 Olympia, WA 98504	360-407-6919
Charles Eaton	Bio-Marine Enterprises	2717 3rd Avenue N Seattle, WA 98109	206-282-4945
Lisa Saban	WESTON	700 Fifth Avenue, Ste 5700 Seattle, WA 98104	206-521-7686
Bob Parker	CORPS NPS-OP-NP	4735 East Marginal Way South Seattle, WA 98124	206-764-3754
Lee Wolf	Columbia Analytical Services	P.O. Box 479 Kelso, WA 98626	360-577-7222
Tom Wright	Corps of Engineers	CEWES-ES-F USA Corps of Engineers, WES Vicksburg, MS 39180	601-634-3708
Lisa Roach	SAIC	18706 North Creek Parkway Ste 110 Bothell, WA 98011	206-485-5800
David Batts	Ecology	Lacey, WA	360-407-6947
Kris Holm	NW Pulp and Paper	1300 114th Avenue SE Bellevue, WA	206-455-1323
Scott Mickelson	Metro Environmental Lab	322 W. Ewing St. Seattle, WA 98119	206-684-2377
Hiram Arden	Corps of Engineers	4735 East Marginal Way S. Seattle, WA 98124	206-764-3401
Laura Weiss	Ecology	P.O. Box 47703 Olympia, WA 98504	360-407-7446
Dave Browning	SAIC	18706 North Creek Parkway Ste 110 Bothell, WA 98011	206-485-5800

SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING
Attendee List (Continued)

Name	Organization	Address	Phone #
Sandy Browning	Striplin Environmental Associates	6541 Sexton Drive Olympia, WA	360-866-2336
Steve Babcock	Corps of Engineers	P.O. Box 3755 Seattle, WA 98124	206-764-3651
Justine Barton	EPA	WD-128 1200 Sixth Avenue Seattle, WA 98101	206-553-4974
Ricardo Marroquin	North Creek Analytical	18839 120th Avenue NE Bothell, WA 98011	206-481-9200
David Kendall	Corps of Engineers	4735 East Marginal Way South Seattle, WA 98124	206-764-3768
Tim Thompson	SAIC	18706 North Creek Parkway, Ste 110 Bothell, WA 98011	206-485-5800
Bart Jardine	AmTest	14603 NE 87th Street Redmond, WA	206-885-1664
Anna Rising	Pacific Northern Analytical	15514 NE 95th Street Redmond, WA 98052	206-881-7538
Robert Wilson	Pacific Northern Analytical	15514 NE 95th Street Redmond, WA 98052	206-881-7538
Alex Sumeri	Corps of Engineers	P.O. Box 3755 Seattle, WA 98124	206-764-3407
Tom Mueller	Corps of Engineers	P.O. Box 3755 Seattle, WA 98124	206-764-6695
Saul Fisher	GeoEngineers	6240 Tacoma Mall Blvd, #318 Tacoma, WA 98409	206-471-0379
Jennifer Stewart	EVS Consultants NW	195 Pemberton Avenue North Vancouver, B.C. V2X2R5	604-986-4331
John Ryding	Herrera Environmental Consultants	2200 Sixth Avenue, #601 Seattle, WA 98121	206-491-9080
Cliff Whitmus	Pentec Environmental	120 3rd Avenue S, Ste 110 Edmonds, WA 98020	206-775-4682
Donald Klopfer	Stillaguamish Tribe	3439 Stoluckquamish Lane Arlington, WA 98223	360-435-2755

SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING
Attendee List (Continued)

Name	Organization	Address	Phone #
R.S. Caldwell	Northwestern Aquatic Services	P.O. Box 1437 Newport, OR 47365	503-265-7225
Bruce McDonald	Black and Veatch	1201 Pacific Avenue, Ste 1100 Tacoma, WA 98402	206-383-1436
Kathy Bradgon-Cook	Ecology	Olympia, WA	360-407-6167
Dale Norton	Ecology	300 Desmond Drive Olympia, WA 98504-7710	360-407-6705
James Cubbage	Ecology	300 Desmond Drive Olympia, WA 98504-7710	360-407-6770
David W. Templeton	Hart Crowser	1910 Fairview Avenue East Seattle, WA 98107	206-324-9530
Lincoln Loehr	Heller, Ehrman, White & McAuliffe	660 Columbia Center 701 Fifth Avenue Seattle, WA 98104	206-389-6219
Bob Chandler	City of Seattle	660 Dexter Horton Bldg. 210 2nd Avenue Seattle, WA 98104	206-684-7595
Bruce W. Rummel	URS Consultants	1100 Olive Way, Ste 200 Seattle, WA 98101	206-224-4525
Cheryl Paston	Seattle Engineering Department	710 2nd Avenue, Room 660 Seattle, WA 98105	206-684-4609
Sharon Metcalf	Seattle City Attorney	600 4th Avenue Seattle, WA	206-233-2161
John Malek	EPA	Seattle, WA	206-553-1286
Kay Kim	Environment Canada	224 W. Esplanade North Vancouver, B.C. V7M3H7	604-666-2685
Deanna Lee	Environment Canada	2645 Dollarton Hwy North Vancouver, B.C. V7H1V2	604-929-2518
Kok-Leng Tay	Environment Canada	45 Alderney Drive Dartmouth Nova Scotia Canada B2Y2N6	902-426-8304
Charlie Wisdom	Beak Consultants	12931 NE 126th Kirkland, WA	206-823-6913

SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING
Attendee List (Continued)

Name	Organization	Address	Phone #
John Hicks	Analytical Resources, Inc.	333 9th Avenue North Seattle, WA 98109	206-621-6490
Margaret Stinson	Ecology	Manchester Lab	360-871-8841
Teresa Michelsen	Ecology	NWRO	206-649-7257
Kim Magruder	EVS Environment Consultants	200 W Mercer Street, Ste 403 Seattle, WA 98119	206-217-9337
Kevin Brix	Parametrix	5808 Lake Washington Blvd NE Kirkland, WA 98033	206-822-8880
Gary Braun	Tetra Tech	15400 NE 90th, Ste 100 Redmond, WA 98053	206-883-1912
Brent Lable	Tetra Tech	15400 NE 90th, Ste 100 Redmond, WA 98053	206-883-1912
Therese Littleton	Corps of Engineers	4735 East Marginal Way South Seattle, WA 98124	206-764-6550
Scott Mickelson	Metro Environmental Lab	322 W. Ewing Street Seattle, WA 98119	206-684-2377
Julie Alainis	Metro Environmental Lab	322 W. Ewing Street Seattle, WA 98119	206-684-2368
Craig Homan	Metro Water Resources	821 2nd Avenue, MS-81 Seattle, WA 98104	206-684-2065
Maria Peeler	Ecology	P.O. Box 47600 Olympia, WA	360-407-6917
Rachel Friedman-Thomas	Ecology	P.O. Box 47600 Olympia, WA	360-407-6909
Brett Betts	Ecology	P.O. Box 47703 Olympia, WA 98504	360-407-6914
Annie Spelner	CAS	P.O. Box 479 Kelso, WA	360-577-7222
Dean Kim	Ecology	P.O. Box 47600 Olympia, WA	360-407-6944
Arthur Whiteley	Marine Environmental Conservation	13244 40th Avenue Seattle, WA 98125	206-364-3337
Anne Robinson	EPA Region X	1200 6th Avenue, WD-128 Seattle, WA 98101	206-553-6219

SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING
Attendee List (Continued)

Name	Organization	Address	Phone #
Stephanie Sterling	Corps of Engineers	4735 East Marginal Way South Seattle, WA 98124	206-764-6945
Debbie Lester	DNR	Olympia, WA	
Jay Spearman	Consultant	12040 98th Avenue NE Kirkland, WA 98034	206-820-1739
Michelle Clapp	Ecology	Olympia, WA	360-407-7557
Pete Rude	Landau Associates	P.O. Box 1029 Edmonds, WA 98020	206-778-0907
Betsy Striplin	Striplin Environmental Associates	6541 Sexton Drive NW, Ste E-1 Olympia, WA 98502	360-866-2336
Ted Benson	DNR	1111 Washington Street SE P.O. Box 47027 Olympia, WA 98504	360-902-1083
Becky Doe	WESTON	700 Fifth Avenue, Ste 5700 Seattle, WA 98104-5057	206-521-7648
Desi Turner	Striplin Environmental Associates	6541 Sexton Drive NW, Ste E-1 Olympia, WA 98502	360-866-2336
Fran Sweeney	DNR	1111 Washington Street SE P.O. Box 47027 Olympia, WA 98504	360-902-1086
Joanne Snarski	DNR	1111 Washington Street SE P.O. Box 47027 Olympia, WA 98504	360-902-1086
Jim Goche	CBCAL	P.O. Box 1602 Tacoma, WA	360-754-3603
M.G. Oleson	Boeing	P.O. Box 3707, MS-7EEH Seattle, WA 98124	206-393-4712
Eric Strout	EcoChem	801 2nd Avenue, #1401 Seattle, WA 98104	206-233-9332
Linda Cox	Corps of Engineers	4735 East Marginal Way South Seattle, WA 98124	206-764-3654

APPENDIX A

Post-SMARM Comments and Responses

POST-SMARM Response to Issues Raised by Public

PSDDA/SMS ISSUES

1. PCB Congener Analysis.

1a. **Question.** What process will be used to decide how congener analysis will be implemented and what interpretation guidelines will be used?

Response. The PSDDA agencies will prepare an issue paper for the next Annual Review Meeting that will detail how the PSDDA program will implement PCB congener analysis requirements. The issue paper will articulate sample preparation methods and analysis requirements or recommendations, and will specify how the results will be interpreted. In developing the guidance for this issue paper, the PSDDA agencies will solicit input from laboratories and the affected dredging community. Possible implementation recommendations are:

☞ Conduct Aroclor® analysis (Method 8080) only in low reason-to-believe PCB concern areas. If total summed PCBs from Aroclor analysis exceed a designated regulatory concern level (i.e., SL, BT, or ML), then conduct congener specific analysis as a second tier. Congener specific analysis would be required in areas where there is a strong reason-to-believe that PCBs are a concern (e.g., lower Duwamish).

☞ Replace Aroclor® analysis with congener specific analysis.

1b. **Question.** Conduct a careful analysis of the cost implications of congener analysis.

Response. The PSDDA agencies will carefully evaluate the cost implications of implementing the congener specific analysis of PCBs.

1c. **Question.** Will the SMS program also address PCB congeners and will the rule be amended on this issue?

Response. The SMS program will follow the lead of the PSDDA program and evaluate the issue paper, and will make a decision on whether or not to implement use of PCB congener analysis in sediment source control and cleanup programs at some later time.

2. **Question.** Clarify the number of water quality analyses required for ammonia and sulfides.

Response. Water quality monitoring for all PSDDA/SMS bioassays except saline Microtox is required at test initiation and test termination to assess the presence of ammonia and sulfides (Clarification Paper, 1993 Annual Review Meeting). The question has been raised regarding the number of replicates to be analyzed. For the PSDDA/SMS bioassays, the preferred method for water quality monitoring is to assess one replicate using a chemistry only beaker, that is, one

not inoculated with organisms. This method allows for the assessment of water quality parameters without a risk of disturbing the bioassay organisms.

3. **Comment.** Clarify the temperature requirements for echinoderm tests.

Response. PSDDA/SMS programs shall conduct larval echinoderm bioassays within the following temperature regimes for each of the three recommended echinoderm species.

Dendraster excentricus:	15°C ± 1
Strongylocentrotus purpuratus:	15°C ± 1
Strongylocentrotus droebachiensis:	12°C ± 1 (Note that test exposures of this species at recommended temperature may result in prolonging the test duration to 96-120 hours.)

4. **Comment.** Some labs may be having trouble meeting the required detection limits for sediment chemical analyses.

Response. The two major causes for difficulty in meeting detection limits under the SMS were addressed in the paper presentation, "Sediment Management Standards Detection Limits."

1. Low SMS criteria for the chlorinated hydrocarbon group: The SMS criteria for this group are so low that TOC normalization may drive dry weight detection limits above criteria.

Resolution: When detection limits for this group of nonionizable organic chemicals can not be adequately reduced to meet SMS criteria, Ecology will accept the lowest dry weight detection limits achieved, provided they are at least as low as SCUM1 recommendations, and the lab must submit adequate explanation of the measures taken to reduce detection limits. This action provides labs unable to meet detection limits driven low by TOC normalization, the option to meet Sediment Source Control User Manual (SCUM1) dry weight detection limits for low level analyses when necessary.

2. Unusually low TOC concentrations: Extremely low levels of TOC may artificially inflate chemical concentrations and drive detection limits over criteria levels for some nonionizable organic chemicals. Sediment sample analyses associated with TOC levels below 0.5% may be more appropriately evaluated on a dry weight basis.

Resolution: Ecology's Environmental Review/Sediment Section or regional sediment technical experts should be contacted when TOC is expected or measured below 0.5% at a sampling site. In these cases, Ecology will determine whether the dry weight LAET criteria will be used in lieu of the SMS criteria to evaluate sediment toxicity on a site-specific basis. When determined appropriate, detection limits need not be TOC

Erratum for the 1995 Sediment Management Annual Review Meeting Minutes:

Please note that in Appendix A (Post-SMARM Comments and Responses), page 3, Part 2 of the response to Question 5 states "While the PSDDA program includes 2-methylnapthalene in the LPAH group, the SMS Rule does not." The resolution paragraph includes a recommendation that "PSDDA drop 2-methylnaphthalene from their LPAH group", but goes on to say that the "PSDDA agencies will no longer require testing for and reporting of 2-methylnaphthalene with submittal of PSDDA characterization data."

This latter statement is incorrect. As 2-methylnaphthalene is included in the SMS Rule and has apparent effects thresholds calculated for it, there is no reason to drop it from the list of PSDDA chemicals of concern. Therefore, the PSDDA agencies will continue to require testing for and reporting of 2-methylnaphthalene, but will no longer include it in the sum for the LPAH group.

concentration in the 34 sediments they reported, principally from waterways on the East, Gulf, and West coasts, ranged from 19 to 670 mg N/Kg dry wt.; the mean concentration was 194 mg N/Kg dry weight with a standard deviation of 172. It is therefore clear that the ammonia concentration in the interstitial waters of those sediments, which are thought to be representative of many of the coastal water sediments near urban and industrial centers of the US, greatly exceed the US EPA water quality criterion and would therefore be expected to be toxic to some forms of aquatic life.

TEST ORGANISMS AND CONDITIONS FOR MEASURING SEDIMENT TOXICITY

In *"Evaluation of Dredged Material Proposed for Ocean Disposal Testing Manual,"* US EPA and US ACE (1991) allow the use of a variety of test organisms for evaluating sediment toxicity. It is of interest to examine the sensitivity of those organisms to ammonia and how the toxicity tests are conducted with reference to the dilution of interstitial water by the addition of test water.

The standard elutriate toxicity test (US EPA and US ACE, 1991) prescribes the mixing of one volume sediment (which is often 40 to 60% water) with four volumes of water. The concentration of ammonia in the interstitial water is thus diluted about 1:9. It is therefore possible that a sediment could be toxic to ambient organisms but not be found to be toxic under the conditions of the test because of the dilution that has occurred in conducting the test. This could be especially true for chemicals like ammonia which, as discussed above, would be expected to be present in interstitial marine and calcareous freshwater waters and not desorbed from the sediment solids. Not considered in the test conditions, however, is the dilution that would occur in ambient waters.

While some aquatic organisms are highly sensitive to the toxic effects of ammonia, others are remarkably insensitive. Some of the organisms that are being widely used today to test for sediment toxicity, such as the amphipods, are remarkably insensitive to ammonia. Ogle (1993) has reported that the amphiphod *Rhepoxynius abronius* shows an ammonia toxicity of about 10 to 20 times less than many other "sensitive" test organisms commonly used for toxicity tests. While the issue of ammonia toxicity to amphipods such as *Rhepoxynius abronius* appears to have been overlooked, it is now becoming clear that amphipods may not be good test organisms for sediment toxicity because of their insensitivity to ammonia relative to that of fish, mysids, and shrimp. Greater consideration needs to be given to the selection of appropriate benthic and epibenthic test organisms to generate useful, interpre laboratory toxicity test data.

As discussed by Lee and Jones (1987, 1991, 1992) and Jones and Lee (1988), a high priority needs to be given to translating the results of laboratory toxicity tests to impacts on beneficial uses of the ambient water; this is especially true for sediment-associated contaminants. Sediments from many natural water systems can be shown to have readily measurable toxicity in a laboratory test system while the ambient waters support good fisheries and other aquatic life resources. The demonstration of statistically significant toxicity in laboratory tests cannot be presumed to indicate that ecologically significant toxicity or impairment of designated beneficial

uses occurs in the ambient water, or indeed that any toxic effects occur in the ambient water. The finding of toxicity in laboratory tests is not tantamount to impairment of beneficial uses of waterbodies that should, *a priori*, cause the public and private interests to pay millions to billions of dollars in an effort to remove the manifestation of toxicity in laboratory tests.

CONTROL OF SEDIMENT AMMONIA

Since the ammonia associated with sediments is of potential concern for toxicity to aquatic life in the interstitial waters and at the sediment-water interface, it is important to understand how ammonia becomes associated with sediments. The aqueous environmental chemistry of ammonia reveals that it does not precipitate and does not tend to sorb onto sediments to a significant extent under typical environmental conditions of ionic strength and relative distribution of major cations in solution. A possible exception to this situation can occur in non-calcareous low TDS waters. Therefore, unlike many other toxic chemicals of potential concern, ammonia does not become part of the sediments through direct sorption or precipitation reactions. Ammonia becomes part of sediments through settling of particulate organic nitrogen. The organic nitrogen, in turn, is mineralized through bacteria-mediated ammonification reactions which lead to a build-up of total ammonia in the interstitial waters.

The concentration of ammonia that develops in sediments is controlled by the rates of ammonification and transport of ammonia from the interstitial water to the overlying water. In sediments that have a low oxygen demand, especially in the upper few millimeters to a centimeter or so, nitrification reactions can convert some of the interstitial water ammonia to nitrite and nitrate. However, since most sediments are anoxic, and since nitrification does not occur under anoxic conditions, the transport of ammonia from the sediments to the overlying waters is the primary mechanism for limiting the ammonia build-up in sediments. As discussed by Lee (1970) and Lee and Jones (1987), the transfer of materials from interstitial water to the overlying water is controlled by physical mixing - advective - processes and not by concentration-gradient - diffusional - processes.

In some areas, particulate organic nitrogen in sediments is derived from untreated wastewater. This was found, for example, in New York Harbor, which until a few years ago received the discharge of large amounts of untreated, raw domestic sewage through direct discharge as well as in combined sewer overflows (Jones and Lee, 1988). For most sediments, particulate organic nitrogen is derived from plant protein sources in non-point source terrestrial runoff and from the decomposition of autochthonous aquatic plants especially phytoplankton.

In order to address the control of ammonia in sediments, it is necessary to determine whether the ammonia that is in the sediments is, in fact, adversely affecting beneficial uses of the ambient waters. If it is determined to be causing a significant adverse impact, it is necessary to understand and quantify the sources of particulate organic nitrogen for the sediments. The relative roles of terrestrial point sources and non-point sources and of aquatic plant sources of particulate organic N in contributing to the ammonia in the sediments that cause aquatic life toxicity need to be determined. Once the significant sources have been identified, a

determination needs to be made of the extent to which the controllable sources can be controlled and the impact that that control would have on the ammonia toxicity of the sediments and the aquatic life resources of concern to the public, which must ultimately pay for such control.

Sufficient understanding of this topic exists to know that in most instances point-source discharges are not the primary source of organic N leading to ammonia toxicity in sediments. In the opinion of the authors, there are few US municipal and industrial wastewater discharges that contribute sufficient concentrations of particulate organic N to be a significant source of ammonia in aquatic sediments. This situation has a significant impact on control options and programs that might be considered for any given sediment.

Given the dominant sources of ammonia in sediments (Lee and Jones, 1992), it is evident that controlling ammonia toxicity in sediments will not be readily achieved in most instances. The ubiquitous sources of particulate organic nitrogen, many of which are natural, will make controlling sediment toxicity due to ammonia difficult and very expensive. If it is not possible to control the ammonia toxicity in a sediment, then appropriate questions should be raised about controlling other contaminants that may be toxic to aquatic life in the sediments. There seems to be little justification for spending large amounts of public money to control the manifestation of laboratory toxicity to Rhepoxynius abronius caused by a heavy metal or a non-polar organic such as a chlorinated hydrocarbon pesticide or a PAH, while ignoring the ammonia toxicity exhibited by another group of organisms that is of even greater importance to the public. These issues will become extremely important as efforts are made to try to implement the sediment quality criteria and standards development approaches being advocated by the US EPA and some states into control programs for point-source and non-point source discharges and runoff.

DISCUSSION AND CONCLUSIONS

There is sufficient ammonia in the sediments (interstitial water) of many US waterways, especially marine and calcareous freshwater systems, to be of potential concern for aquatic life toxicity. While there is a widespread potential for aquatic life toxicity due to sediment-associated ammonia, the water quality significance of that ammonia and of the toxicity manifested from those sediments in laboratory tests is not understood. It is also apparent that some of the test organisms thought to be very sensitive for evaluating sediment toxicity, such as some amphipods, are not suitably sensitive to ammonia to reliably evaluate potential toxicity due to sediment-associated ammonia.

There is need to gain a much better understanding of the potential benefits of controlling sediment toxicity manifested in laboratory toxicity tests. There is also need to develop approaches to more reliably identify those sediments which, owing to their chemical contamination, should be "remediated" and have contaminant input discharge control in order to protect designated beneficial uses of the waterbodies in which they lie.

While the focus of this paper is the potential significance of sediment-associated ammonia as a cause of aquatic life toxicity, similar issues exist for H_2S and low DO conditions in

sediments. Sediments that have sufficient ammonia to cause toxicity to important aquatic organisms could have sufficient H_2S and sufficiently low DO to themselves cause toxicity to aquatic life. Latimer (1992) reported that only a small part of the sediment toxicity found in the US EPA EMAP studies of sediments in the nearshore marine waters of the eastern US was caused by Priority Pollutants. Low DO, as well as ammonia and hydrogen sulfide, would be expected to contribute to the toxicity found in those sediments. The US EPA did not include measurement of ammonia in sediments in the initial EMAP studies.

As more toxicity identification evaluation work is done on the causes of aquatic life toxicity in laboratory tests of sediments, there are increasing reports of the importance of ammonia. In a study of copper toxicity Burgess *et al.* (1993) reported that the toxicity found was likely due to ammonia. The San Francisco Bay Regional Water Quality Control Board (SFBRWQCB, 1993) reported the finding of toxicity in a "pristine" reference site; that toxicity could readily have been caused by ammonia.

The finding of ammonia, H_2S and low dissolved oxygen as a common cause of sediment toxicity raises important questions about regulating sediment quality using equilibrium partitioning based sediment quality criteria. Lee and Jones-Lee (1993a) have discussed the importance of any investigation of sediment toxicity, including evaluation of the presence and significance of toxicity due to ammonia, H_2S, and low dissolved oxygen conditions. Failure to consider the importance of these constituents in sediments in influencing sediment toxicity - sediment quality could result in inappropriate assessment of the benefits of sediment remediation that focuses on heavy metals, organics, or other constituents. Such an approach could result in the sediments still being toxic to key forms of aquatic life due to ammonia, hydrogen sulfide or low dissolved oxygen after remediation has occurred for heavy metals and other constituents.

Some regulatory agencies, including the US EPA in its National Sediment Inventory, are using co-occurrence based chemical sediment "quality" values as part of a sediment regulatory program (US EPA, 1994). Long and Morgan ER-L and ER-M values (Long and Morgan, 1990) and the MacDonald PEL values (MacDonald, 1992) attempt to correlate total chemical concentrations for selected chemical constituents and a sediment toxic response for sediments taken from a wide variety of locations in the US. The tabulation of the co-occurring value of toxic response and chemical concentrations is used to claim that whenever a chemical concentration above a value that someone claims to have found toxicity irrespective of its cause, is justification to assert that any sediment with a concentration above this value could have toxicity due to that chemical. However, in developing these values the developers chose to ignore the ammonia, hydrogen sulfide, and low dissolved oxygen data that was in the data bases that they used. Such an approach is not technically valid for several reasons. As discussed herein, most of the sediment toxicity is due to these chemicals. Further, it has been known for over 20 years that there is no relationship between the toxicity of sediments and the total concentrations of chemicals in the sediments (Lee and Jones, 1992, Lee and Jones-Lee, 1993a). Daskalakis and O'Connor (1994) have reported that based on an evaluation of the US EPA EMAP data for sediments along the eastern US that the Long and Morgan ER-M values did not reliably predict sediment toxicity as measured by toxicity tests using an amphipod.

The so-called toxic responses that were found by various investigators in the Long and Morgan and MacDonald data bases were due to a significant extent to ammonia, H_2S and low DO. As discussed by Lee and Jones-Lee (1994), co-occurrence based values tend to significantly overestimate the water quality significance of the chemicals considered and ignore the vast array of non-regulated chemicals and non-considered chemicals. Any sediment quality ranking - evaluation system must consider the potential significance of ammonia, hydrogen sulfide, and low dissolved oxygen if it is to have any technical validity.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

DEC 21 1993

OFFICE OF WATER

MEMORANDUM

SUBJECT: Technical Panel Recommendations Concerning Use of Acute Amphipod Tests in Evaluation of Dredged Material

FROM: Tudor T. Davies, Director
Office of Science and Technology
U.S. Environmental Protection Agency

David G. Davis, Deputy Director
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U.S. Environmental Protection Agency

John P. Elmore, Chief
Operations, Construction and Readiness Division
Directorate of Civil Works
U.S. Army Corps of Engineers

TO: EPA Regional Ocean Dumping Coordinators

EPA Regional Wetlands Coordinators

Corps of Engineers Regulatory and Civil Works Elements

Over the past two years, the U.S. Army Corps of Engineers (Corps) and the Environmental Protection Agency (EPA) have been working jointly toward development and implementation of two testing manuals for evaluating dredged material proposed for disposal in aquatic environments. These documents are titled, "Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual" and "Evaluation of Dredged Material Proposed for Discharge in Inland and Near Coastal Waters - Inland Testing Manual". The Ocean Disposal Manual was published in 1991, and the draft Inland Testing Manual was recently distributed for Corps and EPA review. Following publication of the Ocean Disposal Manual, as the Corps and EPA began to implement this revised ocean testing protocol, some laboratories experienced problems conducting amphipod bioassays and replicating laboratory test results. Some of the laboratories conducting the tests attributed these problems to ammonia and hydrogen sulfide toxicity, as well as amphipod sensitivity to grain size. In order to evaluate the use of amphipod bioassays in the dredged material regulatory programs, EPA and the Corps convened a

meeting of Experts on June 18, 1993. This memorandum transmits the findings of that meeting and subsequent discussions.

The meeting participants supported the continued use of amphipod bioassays in the dredged material regulatory programs, and recommended application of the guidance provided in this memo until EPA publishes standard sediment toxicity test protocols in 1994.

The meeting participants reviewed the results of EPA research on test protocol development, and the influences of grain size, ammonia, and hydrogen sulfide toxicity. Standard acute amphipod toxicity test method protocols to be completed by EPA this year (for five species) will include this information. Tables 1 and 2, attached to this memorandum, contain test condition acceptability ranges - based on the "best professional judgement" of the EPA researchers developing the standard protocols - for the following test organisms used to evaluate dredged material: marine and estuarine amphipods (Rhepoxynius, Ampelisca, Eohaustorius, Leptocheirus), a freshwater amphipod (Hyalella), a freshwater midge (Chironomus), and a freshwater oligochaete used in bioaccumulation tests (Lumbriculus). Test condition acceptability ranges are given for temperature, salinity, grain size, and ammonia. Hydrogen sulfide toxicity is not believed to be a problem if dissolved oxygen levels are maintained in the overlying water. At certain open-water dredged material disposal sites (e.g., dispersive situations and situations with well-oxygenated overlying water), ammonia and hydrogen sulfide may not be contaminants of concern. Whenever chemical evidence of ammonia is present at toxicologically important levels, and ammonia is not a contaminant of concern, the laboratory analyst should reduce ammonia in the sediment's interstitial water to below 20 mg/l before adding the benthic test organism. Ammonia levels in the interstitial water can be reduced by sufficiently aerating the sample at saturation and replacing two volumes of water per day. The analyst should measure interstitial ammonia each day until it reaches 20 mg/l. After placing the test organism in the sediment, the analyst should ensure that ammonia concentrations remain within an acceptable range (see Tables 1 and 2) by conducting the toxicity test with continuous flow or volume replacement not to exceed two volumes per day. Table 3 lists several peer-reviewed papers that deal with the information discussed above. A comparison of life cycle/ecological characteristics for the marine and estuarine amphipod species mentioned above is presented in Table 4.

The EPA researchers developing the standard protocols recommended that laboratories running the amphipod toxicity tests take the following steps to reduce the likelihood of obtaining invalid test results.

1) Minimize handling stress of the organisms.

2) Ship the test animals to laboratories quickly at appropriate temperatures.

3) Make certain that proper temperature and other water quality characteristics are always maintained for the test animals.

4) For marine tests, run tests within ten days of receiving test animals in the laboratory. (Tests with some species may need to be run sooner.)

5) Conduct concurrent reference toxicity tests at the start of a sediment test.

6) Feed the test animals if necessary before use.

7) Use the proper life stage of animal for the test.

8) Always run necessary controls for the tests.

9) Remember that all amphipod test species are not the same, and be aware of species specific differences in test acceptability conditions.

10) Culture Hyalella azteca at the testing laboratory.

It is recommended that test acceptability conditions (including interstitial water ammonia) be measured before initiating a test. If any test conditions lie outside of acceptability ranges, alternative test species may be chosen for use whose test acceptability conditions match the dredged material. (But for ammonia, follow the guidance in paragraph 3 of this memo.)

The panel discussed performance requirements for selecting a contractor. It was recommended that as part of the "request-for-proposal" process, contractors should be required to submit three sets of control data to show that they can successfully run the particular test. More detailed guidance is available in the draft document "QA/QC Guidance for Laboratory Dredged Material Bioassays" USACE, Waterways Experiment Station (D. Moore, T. Dillon, J. Word, J. Ward, MP XX-93 (draft may be obtained from senior author)]. EPA and the Corps will work on additional detailed guidance for QA/QC of biological tests in 1994.

EPA and the Corps recognize the need for the development of standard amphipod test protocols, and for continued training on amphipod toxicity test methods. EPA will publish and distribute standard acute toxicity test method protocols for all species listed in the attached tables in FY 94. The Corps and EPA will continue to hold training workshops on the test methods, and to develop training tools such as videos describing test method protocols. EPA and the Corps will also initiate discussions on the feasibility of developing a laboratory certification or accreditation program to support dredged material regulatory activities.

If you have additional questions concerning the amphipod bioassays described in this memo please contact the following persons. For questions concerning the freshwater test contact Dr. Gary Ankley at EPA's environmental research laboratory in Duluth, Minnesota 218-720-5603; for questions concerning the marine and estuarine amphipod tests contact Dr. Norm Rubinstein at EPA's environmental research laboratory in Narragansett, Rhode Island 401-782-3002 Dr. Rick Swartz at EPA's environmental research laboratory in Newport, Oregon 503-867-4031, or Dr. Tom Dillon at the U.S. Army Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi 601-634-3922.

Attachments

Table 1

FRESHWATER SEDIMENT TOXICITY AND BIOACCUMULATION
TEST APPLICATION CONDITIONS

PARAMETER	Hyalella	Chironomus	Lumbricul
Temperature (°C)	23	23	23
Overlying Salinity (ppt)	<15	<1	<1
Grain Size (% silt/clay)	full range	pending	full rang
Total Ammonia (mg/L NH_3+NH_4)	*	*	*
Sulfides	**	**	**

*The toxicity of total ammonia to Hyalella azteca is a function of both wa hardness and pH. For Lumbriculus variegatus and Chironomus tentans total ammonia toxicity increases as pH increases, with little apparent effect du to hardness. For a frame of reference, the 10-d LC50 for total ammonia in Lake Superior water (40-42 mg/L hardness) is 17.5 (14.8-20.7) mg/L at pH 7 for Hyalella azteca, 21.4 (19.2-23.9) mg/L at pH 7.8 for Lumbriculus variegatus, and 186 (156-222) mg/L at pH 7.7 for Chironomus tentans. A framework for deciding whether observed sediment (or elutriate) toxicity m be due to ammonia is presented in EPA/USACE (1993; Appendix F).

**Hydrogen sulfide is not likely to be a problem in these tests if adequat dissolved oxygen levels are maintained in the overlying water.

EPA/USACE. 1993. Evaluation of dredged material proposed for discharge in inland and near coastal waters - testing manual (Inland Testing Manual). Draft Report. U.S. Environmental Protection Agency, and U.S. Army Corps of Engineers, Washington, DC.

Table 2

MARINE AND ESTUARINE AMPHIPOD TOXICITY TEST APPLICATION CONDITIONS

PARAMETER	Rhepoxynius	Ampelisca	Eohaustorius	Leptocheirus
Temperature (°C)	15	20	15	25
Overlying Salinity (ppt)	>25	>20	2-34	2-32
Grain Size (% silt/clay)	<90	>10	full range	full range
Ammonia (total mg/L, pH 7.7)*	<30	<30	<60	<60
Ammonia (UI[1] mg/L, pH 7.7)*	<0.4	<0.4	<0.8	<0.8
Sulfides	**	**	**	**

*A framework for deciding whether observed sediment (or elutriate) toxicity may be due to ammonia is presented in EPA/USACE (1993; Appendix F). This document should be consulted if ammonia is suspecte to be a contaminant of concern.

**Hydrogen Sulfide is not likely to be a problem in these tests if adequate oxygen levels are maintained in the overlying water.

[1]Unionized

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Table 3

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Table 4

COMPARISON OF FOUR MARINE AND ESTUARINE AMPHIPOD SPECIES FOR ACUTE TESTS

Characteristic	Rhepoxynius	Ampelisca	Eohaustorius	Leptocheirus
Substrate Relation	Free burrowing	Tube dwelling, closed	Free burrowing	Tube dwelling, open
Zoogeography	Pacific	Atlantic-Gulf San Francisco Bay	Pacific	Atlantic
Habitat	Polyhaline	Poly-upper mesohaline	Oligo-mesohaline	Oligo-meshohaline
Life Cycle	Annual	30-40 days	Annual	30-40 days
Availability	Field	Field-culture	Field	Field-Culture
Response Data Base	Extensive	Extensive	Low to moderate	Low to moderate
Ecological Importance	High	High	High	High

Port of Seattle

May 17, 1995

Mr. David Kendal
Dredged Material Management Office
Seattle District
US Army Corps of Engineers
PO Box 3755
Seattle, Washington 98124-2255

Dear Mr. Kendal,

This is a comment letter on the Puget Sound Dredge Disposal Analysis Program (PSDDA) as it conducts the seventh annual review in conjunction with the Department of Ecology (Ecology) Sediment Management Standards (SMS) Triennial Review Process. The comments provided in this letter relate to the PSDDA program, our comments on SMS review will be provided directly to Ecology.

We would like to start by thanking the PSDDA agencies for presenting the detailed overview in the issue papers of the March 23 information package.

PSDDA TOPICS

PSDDA Status Reports:

Shorelines Permits: - We are pleased for all ports that the Shorelines Permits have been renewed. This shows a continuing confidence in the PSDDA Program.

Small Project Costs: - We support the efforts to provide proceedures that allow cost relief for small projects. We feel that this is a grater problem than the available statistics indicate, because of the number of small projects that have never submitted for PSDDA testing due to the high costs of testing and evaluation.

PCB Congeners: - We are interested in the ongoing research into the various PCB congeners. We are encouraged by the desire of the agencies to regulate based more on the true threats of toxicity. We are also concerned about the cost and how the numbers will be applied. We hope to be included in discussing the results of further investigation, and in frank and open discussions of how guidelines might be derived from the research and applied to projects. These discussions need to start well in advance of any requests to include this additional test in our extensive suite of chemical analysis.

PSDDA Issue Papers

Chemical guidelines at PSDDA Disposal Sites: - We support the modifications outlined in "Refinements to PSDDA Post Disposal Monitoring Guidelines". This seems to be a reasonable response to the anomalies and variability that make interperting the existing guidelines problematic.

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JOINT PSDDA/SMS TOPICS

PSDDA/SMS Clairification Papers

Neanthes Bioassay: - We would like a more problem specific and detailed explanation of the proposals for the Neanthes bioassay. The warning on using undersized worms is very clear. We appreciate that. The change to the mg/ind/day standard looks like just multiplying the results by constants and has no real effect on what we are measuring in this test, how we set up the actual test, or how we interpert the results. It only removes us another step from what we are actually measuring, and therefore may lead to poor interpertation of some problematic results in the future. We are not measuring growth per day per individual, though we can statistically manipulate the data to express it that way. Why do it?

PSDDA/SMS Status Papers

Benthic Issues: - The status report on " Development of Reference Ranges for Benthic Infauna Assessment Endpoints and Evaluation of Alternative Benthic Infaunal Assessment Methods in Puget Sound" raises several points of concern in our minds, though we agree with several of the recommendations (ranges for reference points, multiple end points, taxonomic standardization).

1. - Reference stations must take into account all, non-toxic chemical, factors limiting optimal abundance (e.g. TOC, salinity, sulphide, ammonia, etc.) as additional screens on data before the effects of toxic chemicals can really be evaluated. Without this step the data base will overestimate the effect of the toxic chemical by ascribing all of the lack of abundance to the chemical and not the other factors affecting abundance. This is readily seen in the case of TOC.

2. - Limiting the stations used in the data set to those less than 150 ft. is a serious oversight. It eliminates all comparisons to the sediments at the depths of the disposal site, which is part of EPA's new proposed definition of reference sediment, and meaningful in many situations. It also eliminates finer grained, higher TOC data which can be important. Also, assuming that all stations with a particular grain size have a comparable abundance of major taxa at all depths less than 150 ft. is inaccurate.

3. - Making the assumption that all stations exceeding the SMS are contaminated and potentially affected and all those with lower concentrations are not affected presupposes that previous work establishing the SMS had none of the above problems, and also none of the false positive problems with the bioassays. This is very circular logic and not conducive to updating with the latest available science in the field.

4. - The use of qualifiers like "highly stressed" assumes that all ranges of stress have been assessed within Puget Sound. Not all would agree that "highly stressed" conditions have been found and analysed in Puget Sound. It would be good to reality check the Puget Sound data with other West Coast data. If we find high concentrations for certain chemicals, in other areas, without signs of adverse benthic effects, it would be a flag to see what is driving our Puget Sound assumption of benthic effect.

The conclusion of these concerns is we want to make sure this benthic work is the thorough, scientifically based analysis we need before moving to incorporate its conclusions into PSDDA. We hope to be able to work with Ecology to evaluate this report in detail and to make recommendations on ways to cover the deficiencies.

Microtox: - The status update update on microtox is helpful. We wonder how many of the AETs are driven by the results of this test that we now know has so many problems?

New AET's: - The status report on "Progress Re-Evaluating Puget Sound Apparent Effects Thresholds" is also of great interest to us. There are many areas of concern in the much needed re-evaluation of AETs. Among them are:

1. - The methods for eliminating data from the data base prior to calculating the AET's is a concern. The elimination of "anomalous no hit samples" and other data filters can seriously alter the outcome of the AET calculation. As an example, removal of more than 50% of the amphipod bioassay samples from the data base seems excessive, and will alter the predictive ability of the resulting AET's. Regardless of the methods of data elimination used (and we intend to examine this in detail), we recommend any measures of statistical reliability (sensitivity and effectiveness) should be run on the entire unfiltered data set as this is more representative of the typical data that the guidelines will be used to judge. We need to be alert for getting caught in "circular logic loops" in our tests for reliability.

2. - The inclusion of the echinoderm larval abnormality test as a seperate AET data set, rather than combining it with the existing bivalve larval abnormality/mortality data set is of concern to us. The larval echinoderm abnormality/mortality test has not undergone the standardization in the abnormality endpoint that the bivalve test has, and that in combination with the greater level of structural complexity of the echinoderm larvae means there is a much greater potential variability in the endpoint decisions.

3. - We are checking to see if the Metro data from their large studies in the '80"s are included in the data base. We feel that this data is an important data set and will help us understand the effects at the depths of the disposal sites, as well as give a broader data base.

4. - Also the Port of Seattle, along with other Harbor Island PRPs is in the process of generating a large data set from the Sediment Unit of the Harbor Island Superfund Site. This data set, which has already been collected and is being analysed, will be available soon and has the potential to be important in evaluation of the insitu toxicity of some chemicals. It should be included in any major re-evaluation.

As with the benthic analysis we hope to be working with Ecology on these issues. We hope that this area also gets the full scientific attention needed as we move an updated AET data base into the PSDDA program.

Other Issues

A seperate issue, discussed at the meeting and also related to the Harbor Island data, set is the need to recognize and account for the toxicity of interstitial, as well as test water, ammonia, sulfide, salinity and other compounding effects in the bioassay proceedures. This will help us more accurately predict and assess the true insitu toxicity to the chemicals of concern, those for which we have guidelines. The current proceedures for measuring and tracking these effects are not sufficient for preventing false positives in our bioassay proceedures. There are new techniques available for gathering this important data for our decision making. We would like to recommend that use of these additional techniques and measurements be allowed in all PSDDA Bioassay Proceedures, if the proponent feels their type of sediment may potentially have toxicity from these sources. The appropriate proceedures need to be settled on and discussed with the agencies in advance of the sampling. We would be more than happy to provide you with a copy of the proceedures and approach that was used in the Harbor Island data set.

Thank you for the opportunity to comment. If you have any questions please call me at 728-3192.

Sincerely,

Douglas A. Hotchkiss
Environmental Management Specialist

DAH
3205V

cc. Newlon;
WPPA Johnson; EPA Malek; Ecology Phillips; DNR Hertzog

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May 18, 1995

Dave Kendall
Seattle District Corps of Engineers
PO Box 3755
Seattle, WA 98124-2255

Dear Dave:

Enclosed are my comments for the PSSDA and SMS annual review. They address issues related to the AETs, sediment toxicity tests, and benthic community (=abundance) responses. I hope they are helpful and I would be happy to discuss any of these points with any members of the PSSDA agencies. Thank you for the opportunity to provide these comments.

Sincerely,

Ted DeWitt
Senior Research Scientist
Marine Ecological Processes

THD:bb

enc

Comments for the PSSDA and SMS Annual Review

Theodore H. DeWitt
Senior Research Scientist
Marine Ecological Processes
Battelle/Marine Science Laboratory
Sequim, WA

May 18, 1995

Marine Sediment AET's

1. Why aren't "chemically anomalous" samples included in the AET, or at least included in tables so that the data can be evaluated by others? There is still information value to that data, and the reasons the chemistry data appear anomalous should be described for each sample - that information may help with the interpretation of data in future assessments.

2. The bases for rejecting over 50% (452 out of 824) of the amphipod bioassay samples should be reconsidered? This is a tremendous amount of data to omit. Presumably these studies provided data that were useful for sediment assessments; lack of a grain-size reference does not invalidate these data. The stated "lack of a matching reference sample" seems an arbitrary and unnecessary reason for rejection of most of these data. If grain-size reference sites are missing, you could also use the regression-based models (DeWitt et al.) to examine the extent to which grain-size would be expected to interfere with the results. Likewise, many of the other QA criteria listed in Table B-2 seem unnecessarily proscriptive, such as "statistically inconclusive" and "chemically anomalous" criteria. How does including these data (at least those rejected for lack of grain-size reference data) affect the AETs?

3. Re. the 25% rule for hits in amphipod mortality (pg. 17): 25% seems artificially high and perhaps under protective. How are AET values changed if this is dropped back to 20% or to "anything that is statistically different"? Why not just consider any statistically difference from the negative control to be ecologically significant? What is the ecological basis for deciding that a hit has to be 20-25% greater than some value? This threshold should be based on the population ecology of the test species, not on the *opinion* that some level of mortality is meaningful and another is not.

4. Were non-polar organic contaminant concentrations normalized to measured TOC values for the sample from which the contaminant was measured? Previously, I understand the TOC-normalization was based on an average TOC concentration for the region, which is inappropriate. I would very much like to have had the database to examine in order to evaluate the new AETs.

5. This new database would also be useful for re-examining the particle-size-mortality

regression for *Rhepoxynius* and *Eohaustorius* which I published in the late 80's.

6. A table showing which surveys & data came from before and after 1988 would be useful.

7. Studies are needed to ground truth the benthic abundance responses used in the AETs. A handful (5-10) species underlie the changes observed in most of the "impacted" communities in Puget Sound, but we do not know whether changes in their abundances is caused by chemical contaminants, increased TOC, or correlated factors. One way to approach this is to examine the sensitivities of these species to toxicants, TOC, grain-size, ammonia, and other correlated factors, and relate those responses to field concentrations of these factors which have been associated with changes in benthic abundance.

Freshwater Sediment AETs

1. Why haven't community structure data been incorporated into the AETs?

Amphipod Sediment Toxicity Tests

1. PSSDA should consider including the *Leptocheirus plumulosus* acute and chronic sediment toxicity tests in its suite of methods for sediment assessments. The advantages of these tests are: 1) wide tolerance to salinity (1-30‰) and grain-size (sand to very fine mud; it's native habitat is fine mud), 2) the amphipods can be cultured, thus providing year-round availability and uniform quality, 3) high sensitivity to contaminants (mortality comparable to *Eohaustorius* and *Ampelisca*, but reproductive sublethal endpoint of chronic test more sensitive than *Rhepoxynius* mortality), 4) availability of published protocols for both tests, including ASTM and EPA standard methods for the acute test (EPA standard method for chronic in development this summer), 5) availability of a true life-cycle test, and 6) interpretive guidance in the form of models that link toxicity test endpoints to population growth. These tests have been used to assess sediment contamination in several parts of the country, including Chesapeake Bay (Baltimore Harbor), San Francisco Bay (Lauritzen Canal), Massachusetts Bay (dredged spoil sites), Long Island Sound (dredged spoil sites), and Gulf of Mexico (EMAP sites).

2. Effects of interstitial water ammonia must be included in Puget Sound sediment toxicity test assessments. However, the procedures recommended by EPA and the Corps should be viewed with caution because their approach to reducing interstitial ammonia (ie, exchanging the overlying water in test chambers) may also result in removing contaminants present in the interstitial water; many studies have shown that the most readily-bioavailable fraction of

chemical contaminants is that which is dissolved in interstitial water. Thus, the "approved" procedure for reducing ammonia may also reduce the toxic fraction of sediment-associated contaminants.

3. The utility of grain-size reference sites should be evaluated. Appropriate sites are often located at a distance from study sites, and the addition of an extra sample is always costly. One approach would be to compare the reference site data with the DeWitt et al. grain-size effects model. If the model leads to the same conclusions as the reference site approach, then significant cost savings could be achieved by using the model.

Benthic Infaunal Responses

1. Same comments as in AET#6 above: need to evaluate experimentally the factors that the "sensitive" species are really responding to at "impacted" sites. Current methods (multivariate, etc.) are all correlative and suffer from lack of mechanistic underpinning.

APPENDIX C

SMARM Overheads

SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING

MEETING OBJECTIVES AND PURPOSE

- Obtain public input on proposed changes to the PSDDA Management Plan per Clarification Papers mailed out with the meeting announcement.
- Discuss disposal site management actions and changes.
- Discuss Status Reports on important ongoing actions within the PSDDA Program and SMS Group.
- An additional objective taking place outside of this meeting will be to conduct a Public Hearing to accept formal public comment on necessary revisions to the SMS rule. The Hearing will take place in this room at 7 p.m. on 3 May 1995.

Overhead 1-1

SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING

- The meeting is hosted by the Washington State Department of Ecology.
- The meeting reviews PSDDA activities during dredged material management year 1994 (June 16, 1993 - June 15, 1994).
- This meeting also serves as Ecology's Sediment Management Standards (SMS) Triennial Review process.

Overhead 1-2

SUMMARY OF SIXTH PSDDA ARM (MAY 1994) COMMITMENTS AND ACCOMPLISHMENTS

- Actual versus predicted volumes and future capacity of PSDDA disposal sites. The post ARM evaluation of this issue indicated that all sites have sufficient capacity to last at least 40 years given the present site usage.

- Debris disposal at PSDDA sites: The PSDDA agencies allowed a small "de minimus" (200-300 cubic yards) disposal of riprap (passing through 24" by 24" steel grid) at the Elliott Bay site as part of the Port of Seattle's T-30 Apron rehabilitation project. Post disposal monitoring (side scan survey) indicated the rip rap was not visible on site and there were no discernible impacts. The PSDDA policy will continue to be no debris disposal, but the agencies are willing to consider "de minimus" discharges of incidental debris on a case-by-case basis.

Overhead 2-1

SUMMARY OF SIXTH PSDDA ARM (MAY 1994) COMMITMENTS AND ACCOMPLISHMENTS

- The PSDDA agencies re-examined cost impacts to small projects of sampling and testing. Stephanie Stirling (Corps) will present a status report on this issue later in the meeting

- The PSDDA agencies suspended use of the saline Microtox bioassay for the past year. The PSDDA agencies recommend continuing this suspension during the coming year. Theresa Littleton (Corps) will review the status of microtox use later in the meeting.

- The PSDDA agencies combined the ARM with the Sediment Mangement Triennial Review process as recommended by the public. The Interagency / intergovernmental agreement signed in May 1994 will be amended to reflect this change.

Overhead 2-2

SUMMARY OF SIXTH PSDDA ARM (MAY 1994) COMMITMENTS AND ACCOMPLISHMENTS

- The abnormality performance standard for the sediment larval test was eliminated and is no longer a requirement. This revision is reflected in the soon to be finalized PSEP bioassay protocols.
- The PSDDA agencies were asked to reconsider alternative approaches to laboratory and field bioaccumulation for dredging and monitoring evaluations. The PSDDA program has the flexibility to consider alternative biological effects assessment tools as part of a Tier IV evaluation of dredged material on a case-by-case basis.
- The PSDDA agencies are open to consideration of alternative bioeffects assessment tools in monitoring the disposal sites. However, the PSDDA agencies are concerned about falling revenues from disposal fees used to fund chemical and biological monitoring. Any major adjustments to the biological effects monitoring assessment tools would have to be evaluated for both technical and cost effectiveness, before changes to the monitoring plan could be proposed by the PSDDA agencies.
- An update on Ecology's human health criteria development process and its implications to PSDDA and SMS will be discussed later at this meeting by Laura Weiss (Ecology).

Overhead 2-3

PSDDA PROJECT AND TESTING ACTIVITIES

Dredging Year 1994

June 16, 1993
to
June 15, 1994

Overhead 3-1

DY94 PSDDA EVALUATION ACTIVITIES

Ranking Determinations	13
Sampling Plan Review	15
Data Review/ Suitability Determination	11

15 Total Projects 1,133,200 cubic yards

Overhead 3-2

PROJECT DEFINITION

DY 94 projects are defined as those projects for which the PSDDA agencies made suitability determinations or partial characterization rankings between 16 June 1993 and 15 June 1994, or for which sampling and testing was completed and the application for open-water disposal was withdrawn.

11 projects

767,100 cubic yards

Overhead 3-3

DY94 PROJECTS

- Port of Brownsville - Port Orchard
- Des Moines Marina - Seattle
- Indian Cove Moorage - Hartstene Island
- Konoike-Pacific Terminals - Tacoma
- Lone Star Northwest, Taylor Way - Hylebos
- Port of Seattle, Terminal 30 - Seattle
- Sinclair Inlet Marina - Sinclair Inlet
- Port of Tacoma, West Blair Terminal Development - Tacoma
- US Navy Pier D (Round 2) - Bremerton
- US Navy Norton Terminal - Everett
- Warren Avenue CSO - Bremerton

Overhead 3-4

DY94 PROJECT INITIAL RANKING

Rank	Project
Low	0
Low-Moderate	1
Moderate	4
High	6

Overhead 3-5

DY94 SAMPLING PLANS

- 11 projects
- 767,100 cubic yards (full characterization)
- 94 field samples
- 50 dredged material management units

Overhead 3-6

DY94 CHEMICAL TESTING

- 6 of 11 projects had screening level exceedances
- 185 screening levels were exceeded
- 5 bioaccumulation triggers were exceeded
- 7 maximum levels were exceeded

Overhead 3-7

DY94 BIOLOGICAL TESTING

- 6 projects required biological testing
- Tiered testing was conducted for 5 projects
- 29 dredged material management units were tested

Overhead 3-8

normalized and the SCUM1 dry weight detection limit recommendations should be followed.

5. **Question.** Will the new chemical summing methods be used in recalculating AETs?

Response.

1. AET calculations will use this method consistent with past practice.

AET values for LPAH or HPAH can be calculated in two ways. The first method, which sums only the detected concentrations for individual PAHs (except 2-methylnaphthalene), was used to derive both the 1988 and 1994 AET values. The second method sums all individual PAH results (except 2-methylnaphthalene), including individual detection limits for those not detected.

The chemical summing method currently described in the Sediment Management Standards Rule requires detection limits for undetected chemicals to be added to detected chemical concentrations to calculate a group sum. This method has not been used in contaminated sediment site determinations as the automated SEDQUAL clustering process excludes data qualified as "undetected", nor was it used to calculate the original AETs.

Resolution: Ecology will recommend that the chemical summing method currently described in the SMS Rule be revised to be consistent with the PSDDA method. The PSDDA method adds only detected chemical concentrations to calculate a group sum and, when none are detected, reports only the highest detection limit for a chemical in the group as the group sum. AET recalculations will use this method consistent with past practice.

2. While the PSDDA program includes 2-methylnaphthalene in the LPAH group, the SMS Rule does not.

Resolution: Ecology recommends no change be made to the SMS Rule LPAH grouping and that PSDDA drop 2-methylnaphthalene from their LPAH group. The early PSDDA program based inclusion of 2-methylnaphthalene on the best existing information at the time. Since then, however, it has been found that 2-methylnaphthalene is no more toxic than any of many other alkylated forms of naphthalene substituted LPAHs, nor is it in greater abundance. As none of the other alkylated forms of naphthalene are included in the LPAH group, neither should 2-methylnaphthalene be included. In addition, the AETs on which both the PSDDA and SMS criteria are based do not include 2-methylnaphthalene in the LPAH group. It is not scientifically sound to compare an LPAH group sum which includes 2-methylnaphthalene to a criteria which does not. Therefore, the PSDDA agencies will no longer require testing for and reporting of 2-methylnaphthalene with submittal of PSDDA characterization data.

6. **Comment.** Re-evaluate "artifact toxicity" effects of bioassay protocols (sediment disturbance; static testing) on validity of current bioassays and chemical SMS criteria/PSDDA guidelines.

Response. Bioassay testing under the Sediment Management Standards is normally being conducted to characterize surface sediments at a cleanup site or outfall discharge location. Many of these locations are in nearshore, urban environments. In these areas, bioassay tests on undisturbed sediment samples may not be representative of actual conditions in the environment. In nearshore areas, surface sediments are routinely disturbed by wind waves, wakes, prop wash, fishing activities, anchors, waterfront construction activities, and other natural and anthropogenic effects. In addition, the logistics and expense of collecting undisturbed sediment samples for bioassay testing would be a hardship for regulated parties, since as many as 50 stations may be sampled during larger remedial investigations. During many investigations, large sample volumes are being split for multiple bioassays and chemical analyses for the purposes of evaluating the specific causes of toxicity and to differentiate sources and liable parties. These correlative evaluations are made more difficult if chemical and biological testing cannot be conducted on the same homogenate.

Other physical and biological artifacts of testing, such as flow-through vs. static testing, handling and transportation of organisms, and test organism viability are well-evaluated through current QA/QC protocols, including use of negative and positive controls and reference samples. Other potential chemical sources of toxicity (ammonia and salinity) are discussed in more detail in responses 7 and 8.

7. **Comment.** Evaluate effect of low interstitial salinity on validity of bioassays and chemical criteria/guidelines (especially for samples taken near the low water line).

Response. Both PSDDA and the Sediment Management Standards programs currently address interstitial salinity issues on a site-specific basis. At any site where the salinity is unknown or in question (e.g., estuarine sites), PSDDA agencies recommend and Ecology requests evaluation of interstitial salinity prior to or concurrent with bioassay testing. Interstitial salinity may be evaluated in the field prior to developing the sampling and analysis plan if this information is needed to select appropriate bioassay organisms. If low interstitial salinities are found, analogous freshwater or estuarine bioassay species are substituted for marine species, when available. In tidally-influenced situations, salinities are measured over the tidal cycle to identify a range of salinities that may be present when the samples are collected. In addition, interstitial salinity is measured in the laboratory prior to bioassay testing and the interstitial salinity adjusted as necessary to meet bioassay requirements. Every effort is made to select bioassay organisms relevant to the site that will not require adjustment of interstitial salinity, but there are not yet approved larval or chronic tests (other than Microtox) that can tolerate the wide range of salinities found at some estuarine sites. See response 15 and response to Dr. DeWitt's post-SMARM comment letter for more discussion of low-salinity chronic tests.

8a. **Comment.** Reevaluate effects of ammonia toxicity on bioassays and chemical criteria/guidelines.

Response. The PSDDA/SMS programs acknowledge the concern about ammonia effects on bioassay responses. The PSDDA program has considered ammonia/sulfide effects since 1989 in evaluating sediment characterization data, and have always exercised best professional judgement when data demonstrate significant effects from these parameters. However, it would be practically impossible to re-evaluate the AET database for ammonia/sulfide effects at this time. This is largely due to the fact that much of the historical pre-PSDDA data and data from other sources entered into the sediment quality database do not have these parameters associated with the toxicity data. It will be possible in the future to examine the effects of ammonia and sulfide on AETs, because these data are now submitted with all toxicological data.

8b. **Comment.** PSDDA/SMS should recommend ammonia interstitial testing at the option of the project testing applicant.

Response. The PSDDA agencies recommend that for the amphipod and *Neanthes* bioassays that **interstitial measurements** of ammonia and sulfides be collected at the option of the project proponent. A protocol for collecting interstitial water should be included in the sampling and analysis plan (SAP) and must be approved by the PSDDA agencies and SMS program prior to initiating bioassays. However, the requirement to collect dissolved ammonia and sulfide measurements in a single replicate test (chemistry only) beaker at test initiation and test termination will remain in effect. The PSDDA agencies will continue to examine ammonia and sulfide effects on bioassay data, and will evaluate ongoing national guidance regarding this issue as it becomes available for potential future implementation.

9a. **Question.** What is the availability of the AET recalculation report?

Response. The draft AET report entitled "Progress Re-evaluating some Puget Sound Apparent Effects Thresholds (AETs)" was subject to peer review in April 1995. Most of the comments received during peer review have been incorporated into a subsequent draft of this technical report. Due to multiple, competing sediment management program initiatives and resource limitations the PSDDA agencies have decided to temporarily delay the public review of the AET report. At such time that public review is conducted, the report will be sent to those attending the May 3-4, 1995 Sediment Management Annual Review Meeting and to other interested persons.

9b. **Question.** What is the process for evaluating if/how new AETs might be used in sediment management programs, and when would this occur?

Response. The process for evaluating if/how new AETs might be used in sediment management programs has not been completely defined. To date, the draft technical document has been peer reviewed (see comment/response 9a). The process, in its entirety, will include development of a regulatory implications analysis, conducting public review of both the technical document and

the implications analysis, and convening a Regulatory Work Group to address outstanding technical and policy issues. Given multiple, competing sediment management program initiatives coupled with resource limitations, the timing for the process has been delayed. When the PSDDA agencies complete the aforementioned process, Ecology's SMS program will coordinate with the PSDDA program for the proposed use of any new AET values.

10. **Comment.** The PSDDA agencies and SMS group should coordinate with sediment programs in Canada regarding Microtox responses. It was suggested that PSDDA/SMS should also consider use of a "bacterial community test" and alternative tests as potential replacements to the saline Microtox test.

Response. The PSDDA agencies and SMS group are very interested in collaborating with our colleagues in Canada on testing issues. Several SMARM attendees working for Environment Canada expressed an interest in PSDDA agencies sharing data on the side-by-side comparison of the saline and solid-phase Microtox bioassays currently being conducted by the PSDDA agencies. Dr. Kok-Leng Tay (Environment Canada) also indicated that he would be willing to provide the PSDDA agencies with a protocol for a Bacterial Community Bioassay which has shown promise in delineating contaminated sediment sites in Nova Scotia. The PSDDA agencies are willing to consider new bioassays for regulatory implementation and will coordinate with Environment Canada on bioassay issues, especially Microtox and any other new protocols being developed.

The PSDDA agencies have also been approached by Dr. Jack Anderson (Columbia Aquatic Sciences) to consider conducting some side-by-side comparisons of using a Biomarker P450 RGS test with the Microtox evaluation study as a potential alternative test. According to Dr. Anderson this test has shown itself to be sensitive to toxic and/or carcinogenic compounds (e.g., dioxins, PCBs, PAHs) in sediments. The PSDDA and SMS programs are receptive to consideration of new tests that are environmentally relevant, and cost effective. They will consider doing some side-by-side testing with this test to evaluate the test response concordance within the test suite and especially in comparison to Microtox responses.

11. **Question.** What is the process for public review of the benthic standards?

Response. The PSDDA agencies have identified the following approach for public review of the two-technical documents that provide recommendations concerning benthic infaunal measurements in Puget Sound sediment management programs: "Development of Reference Ranges for Benthic Infauna Assessment Endpoints in Puget Sound", prepared by Striplin Environmental Associates, Inc. and "Evaluation and Recommendation of Revised SMS Benthic Infaunal Sediment Standards", prepared by Roy F. Weston Consultants.

The PSDDA agencies will review final versions of each document to ascertain if the documents adequately address and/or incorporate the PSDDA agencies' comments. After PSDDA approval of the final documents, Ecology will distribute the final documents to the public for review.

The PSDDA agencies also intend to discuss SMS and PSDDA program implementation of the recommendations in each report. Upon agreement, the programs will identify proposed modifications based on the reports to the public for comment. Final PSDDA program changes will be made after consideration of public comments on the documents and will be identified at the 1996 SMARM. Modification of the SMS rule must follow state administrative procedures for rule revision and public comment. Any proposed revision of benthic infaunal SMS procedures and criteria will be publicly announced by mail and in the Washington State Register.

PSDDA ISSUES

12. **Comment.** The agencies need to encourage local governments to incorporate the PSDDA program into their shoreline master program, using the recommended language previously prepared by PSDDA.

Response. The Department of Ecology's Shorelands Program (Shorelands) has incorporated the PSDDA recommended language into their Guidebook, which was reissued in 1994. The Guidebook encourages every local government that undertakes a Shoreline Master Program (SMP) amendment project that addresses PSDDA to go ahead and make those amendments. Ecology cannot require a local government to amend their master program or address the sediment management issue. However, things are changing. The passage of ES HB 1724 (GMA, SMA and SEPA Integration) during the 1995 Legislative session creates an opportunity to comprehensively address this issue. Under this bill, Shorelands will be developing new guidelines for local master programs and will be adopting those guidelines as Washington Administrative Code. The approximate timeline for developing new guidelines is 20 months (Dec. 1996). Once Shorelands develops the new guidelines, local governments will have two years to rewrite or amend their master programs to comply with them. These guidelines will address the full range of shoreline issues. At that time, each local government on Puget Sound should adopt the PSDDA language within their master programs.

13. **Comment.** Remember to address statistical power in the Commencement Bay monitoring of the new approach to perimeter chemistry guidelines.

Response. The PSDDA agencies will assess the statistical power of the tests at perimeter chemistry stations as part of the 1995 monitoring effort in Commencement Bay.

14. **Comment.** Ask the NW Straits Marine Sanctuary program to limit their involvement in dredged material management through participation in the PSDDA program and process.

Response. A "Revised Discussion Paper of the Northwest Straits National Marine Sanctuary Project (Sanctuary Project)" was published jointly by Department of Ecology (Ecology) and National Oceanic and Atmospheric Administration on May 3, 1995. Where the previous version of the Discussion Paper identifies numerous areas where the Sanctuary Project could overlap with the PSDDA program, the revised Discussion Paper explicitly states that the Sanctuary Project will not "interfere with the Puget Sound Dredged Disposal Analysis Process".

The PSDDA agencies will continue to coordinate with Ecology's Sanctuary Program Manager during the scoping of the Draft Environmental Impact Statement and development of the Sanctuary Management Plan.

SMS ISSUES

15. **Comment.** The SMS rule should be amended to allow the use of *Neanthes* as a biological test for low salinity sediment environments.

Response. Because of the few low-salinity chronic tests available for use, the question has been raised whether *Neanthes* protocols could be revised for use with low-salinity sediments. Mike Johns (responsible for key research framing the *Neanthes* Growth Bioassay protocol) provided the following information: When the *Neanthes* test was under development, salinity testing was conducted to evaluate the sensitivity of the organism to low salinities. Normal survival was seen at salinities down to 19-20 ppt, but 50% mortality was observed at a salinity of 15 ppt after only 4 days. Therefore, the lower salinity limit in the protocol (20 ppt) is important to observe.

At one site (Norfolk CSO on the Duwamish River), the *Neanthes* test was conducted on low-salinity sediments with interstitial salinity adjusted upward to above 20 ppt by the laboratory prior to testing. The testing protocol was revised to accommodate this adjustment after consultation with Ecology and EVS; interstitial salinity was adjusted using the same procedures described in the larval bioassay protocols. Settling times range from < 1 to 4 hours depending on the amount of fines in the sediment samples. The data from this project are currently undergoing QA/QC review and results are not yet available. Over the next year, Ecology will consider the use of *Neanthes* for estuarine sediments using this procedure, and results will be reported at the next Annual Review Meeting. Until this procedure has been tested at more sites, it would be premature to revise the protocols or the SMS rule. However, applicants are always able to request use of alternative bioassay procedures on a site-specific basis, particularly for estuarine or freshwater sites, which are handled on a case-by-case basis (WAC 173-204-130(4)); also see clarification paper prepared by Brett Betts, Ecology, pages 3-15 to 3-16, in 1994 PSDDA Biennial Report).

16. **Question.** Will the revised PSEP bioassay protocols be published before the triennial rule review comment period ends?

Response. The Puget Sound Water Quality Authority is currently overseeing the final publication of the revised Puget Sound Estuary Program (PSEP) bioassay protocols. They have identified that the PSEP bioassay protocols will be finally published in July 1995. Ecology plans to begin formal rule modification process for modifications to the Sediment Management Standards rule bioassays in August 1995. The new PSEP bioassay protocols will be available to the public for review of the SMS bioassays as identified at the 1995 SMARM.

17. **Question.** Historic contamination from existing outfalls could be corrected if clean sediments were allowed to be discharged via the outfall pipe. Will the NPDES program suspended solids requirements allow this to occur?

Response. A former Pollution Control Hearings Board ruling prohibited reintroduction of solid waste (clarifier solids) into the outfall discharge, effectively forbidding reintroduction of any material that might be considered a solid waste. If one proposed to introduce clean solids (not solid waste) into an outfall, several considerations would be necessary to determine the fate and transport of the material. An important concern associated with this proposal is that clean sand would not have the same transport properties as the suspended solids routinely discharged from a wastewater outfall. It would be necessary to introduce fine solids into the discharge line to mimic the characteristics of routinely discharged suspended solids. Introduction of any substance other than the original effluent could result in physical clogging or plugging of the discharge pipe or diffuser.

More cost effective and environmentally manageable enhanced natural recovery approaches have been approved by the Sediment Management Standards cleanup program. Those could include windrowing (use of a bottom dump barge to spread rows of clean material) and thin-layer capping. At this time Ecology advocates these more environmentally manageable and cost effective approaches to enhanced natural recovery.

18. **Comment.** Human Health Sediment Criteria. Ecology needs to (1) verify the science carefully; (2) prepare an impact statement before the rules are adopted; (3) allow the option to go straight to fish tissue analysis when appropriate; (4) identify the specific statutory mandate for the human health criteria; (5) explain to the public the risks of fish contamination in context with other food sources; and (6) apply the criteria only in areas where fishing or shellfishing occurs or may occur (i.e., not everywhere).

Response. The Sediment Management Standards (SMS) receives its authority for Human Health Sediment Criteria rule making from the Model Toxics Control Act (RCW 70.105D), Water Pollution Control Act (RCW 90.48), and Puget Sound Water Quality Authority Act (PSWQA)(RCW 90.70). In addition, the PSWQA Comprehensive Conservation and Management Plan requires the SMS rule to protect both biological resources and human health. Immediately prior to adoption in 1991, the public and the Ecological Commission demanded, and then director Chris Gregoire committed Ecology to develop human health sediment criteria. Ecology is required by law to prepare a Small Business Economic Impact Statement and a Cost/Benefit Analysis. An Environmental Impact Statement was written for the adoption of the SMS in 1991. Ecology is using the technical expertise of the Department of Health to develop the criteria. In addition, a sediment scientific review board (SSRB)[1] composed of national experts has been established to help peer review the documents and verify scientific methods.

[1] The SSRB has already met once.

As suggested, Ecology is planning to propose a rule that allows the option of testing for contaminants in fish tissue as a way of confirming assumptions about bioaccumulation. We agree that fish is a valuable and healthy source of protein and other nutrients. This is why the criteria are needed; to ensure a safe supply of fish for consumption by Puget Sound residents and others. The two-tiered approach to the Human Health Sediment Criteria will allow for site-specific considerations such as fish consumption rates. This raises an interesting policy issue of current vs. future uses of the resources. If we find that no fishing is occurring at a contaminated site, can we then say that there will be no human exposure in the future?

19. **Question.** Will the saline extract Microtox continue to be used in the SMS program?

Response. Yes, Ecology will continue allowing the use of the saline Microtox test by rule. However, the SMS program will continue to coordinate with the PSDDA program on improvements or alternatives to the Microtox test. As noted at the SMARM, the PSDDA agencies are currently evaluating the solid phase Microtox test as a potential replacement for the saline extract Microtox test. In this regard, the PSDDA and SMS programs will evaluate results from a national round robin test with the solid phase Microtox protocol to be conducted during Fall 1995.

PSDDA / SMS Responses to Comment Letters Submitted After the SMARM[2]

1. Doug Hotchkiss, Port of Seattle.

(1) **Comment.** Shoreline Permits: **Response.** Comment noted.

(2) **Comment.** Small Project Costs: **Response.** Comment noted.

(3) **Comment.** PCB Congeners: **Response.** See comment, response 1.

(4) **Comment.** Chemical Guidelines at PSDDA Disposal Sites: **Response.** Comment noted.

(5) **Comment.** *Neanthes* Bioassay: Why change from biomass to growth endpoint, and the lack of a clear problem statement?

Response. The *Neanthes* Growth Test was established as one of the first chronic/sublethal bioassays to be used in assessing sediment toxicity. The PSDDA program implemented the growth endpoint for the *Neanthes* 20-day Growth Test after the 1994 ARM. Adoption of a

[2] See attached letters located in Appendix B for detailed comments and questions.

growth endpoint was recommended in papers by Dillon, Moore and Gibson (1993)[3] and Moore and Dillon (1993)[4]. They noted that between one week and eight weeks post emergence the growth rate of juvenile *N. arenaceodentata* was very linear. Dillon, Moore and Gibson (1993) provided five reasons for using growth rate as the interpretative endpoint:

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

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

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

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

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

Moreover, recent research by Moore and Dillon (1993) provided interpretive guidance on the growth endpoint, quantifying the relationship between growth diminution and subsequent reproduction. The SMARM clarification paper on *Neanthes* acknowledges this information and provides further guidance on the growth endpoint relative to sublethal effects. The PSDDA program establishment of an interim control growth performance standard for *Neanthes* is deemed necessary to insure successful laboratory performance with healthy and viable worms in order to measure sublethal effects in treatments attributable to sediment bound contaminants. The PSDDA agencies will continue to monitor laboratory performance and expect to adjust this guideline as needed in the future. Please see the final clarification paper provided as an attachment to these minutes in Appendix D.

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[3]Dillon, T.M.; D.W. Moore,; and A. B. Gibson. 1993. Development of a chronic sublethal bioassay for evaluating contaminated sediment with the marine polychaete worm *Nereis (Neanthes) arenaceodentata*. Environ. Tox. and Chem. 12: 589-605.

[4]Moore, D.W., and T.M. Dillon. 1993. The relationship between growth and reproduction in the marine polychaete *Nereis (Neanthes) arenaceodentata* (Moore): implications for chronic sublethal sediment bioassays. J. Exp. Mar. Biol. Ecol. 173: 231-246.

(6) **Comment.** Benthic Issues:

A. Reference stations.

B. Limiting stations < 150 feet.

C. Assumption that all stations exceeding SMS are contaminated and those less than SMS guidelines are not. This is circular logic given potential false positives for bioassays.

D. Highly Stressed qualifier code.

Response. The PSDDA and SMS programs acknowledge the potential for conventional sediment contaminant impacts to benthic abundance in reference areas and elsewhere in Puget Sound. One difficulty in interpreting the historical Puget Sound reference area benthic data is the lack of synoptic conventional sediment contaminant data available, i.e., ammonia was not routinely analyzed and reported. However, using chemistry to screen and identify an acceptable subset of Puget Sound sampling stations for the reference area performance standards project is consistent with the adopted SMS rule and regional sediment quality designation practices.

Selection of the Puget Sound benthic reference area data for the category of < 150 ft. was based primarily on a consideration of statistical needs (the deeper sediment benthic data had an inadequate number of stations to support statistical analyses), and secondarily in consideration that this zone represented the predominant area for sediment source control and cleanup activities. The development of benthic reference area performance standards for this shallower zone was never intended to replace current PSDDA program disposal site "reference sediment" comparisons for deeper sediment areas.

The PSDDA and SMS programs will continue to coordinate with regional and national benthic experts to fully evaluate the physical and chemical factors that the benthic infauna may be reacting to, and to characterize the relationship between a "stressed" benthic community and an impact site.

Finally, the PSDDA and SMS programs are committed to a careful, scientific evaluation of the contribution of sediment conventionals to adverse biological effects for benthos and bioassays. Of course, the focus of these studies will be to improve the tiered chemistry and biological effects evaluation methodologies adopted in the PSDDA and SMS sediment management programs. In addition, it will assist in clearly identifying and quantifying analytical results for false positive and false negative impacts associated with interpreting biological endpoints.

Comment. Microtox.

Response. See comment/response 19.

(7) **Comment.** New AET's, exclusion of certain synoptic data from AET calculations.

Response. See response 2c to Dr. Ted DeWitt's post-SMARM comment letter. Also see SMARM minutes @ page 27 (Tom Gries response to question)

(8) **Comment.** Regarding the availability of other key, synoptic data sets which should be included in AET calculations.

Response. The PSDDA agencies recognize that certain historic and new synoptic data sets which have the potential to affect both the current (1988) AET values and the newly-calculated 1994 AET values. However, there will likely always be a steady flow of new synoptic data being submitted or becoming available to the PSDDA agencies. From a process standpoint, the agencies must set an operational "cutoff" for data review and entry, beyond which AET recalculations must begin and it is more difficult to incorporate new synoptic data. The PSDDA agencies agree to consider this effort as part of the Regulatory Workgroup process.

(9) **Comment**. Regarding the calculation of echinoderm abnormality AETs separate from 1986 oyster abnormality AETs.

Response: There are at least two main reasons why the PSDDA agencies separate echinoderm abnormality AETs from the 1986 oyster abnormality AET values. First, the 1986 oyster AETs were based on toxicity test protocols which differed substantially from all the subsequent data which was gathered, quality assured and entered into the sediment quality database. Second, the bivalve (mollusc) and echinoderm taxonomic groups may be expected to respond differently to sediment toxicity testing. For this reason, experts attending the 1993 PSDDA Annual Review Meeting recommended abandoning preliminary AETs which were based on combined bivalve and echinoderm larvae abnormality bioassay results, and calculate bivalve and echinoderm AETs separately.

A "Regulatory Work Group" will be convened by the PSDDA agencies later this year. They will likely play a major role in determining if and how the 1994 echinoderm abnormality and 1986 oyster abnormality AETs will be used in future regulatory programs.

(10) **Comment.** Interstitial salinity and ammonia.

Response. See comment/response 7 and 8.

2. Dr. Ted DeWitt, Battelle Northwest Laboratory

(1) **Comment.** Marine Sediment AET's:

a) Include chemically anomalous samples in the AET calculation, or include in tables so that the data can be evaluated by others.

Response. The PSDDA agencies calculated 1994 AET values using methods generally consistent with those used to derive the 1988 AETs which form the basis of current regulatory guidelines and criteria. The 1988 AETs were calculated after excluding certain anomalous samples from the sediment quality database. An anomalous sample was defined as one showing no significant biological effect (amphipod mortality or benthic abundance depression) but having a chemical concentration at least three times greater than the next highest "No Hit" sample. (PSEP. 1988. Sediment Quality Values Refinement: Volume I. Update and Evaluation of Puget Sound AET. Appendix C. Prepared for the U.S. EPA, Puget Sound Estuary Program (PSEP), by PTI Environmental Services, Inc.)

Chemically anomalous samples excluded from AET calculations are listed in the draft of Appendix B, Table B-7. Future AET recalculations may elect to use a statistical test for outliers to exclude anomalous "No Hit" samples.

b) Appropriateness of using a 25% mortality trigger to define a significant effect in *Rhepoxynius abronius*.

Response. To be consistent with the existing amphipod mortality AETs, the PSDDA agencies' calculations were based on the same definition of a significant adverse effect ("Hit") in 10-day amphipod mortality bioassay samples as was used in 1988 (PSEP, see above). The 25% (absolute) mortality level was based on earlier findings (Mearns, et al. 1986. Inter-laboratory comparison of a sediment toxicity test using the marine amphipod, *Rhepoxynius abronius*. Mar. Environ. Res., 19:13-37).

If the Regulatory Work Group recommends that new amphipod AETs be based on a different definition of a significant adverse effect (e.g., "anything that is statistically different (from reference)" or just statistically different from the negative control sample), then the resulting AET values would be expected to be lower and more sensitive predictors of adverse effects. However, the "real world" implications of lower amphipod AET values are not known.

c) Basis for rejecting numerous synoptic samples.

Response. Most of the available synoptic samples not included in 1994 AET calculations lacked a reference sample or the associated reference sample did not meet quality assurance guidelines or performance standards. Relatively few samples were excluded because they were found to be "statistically inconclusive" or considered "anomalous" as defined in PSEP (1988). The number of samples excluded, and the reason why they were excluded, is summarized in the draft of Appendix B, Tables B-2 through B-5. The PSDDA agencies initially tried to maximize the number of new synoptic samples included in preliminary recalculations of AETs. When reference samples were not collected or reference results were not available, test samples were compared to negative control sample results. This resulted in a much higher number of samples being

classified as "Hit" samples. The resulting AET values were often unrealistically low and the overall reliability of those values was also quite low (PSDDA. 1993. Minutes from the Annual Review Meeting for Dredging Year 1992.). For these reasons, the agencies eliminated such comparisons and used only surveys for which reference data were available. Test sample results were excluded if the associated reference sample did not meet quality assurance guidelines or performance standards.

d) Were non-polar organic contaminant concentrations normalized to measured TOC values for the sample from which the contaminant was measured, or were average TOC concentrations for the region used to normalize the data?

Response. In order to calculate a TOC-normalized AET value, each sample in the sediment quality database (SEDQUAL) must have associated with it concentrations of chemicals of concern AND of TOC. The PSDDA agencies believe that all of the TOC data which have been added to SEDQUAL since 1989 represent individual samples or subsamples, and did not result from averaging TOC values within a region.

e) Use the database to examine the particle size mortality regression for *Rhepoxynius* and *Eohaustorius*.

Response. The PSDDA program examined this issue previously and documented significant correlations between *Rhepoxynius abronius* mortality and various sediment particle size fractions (e.g., percent fines and percent clay)(Corps of Engineers-Seattle District, in: PSDDA. 1993. Minutes from the May 1993 Annual Review Meeting for Dredging Year 1992). For this reason, the agencies did not pursue a more comprehensive analysis using the entire new AET database.

f) Provide a table showing which surveys were added to SEDQUAL since 1988 AET.

Response. This information is contained in the draft of Appendix B, Table B-8.

g) Studies are needed to ground truth the benthic abundance responses used in the AETs, particularly TOC, grain-size, ammonia, and other correlated factors, which may have been associated with changes in benthic abundance.

Response. See comment and response to (5) below.

(2) **Comment.** Freshwater Sediment AETs. Why haven't community structure data been incorporated into the AETs?

Response. The development of freshwater sediment criteria has not considered benthic community structure primarily due to the lack of synoptic benthic data for the historical freshwater sediment data collected in Washington State. Recently, the Lower Columbia River Bi-State Study has completed benthic analyses, but this data represents estuarine conditions as

defined by the SMS rule and therefore has not been incorporated into the freshwater sediment quality database, FSEDQUAL. When enough samples have been collected and entered into FSEDQUAL (approximately 50), preliminary freshwater sediment benthic AET values will be developed.

Ecology has developed: "A Review of Interpretation Methods for Freshwater Benthic Invertebrate Survey Data Used by Selected State and Federal Agencies" (1991). This document identifies that multiple methods exist for interpretation of freshwater benthic community impacts. Ecology has not identified a preferred benthic interpretation method(s) pending review of future Washington State freshwater sediment benthic data.

(3) Comment. Amphipod Sediment Toxicity Tests

a) The PSDDA agencies should consider including the *Leptocheirus plumulosus* acute and chronic sediment toxicity tests in a suite of methods for sediment assessments.

Reasons for considering this test species are:

1) It exhibits a wide tolerance to salinity (1-30 ‰)
2) Exhibits wide tolerance to grain-size (sand to very fine mud; its native habitat is mud)
3) Can be cultured with year round availability and uniform quality
4) Exhibits high sensitivity to contaminants (mortality comparable to *Eohaustorius* and *Ampelisca*), but reproductive sublethal endpoint of chronic test more sensitive than *Rhepoxynius*.
5) True life-cycle test
6) Interpretive guidance available

Response. The PSDDA agencies will evaluate this test to assess dredged material when resources and staff become available.

(4) Comment. Effects of interstitial water ammonia on bioassay responses must be included.

Response. See comment and responses 7 and 8.

(5) Comment. The utility of grain-size reference sites should be evaluated.

Response. The PSDDA and SMS programs are always interested in examining alternative approaches, when they effect a cost savings and still provide high quality data necessary for regulatory decision-making. When staff and resources become available, the agencies will examine and compare reference site data collected with the DeWitt et al. grain-size effects model to evaluate its usefulness as an alternative to reference site data in decision-making.

(6) Comment. Benthic Infaunal Responses. Need to evaluate experimentally the factors to which the "sensitive" species are really responding at "impacted sites". Also need to ground

truth the data used to calculate 1988 benthic abundance AETs, especially to control for negative effects due to TOC, grain size, ammonia, etc.

Response. The scope of the current AET re-evaluation does not include AETs based on benthic infaunal effects. When the current effort was begun, insufficient new benthic data were available to justify recalculating benthic AETs. Benthic experts had recommended that benthic AETs be recalculated based on one or more alternative endpoints, e.g., species richness, not just the abundance of major taxonomic groups. But there was no policy decision on which endpoints to use. The PSDDA agencies recognize that historic benthic effects data may need to be re-evaluated using alternative endpoints and considering the emerging evidence that conventional factors may adversely affect benthic organisms. The PSDDA agencies will evaluate this issue further subject to availability of staff and resources.

APPENDIX B

SMARM Public Issue Papers and Post-SMARM Comment Letters

WASHINGTON PUBLIC PORTS ASSOCIATION

April 28, 1995

Mr. David Kendall
Dredged Material Management Office
Seattle District
US Army Corps of Engineers
PO Box 3755
Seattle, WA 98124-2255

Dear Mr. Kendall,

This is a comment letter to the Puget Sound Dredged Disposal Analysis (PSDDA) program, as it as it conducts its seventh annual review meeting in conjunction with the Department of Ecology's Sediment Management Standards Triennial Review Process. These comments are provided on the materials that relate to the PSDDA program; our comments on the SMS Triennial Review will be provided directly to the Department of Ecology through its review process.

Our first overall comment is that we like the joint presentation that has been provided by the Corps and the Department of Ecology. The March 23 information package was a comprehensive overview of the proposed changes to the PSDDA program, and we appreciated having all of this information accessible in one place.

Our Association is also presenting one Issue Paper for discussion at this year's Annual Review. The enclosed paper relates to the potential involvement of the Northwest Straits National Marine Sanctuary in the PSDDA program. I will be presenting this paper at the appropriate public comment time on the agenda.

Our specific comments follow:

We are very pleased to see that all of the disposal site shoreline permits have been obtained. We reiterate our perennial comment that the Department of Ecology Shorelands program needs to make certain that the various local jurisdictions noted in Table 1 have received the model shoreline master program element contained in Exhibit B of the Phase I PSDDA Management Plan Report.

We support the proposed program modification outlined in the Issue Paper titled: "Refinements to PSDDA Post Disposal Monitoring Guidelines". The recent routine monitoring anomalies at the various disposal sites have been vexing to all of us, and the proposed program modification seems a very reasonable and prudent response to the current troublesome monitoring interpretations and procedures.

We have some questions stemming from the clarification paper titled "Interim Growth Rate and Mortality Guidelines for the Neanthes 20-day Growth Bioassay". **The problem identification section of this paper does not identify any clear problem, and we are not sure if this program change will lead to any difference in the amount of dredged material that qualifies for open-water disposal.** The exact rationale for moving to 0.72 mg/ind/day is not clear, and our reading of the paper leads us to conclude that the validated sample size that led to this change was very small. (n=6?)

For these reasons, and because this change has also been picked up in the proposed rule language as an amendment to the state sediment management standards, we would like to see a more thorough discussion of this issue at the ARM.

The status report titled "Development of Reference Ranges for Benthic Infauna Assessment Endpoints and Evaluation of Alternate Benthic Infauna Assessment Methods in Puget Sound" also raises some questions in our minds. In particular, we are wondering if the studies that are discussed account for address natural variations in benthic infauna that are due entirely to TOC content. We have some additional questions on this status report that we will raise at the meeting.

We also note with interest the status report titled: "Progress Re-Evaluating Puget Sound Apparent Effects Thresholds". Given the statistical laws that govern AETs, how is it that so many of the AET levels (particularly Screening Levels) are going down? This must be due to throwing out a certain amount of data. If this is the case, then why has this data been removed from the database?

In particular, we are concerned about the screening methods for inclusion of bioassay results in the data set used to recalculate the 1994 AETs. Among our concerns are the removal of anomalous "no hit" data. We would also like a discussion of this topic at the meeting. (This type of question may be best addressed by the Regulatory Work Group that is referenced in the paper. We would also like this work group to address the issue of the increasing incidence of false positives in the data.)

We also would like to receive a copy of the final version of the Grays Harbor and Willapa Bay Dredged Material Evaluation Procedures and Disposal Site Management Manual at the meeting, if it is available.

Finally, we would like an update on the issue of debris screens. Specifically, what is the current debris screen policy, and are there any changes being considered for it?

I hope these comments are useful to the agencies as you proceed in implementation of this important program.

Yours truly,

WASHINGTON PUBLIC PORTS ASSOCIATION

Eric D. Johnson
Environmental Affairs Director

enclosure

c: Keith Phillips, Department of Ecology
Phil Hertzog, Department of Natural Resources
John Malek, Environmental Protection Agency, Region X
WPPA Environmental Committee

ISSUE PAPER

INVOLVEMENT OF THE PROPOSED NORTHWEST STRAITS MARINE SANCTUARY IN THE PSDDA PROGRAM

Prepared by Eric Johnson (Washington Public Ports Association, 360/943-0760)

INTRODUCTION

In 1988 the Congress directed the National Oceanic and Atmospheric Administration (NOAA) to study the establishment of a national marine sanctuary in the waters surrounding the San Juan Islands. Since then, NOAA has been embarked on a study in partnership with the Washington Department of Ecology. The boundaries of the sanctuary study area include most of the state waters north of the southern end of Whidbey Island, to the Canadian border, as well as the entire U.S. side of the straits of Juan de Fuca.

While there are many national marine sanctuaries throughout the country (including one off Washington's Olympic coast), this is the first national marine sanctuary ever proposed for an area that is entirely within one state's territorial waters.

The Marine Protection, Research and Sanctuaries Act provides that the management plan for a sanctuary will be the federal Environmental Impact Statement. This EIS is written in partnership with any affected state, and the Governor of the state has the opportunity to veto any provision of the sanctuary management plan.

At this time, NOAA and Ecology have scoped the EIS for the proposed Northwest Straits Sanctuary. The geographic and program scope of the program are not yet determined. A public and interest group involvement program is under way, with the goal of having a draft EIS completed by December 1995. At that time, NOAA and the state will decide whether to proceed with sanctuary designation.

PROBLEM IDENTIFICATION

Throughout the past seven years, sanctuary documents have made references to becoming involved in dredging and dredged material disposal decisions in sanctuary waters. Despite attempts by PSDDA participants and proponents to direct NOAA to the existing PSDDA annual review process with any dredging concerns, the most recent policy paper clearly envisions possible sanctuary involvement in the PSDDA program. The Draft Working Paper for the Proposed Northwest Straits National Marine Sanctuary (March 1995), drafted jointly by NOAA and Ecology lists as possible options for action:

"Conduct biological monitoring at open water dredged material disposal sites in Northwest Straits" (Option WQ 20)

"Lend support to review of PSDDA program and sites" (Option WQ 27)

"Study/monitor impacts of all upland, shoreline and marine uses on marine habitat/wetlands" (Option H 10)

Clearly, the first two options are aimed at sanctuary involvement in the PSDDA program in a way that is not anticipated by or accounted for in the existing PSDDA program.

PROPOSED ACTION

Both NOAA and the Department of Ecology should clearly state that the Northwest Straits National Marine Sanctuary will not involve itself in dredging permitting decisions, or in suitability determinations for open-water disposal, or in monitoring or management of the open-water dredged material disposal sites, except through the established process of the PSDDA Annual Review.

REFERENCES

NOAA/Ecology, 1995. Draft Working Paper for the Proposed Northwest Straits National Marine Sanctuary.

NOAA/Ecology, 1992. Northwest Straits, Washington National Marine Sanctuary: A Partnership for Protection.

HELLER EHRMAN WHITE & McAULIFFE

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ANCHORAGE
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April 28, 1995

Brian Applebury
Acting Chief, Operations Division
Seattle District
Corps of Engineers
Dredged Material Management Office
P.O. Box 3755
Seattle, WA 98124-2255

Re: Issue papers for consideration in Sediment Management Standards Triennial Review

Dear Mr. Applebury:

Enclosed are two issue papers to be added to the agenda for the Sediment Management Annual Review Meeting. One paper addresses the need to evaluate the effects of apparent toxicity resulting from artifacts of the bioassay methods. The other paper addresses the need to consider the effects that ammonia has on bioassay results as well as on the standards and the PSDDA analysis process. Each expresses concerns that failure to understand these issues may have lead to management programs that feature excessively conservative standards.

Very truly yours,

HELLER, EHRMAN, WHITE & McAULIFFE

Lincoln C. Loehr
Environmental Analyst

Triennial Review

Sediment Management Standards (SMS) Rule
Chapter 173-204 WAC

Action: Need to evaluate the effects of apparent toxicity resulting from artifacts of the bioassay methods. Are these tests, and the standards that are based on these tests, really representative of toxicity under ambient conditions?

Subject: Validity of bioassay protocols and the historical bioassay data as representing toxicity of sediments in Puget Sound.

Author: Lincoln Loehr, Heller, Ehrman, White & McAuliffe

Date: April 27, 1995

INTRODUCTION

The sediment management standards were developed based on Apparent Effects Thresholds determined by use of sediment bioassays that subjected organisms to exposures of disturbed sediments under static conditions. Organisms in the real world live in a flow through environment, not a static one, and many sediments are not disturbed. The great majority of the sediment quality standards and the minimum cleanup levels were set by sediment bioassay results, not by benthic population assessment.

If some of the apparent toxic effects are associated with artifacts of the test methods, and not the real world conditions, then the standards themselves are overly protective. If this is the case, then we may have defined a problem for ourselves, at least in some instances, where no problem exists.

Presumably the sediment management standards provide a way out, in that if the sediment chemistry exceeds the standards, the discharger may override the results with the use of sediment bioassays. Unfortunately, these are the same bioassay protocols used to develop the standards, with the same problem of being

static tests with disturbed sediments. Hence, the potential flaw remains.

The potential effect of artifact toxicity needs to be evaluated to see if the standards are overly conservative and to allow for correcting the standards or to allow for confirmatory testing that is more representative of ambient conditions.

PROBLEM IDENTIFICATION

In developing the sediment management standards, DOE requested a review by EPA's Science Advisory Board (SAB) of the AET methodology. The SAB raised a number of concerns, and DOE failed to address some of these concerns in developing, adopting and implementing sediment standards. Specifically, the SAB noted the following:

> "The Puget Sound study concentrated on the chemical and biological data and used little or no physical data (currents, salinity, turbulence, and sediment characteristics) in the development of AET. **Until the effect of physical factors on AET is adequately studied, the present AET values could contain significant errors and the AET cannot be applied generically with confidence.** (emphasis added)."

SAB (1988) at 11.

Physical factors that I do not believe have been adequately evaluated in the development of the Sediment Management Standards include 1) the effects of running bioassays on disturbed sediment samples, 2) the effects of running bioassays under static conditions, and 3) the possible impact on the sediment quality standards associated with lower pore water salinities when no pore water salinity measurement was made.

The effects of running bioassays on disturbed sediment samples

Sediment bioassays run on disturbed sediment samples may not really represent toxicity in the ambient waters if the ambient sediments are not disturbed.

The SAB report includes examples of factors that may give rise to biased relationships between the exposure and response variables. One of these factors was:

> **"Bioassays conducted with homogenized sediments or with supernatants derived from agitated sediments as opposed to undisturbed sediments."**

SAB (1988) at 13.

In January 1991, shortly before the sediment management standards were adopted, research results by Word, Claiborne, Ward and Chapin (1991) were presented at the Puget Sound Research '91 conference on "The Effect of Test Sediment Stabilization and Disturbance on Acute Toxicity to the Amphipod *Rhepoxynius abronius*." This presentation showed an example where test sediments that showed toxicity under the required test protocols were allowed to stabilize for a period of several weeks before commencing the tests. The toxic effects went away. If those same sediments were redisturbed, the toxic effects returned.

The test results cast doubts on the validity of establishing sediment quality standards based on these tests for sediments that in nature may be undisturbed. The same issue is a concern with other sediment bioassay methods. The bivalve larval test and the Microtox test each used highly agitated mixtures of sediment and water, rather than stable sediments. Recently the bivalve larval test protocol was changed to try to avoid one artifact toxicity effect, by allowing a period of settling following agitation before inoculating with larvae. The studies with *Rhepoxynius abronius* and the necessity to change the bivalve larval test protocols illustrate the issues that the SAB expressed concern with.

<u>The effects of running bioassays under static conditions</u>

EPA's Office of Marine and Estuarine Protection (1990) noted:

> "The test system described by Swartz et al. (1985) for the phoxocephalid amphipod <u>Rhepoxynius abronius</u> is recommended for bioassays with this and other amphipod species. **Some amphipods do not survive well under static conditions and, therefore, should be tested using only a continuous flow or static renewal test design.**" (emphasis added)

and,

> "The use of flow-through exposure systems is preferred **to minimize the chances that stressful artifacts of experimental procedures will affect the results**; static renewal systems may be acceptable." (emphasis added)

Fredericka Ott (1985) observed higher mortalities in static bioassays than flow through bioassays.

The effect on the sediment quality standards of not measuring the pore water salinity

The sediment quality standards have reserved a section for standards for low salinity sediments. This is in recognition that when pore water salinities are less than 25 parts per thousand, the standards should not be based on bioassays with organisms that do not tolerate lower salinities.

Ramsdell, Strand and Cullinan (1989) reexamined sediment data from Sequim Bay and noted that earlier hits on the amphipod bioassay may have been related to,

> "....a relatively low interstitial salinity (24 o/oo)."

They further noted that,

> "Swartz et al. (1985) determined that R. abronius is sensitive to low salinity",

and they concluded that,

> "....a test sediment's interstitial salinity must be at least 25 o/oo before salinity effects on survival could be discounted."

Most of the SEDQUAL data base that was used to develop the Sediment Management Standards did not include measurements of pore water salinities. Perhaps it was simply assumed that they would be saline. Groundwater does flow into Puget Sound, and in places it will come through the sediments. Much of the SEDQUAL data based used to develop the Sediment Management Standards included samples from the Duwamish River. It is possible that some hits with amphipods might actually have been a result of low salinity that was not measured and therefore not considered.

DISCUSSION

Prior to the adoption of the sediment management standards, I asked that the DOE examine the effect of the Ward, Claiborne, Word and Chapin study on the standards. I asked that the effects of static versus flow through bioassays be evaluated. I also questioned whether the SEDQUAL data base used in the Puget Sound Sediment Standards development included routine measurements of pore water salinity. I do not believe that these evaluations were made. Now that the Department of Ecology is beginning a triennial review of its sediment management standards, it is appropriate that these issues be evaluated and resolved. The cost ramifications of potentially overly stringent standards demands that this analysis be performed.

PROPOSED ACTION

The triennial review of sediment management standards must evaluate the role of artifact toxicity in the present biomonitoring tests. Unless the evaluation determines that artifact toxicity is not significant, the Department of Ecology must develop alternate test protocols for confirmatory testing that reduce or eliminate artifact toxicity, and allow new data, with the new protocols to move the standards upward in a timely manner. If artifact toxicity is suspected to be a major problem, then it may be necessary to suspend the standard until it is resolved. In such case, it is still possible to assess the sediment quality through biological population assessment methods alone.

REFERENCES

EPA Office of Marine and Estuarine Protection, January 1990. Draft Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters (EPA-503-8-90/002)

EPA Science Advisory Board, July 1989. "Evaluation of the Apparent Effects Threshold (AET) Approach for Assessing Sediment Quality." SAB-EETFC-89-027.

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J.Q. Word, B.W. Claiborne, J.A. Ward and C. Chapin, 1991. "The Effect of Test Sediment Stabilization and Disturbance on Acute Toxicity to the Amphipod *Rhepoxynius abronius*." in, Puget Sound Research '91 Proceedings, Volume 2, pp 441-448.

Triennial Review

Sediment Management Standards (SMS) Rule
Chapter 173-204 WAC

Action: Need to evaluate the effects of ammonia on sediment bioassay results, and whether ammonia toxicity should lead to a re-evaluation of our sediment standards.

Subject: Validity of bioassay protocols and the historical bioassay data as representing toxicity of sediments in Puget Sound when ammonia has not been considered.

Author: Lincoln Loehr, Heller, Ehrman, White & McAuliffe

Date: April 28, 1995

INTRODUCTION

Ammonia may naturally occur in sediments at toxic levels. This has not been evaluated or controlled for in the historical data. Perhaps some of our sediment standards, based on AETs, may have been influenced by ammonia toxicity. Also, does it make sense to clean up to non-toxic levels for one parameter when the natural toxicity from ammonia may be greater, and may re-establish itself after a cleanup anyway? There could also be related hydrogen sulfide issues.

PROBLEM IDENTIFICATION

Recently, EPA identified ammonia as an issue in Amphipod bioassays. Unfortunately, the information was not distributed rapidly to users with a real need to know. I have included a copy of EPA's letter to this issue paper, along with a discussion of toxicity of ammonia in aquatic sediments and its implications for sediment quality evaluation and management prepared by Anne Jones-Lee and G. Fred Lee.

PROPOSED ACTION

Both PSDDA and the triennial review of sediment management standards must evaluate the role of ammonia toxicity in the present biomonitoring tests. Unless the evaluation determines that ammonia toxicity is not significant, PSDDA and the Department of Ecology must develop alternate test protocols for confirmatory testing that reduce or eliminate the possible ammonia toxicity. Ecology must allow new data with the new protocols to move the standards upward in a timely manner. If ammonia toxicity is suspected to be a major problem, then it may be necessary to suspend the sediment standards until the ammonia issue is understood and resolved. In such case, it is still possible to assess the sediment quality through biological population assessment methods alone.

Perhaps hydrogen sulfide warrants similar scrutiny.

REFERENCES

EPA, December 21, 1993. Letter from Tudor Davies, David Davis and John Elmore to EPA Regional ocean Dumping Coordinators, EPA Regional Wetlands Coordinators and Corps of Engineers Regulatory and Civil Works Elements.

(Note: this letter explains how laboratories should reduce ammonia in sediment's interstitial water to below 20 mg/l before adding benthic test organisms. Tables in the letter also state that hydrogen sulfide is not likely to be a problem in these tests if adequate dissolved oxygen levels are maintained in the overlying water. That sounds quite a bit different than a static test protocol...)

Jones-Lee, A. and G. F. Lee. 1995. "Toxicity of Ammonia in Aquatic Sediments and its Implications for Sediment Quality Evaluation and Management." Submitted to Journal of Water Research, January 1995.

C:\LCL\SEDIMENT\TRI-RW.#2

Toxicity of Ammonia in Aquatic Sediments and its Implications for Sediment Quality Evaluation and Management[1]

Anne Jones-Lee, Ph.D. and G. Fred Lee, Ph.D., P.E., D.E.E.

G. Fred Lee & Associates
El Macero, California USA 95618

ABSTRACT

Ammonia is a common contaminant in many aquatic sediments which can arise from both natural and anthropogenic sources. Un-ionized ammonia is highly toxic to many forms of aquatic life. Studies on a variety of US waterway sediments taken near municipal industrial areas show that ammonia is a frequent cause of toxicity in laboratory toxicity tests of aquatic sediments. Sediment quality investigations should evaluate whether sediment toxicity is caused by ammonia in the sediments and its significance to the beneficial uses of the waterbody.

KEY WORDS - ammonia, toxicity, sediments

INTRODUCTION

Jones and Lee (1978) and Lee *et al.* (1978) found that sediments from many US waterways showed some toxicity to test organisms in four-day laboratory toxicity tests on sediment elutriates. The toxicity, however, was far less than would be predicted based on the concentrations of the variety of contaminants in the sediments (Jones *et al.*, 1981). Jones and Lee (1988) subsequently reported that for a group of those sediments they examined further, the toxicity appeared to be due to the ammonia in the sediments. Ankley *et al.* (1990) also reported that ammonia was the constituent responsible for toxicity found in laboratory tests of sediments from the upper Fox River in Wisconsin.

AMMONIA IN AQUATIC SEDIMENTS

While the aquatic chemistry of organics, heavy metals, and many other chemicals in aquatic sediments is complex, the chemistry of ammonia is relatively simple and straightforward, especially in marine systems. Ammonia exists in aquatic sediments in two forms, the ammonium ion (NH_4^+) and un-ionized ammonia (NH_3). Un-ionized ammonia is highly toxic to some forms of aquatic life, while the ammonium ion is largely non-toxic or significantly less toxic. The distribution of ammonia between those two forms in water is controlled by pH, temperature, and ionic strength. In freshwater sediments at pH 8.0 and 27°C, about 3% of the total ammonia is present in the un-ionized form, while in saline water (20‰) of the same temperature and pH, about 4% of the total ammonia is in the un-ionized form (US EPA, 1989;

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[1] Submitted for publication, Journal of Water Research, January 1995.

Thurston *et al.*, 1979).

The US EPA (1989) has determined that the chronic water quality criterion for un-ionized ammonia in marine waters is 0.035 mg/L NH_3 based on the sensitivity of mysids, various types of shrimp, and fish. The US EPA (1989) determined a saltwater Final Acute Value for ammonia of 0.465 mg NH_3/L. In their studies of the toxicity of ammonia from New York Harbor sediments to *Palaemonetes pugio* (grass shrimp) Jones and Lee (1988) found that the concentrations of un-ionized ammonia in those systems in which the 96-hr survival was about 50% was on the order of 0.3 to 0.5 mg N/L. That finding was in keeping with those reported by Hanson (1986) and Hall *et al.* (1978). Such an LC50, however, was considerably lower than that reported by US EPA (1989) for another investigator's tests with juvenile and adult grass shrimp, of 2.6 mg/L. That value is believed to be in error.

For freshwater, the US EPA (1987) has established an un-ionized ammonia four-day average chronic criterion of about 0.02 mg/L NH_3; at lower temperatures and pH's, that value is about 0.01 mg/L NH_3. Acute:chronic ratios range from 3 to 43 mg/L NH_3; 96-hr LC50's were reported as low as 0.08 mg/L NH_3. Salmonids are among the most ammonia-sensitive of the freshwater organisms tested.

In marine sediments, ammonia would be expected to show little tendency to sorb onto sediments because of the high ionic concentrations of sodium, calcium, and magnesium in the interstitial waters, the comparatively low concentration of ammonia, and the low sorption tendency of ammonia compared with calcium, magnesium, and sodium. Ammonia associated with the sediment would thus be present largely dissolved in the interstitial water.

Many of the analytical procedures used for measuring ammonia in sediments involve the addition of water (e.g., ammonia electrode measurements). It is therefore necessary to consider any dilution of interstitial water ammonia associated with the chemical analytical or toxicity test procedures used. The measurement of ammonia in sediments is sometimes accomplished after distillation of the ammonia from the sediment sample. Under these conditions, the amount of water added in the distillation flask does not affect the results of the test.

In order to compute the un-ionized ammonia concentration in the interstitial water for the ambient sediments, it is necessary to know the percent moisture in the sediments. Typically, aquatic sediments range from 40% to 60% moisture. A marine sediment interstitial water with 40% solids, pH 8.0, temperature 20°C and total ammonia of 1.5 mg N/Kg dry weight, would be expected to have sufficient un-ionized ammonia in the interstitial waters to exceed the US EPA chronic water quality criterion for ammonia.

In the 1970's, the authors (Lee *et al.*, 1978 and Jones and Lee, 1978) conducted an extensive study of sediment-associated contaminants largely in estuarine and marine waterways near urban and industrial centers throughout the US. Concentrations of ammonia and a variety of other contaminants (including heavy metals, chlorinated hydrocarbon pesticides, and PCB's) were determined, and aquatic life toxicity evaluated. As shown in Table 1, the total ammonia

Concentrations of Ammonia in Sediment
from Studies of Lee *et al.* (1978)

Location	Sediment Ammonia (mg N/kg dry wt.)
Oakland, CA	30
Los Angeles, CA (site 1)	624
Newport, RI	24
Stamford, CT	123
Norwalk, CT (site 1)	173
Norwalk, CT (site 2)	168
Foundry Cove, NY	114
Menominee River, MI/WI (site 1)	670
Menominee River, MI/WI (site 2)	382
Wilmington, DE	47
WES Lake, MS	66
Apalachicola, FL (site 1)	178
Apalachicola, FL (site 2)	82
Apalachicola, FL (site 3)	158
Apalachicola, FL (site 4)	146
Apalachicola, FL (site 5)	168
Upper Mississippi River, MN	25
James River, VA	294
Bailey Creek, VA	131
Texas City Channel, TX (site 4)	294
Texas City Channel, TX (site 5)	36
Texas City Channel, TX (site 6)	222
Houston Ship Channel, TX (site 1)	182
Houston Ship Channel, TX (site 2)	218
Houston Ship Channel, TX (site 3)	83
Port LaVaca, TX	19
Duwamish River, WA (site 1)	33
Duwamish River, WA (site 2)	131
Duwamish River, WA (site 3)	90
Perth Amboy Channel, NJ	628
Perth Amboy Anchorage, NJ	274
Bay Ridge Channel, NY	235
Mobile Bay, AL (site 1)	381
Mobile Bay, AL (site 2)	197
Mean	194
S.D.	172

DY94 SUITABILITY DETERMINATIONS

- 10 projects
- 50 chemical analyses
- 29 biological analyses
- 17 DMMU failed (69,276 cubic yards)

Overhead 3-9

DY94 DISPOSAL

♦ Commencement Bay	5,616
♦ Elliott Bay	79,739
♦ Port Gardner	236,749
♦ Rosario Strait	82,260
♦ Total	404,364

Overhead 3-10

DY95 PROJECTS

- 12 projects
- 8 suitability determinations
- 780,760 cubic yards

Overhead 3-11

Other Evaluation Activities

- Grays Harbor/Willapa Bay
- Columbia River
- Federal Superfund Projects

Overhead 3-12

PRESENTATION AGENDA

- PSDDA Monitoring Framework
- Tiered Full Monitoring Approach
- 1994 Findings
  - SVPS
  - Sediment Chemistry
  - Sediment Bioassays
- 1994 Evaluations
- Monitoring Modification Recommendations

Overhead 4-1

PSDDA MONITORING FRAMEWORK

- 1. Dredged material remain onsite?
  - Sediment Vertical Profile System
  - Sediment Chemistry
- 2. Biological effects conditions exceeded?
  - Sediment Chemistry
  - Sediment Bioassays
- 3. Adverse effects to offsite biological resources?
  - Tissue Chemistry
  - Infaunal Community Structure

Overhead 4-2

TIERED FULL MONITORING APPROACH

- Collect full-monitoring samples
- Analyze partial-monitoring samples
    - Archive samples not analyzed
- If partial-monitoring analysis indicate problems, analyze archived samples

Overhead 4-3

MONITORING STATIONS

Zone (Z): disposal target zone

Site (S): outside Z, but within site boundary

Perimeter (P): 0.125 n mi. outsite site boundary

Transect (T): radial transects downcurrent from disposal site

Benchmark (B): Proximal to, but unaffected by disposal events

Overhead 4-4

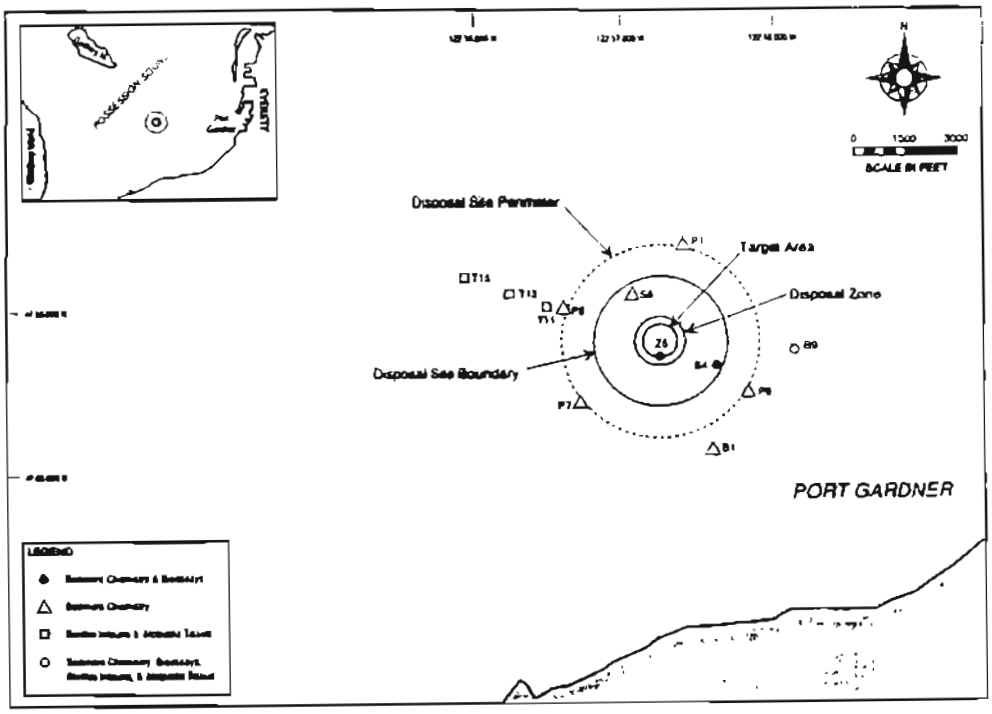


Figure 3-1. Port Gardner chemical and biological sampling stations in 1994.

Overhead 4-5

ADDITIONAL1994 MODIFICATIONS

- Analyze all stations for mercury and volatiles
- *Ampelisca abdita* 10-day amphipod test
- Standardize benthic infaunal collections
  - Top 10 cm through 1.0 mm screen
  - >10 through 1.0 mm screen
    - Archived for analysis if transect stations exceed guideline values

Overhead 4-6

FINDINGS

- SVPS
- Site Chemistry
- Site Bioassays

Overhead 4-7

SEDIMENT VERTICAL PROFILE SYSTEM (SVPS)

- Survey and stations
- Criteria used to distinguish dredged from ambient sediment
- Effect of dredged material on other measurements
  - grain size
  - RPD
  - Successional Stages
- Overall impressions of conditions at the entire site

Overhead 4-8

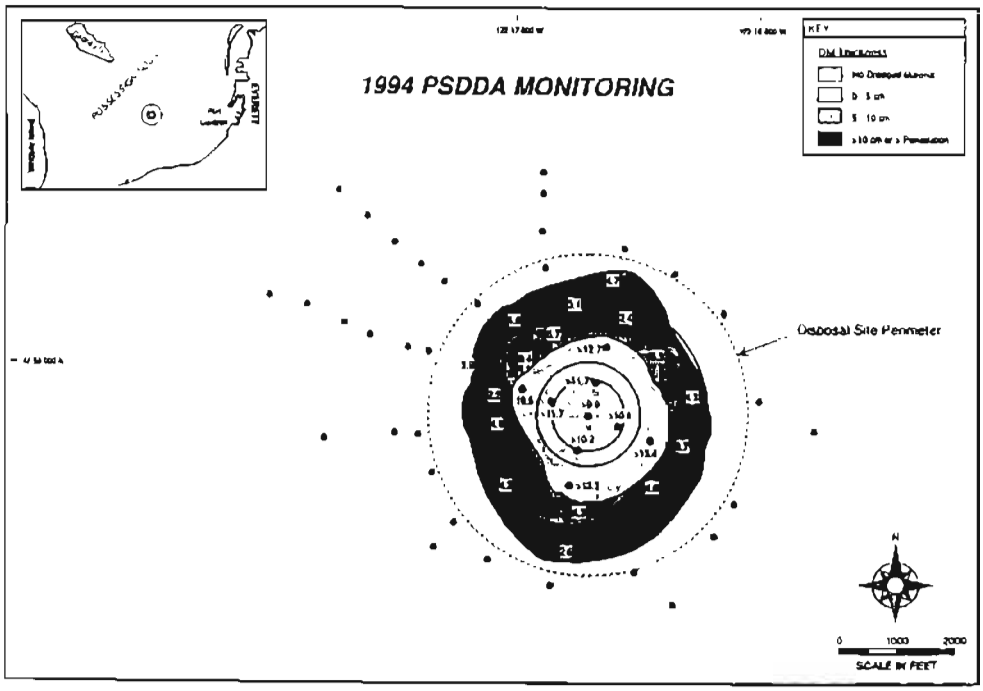


Figure 4-7. The distribution of dredged material at the Port Gardner PSDDA dredged material disposal site. Thickness of the DM deposit is contoured. Thicknesses are measured in centimeters.

Overhead 4-9

SEDIMENT CHEMISTRY

- PSDDA SL exceeded only for Hg and phenol
  - Hg elevated at benchmark and perimeter single replicates only
    - Mean of three replicates less than SL
  - Phenol elevated at one site (Z) and three perimeter stations
    - Additional analysis of benchmark phenols required
- PSDDA ML not exceeded in any sample
- Triplicate analysis for PGP08 demonstrated COVs 0 - 31 %

Overhead 4-10

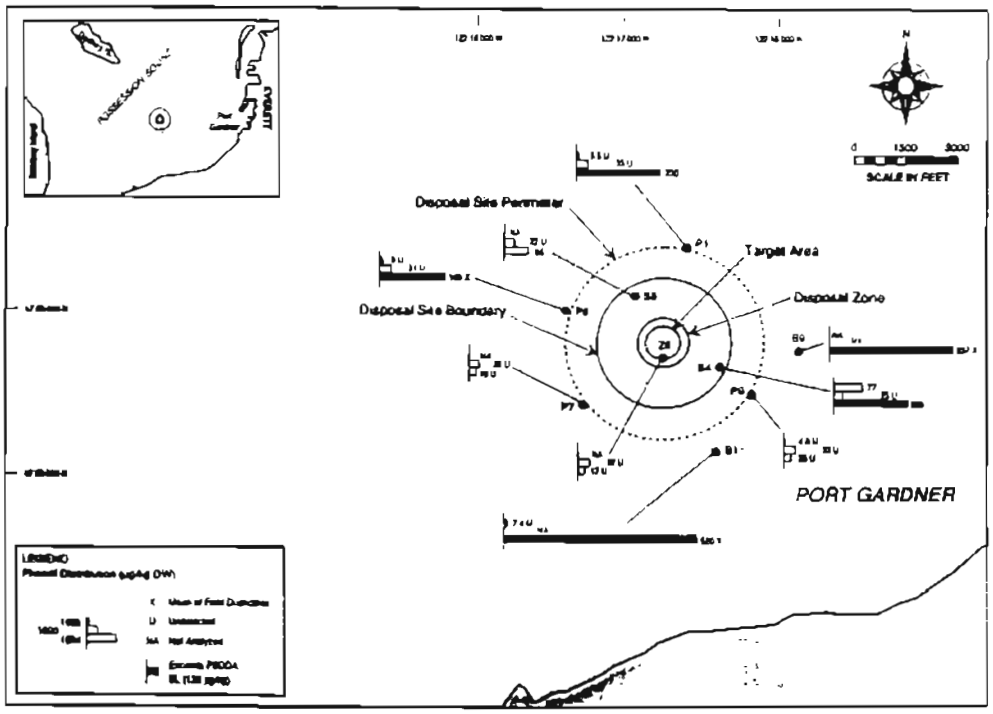


Figure 5-2. Phenol concentrations for the Port Gardner baseline, 1990 full monitoring, and 1994 tiered full monitoring surveys. At stations where phenol was undetected, the detection limit is reported.

Overhead 4-11

SEDIMENT BIOASSAYS

- First set of *Ampelisca* and echinoderm bioassays invalid
  - Poor reference sediment survival
  - *Neanthes* and Microtox acceptable
- Second set of *Ampelisca* and echinoderm bioassays valid
  - Included site and benchmark stations
- No exceedances of biological effects criteria in bioassay results

Overhead 4-12

EVALUATION OF 1994 MONITORING DATA

- Question 1: Does dredged material remain onsite?
  - Hypothesis 1: Dredged material within site boundary.
  - SVPS data confirms hypothesis

Overhead 4-13

EVALUATION OF 1994 MONITORING DATA

- Question 1: Does dredged material remain onsite?
  - Hypothesis 2: Chemical concentrations offsite do not increase over time due to dredged disposal.
    - Guideline values exceeded at perimeter stations
    - Temporal data suggest "steady state" for most metals and organics
    - Data suggest confirmation of hypothesis

Overhead 4-14

EVALUATION OF 1994 MONITORING DATA

- Question 2: Biological effects conditions exceeded?
  - Hypothesis 3: PSDDA Site Condition II for sediment chemistry
    - No ML exceedance, hypothesis is not rejected
  - Hypothesis 4: PSDDA Site Condition II for sediment bioassays.
    - No bioassay exceedance; hypothesis is not rejected

Overhead 4-15

EVALUATION OF 1994 MONITORING DATA

- Question 3: Adverse effects to offsite biological resources?
  - Dredged material remained onsite
  - Therefore, not necessary to address Question 3

Overhead 4-16

RECOMMENDATIONS

Discontinue use of guideline values in current form for assessing offsite chemical effects

PSDDA Perimeter Chemistry Trigger Approach Assessment, Draft Report

March 26, 1993

1993 REPORT CONCLUSION

Procedures presently used to determine if the concentrations of chemicals of concern have increased at perimeter locations surrounding PSDDA disposal sites in Elliott Bay and Port Garner have led to conclusions that are not supported by the results of physical and biological monitoring.

A critical analysis of these chemistry evaluation procedures leads to a suggestion that the statistical foundation underlying the current approach is flawed and responsible for indications that dredged material disposal activities have increased chemical concentrations outside of the disposal sites

STATISTICAL PROCEDURES RECOMMENDATION

Carry out a statistical test (e.g., t-test) comparing baseline and post-disposal concentrations. Determine the significance level (p value).

Combine p-values for a test of the global null hypothesis that the changes across chemicals are due to chance.

Overhead 4-19

STATISTICAL PROCEDURES RECOMMENDATION

Replace the method with a classical hypothesis testing approach. Carry out the testing chemical-by-chemical, but combine significance levels for an overall test of the null hypothesis that the dredged material has not moved, and that concentrations have not increased.

Overhead 4-20

Overview: Sediment Management Standards Implementation and Triennial Review

presented by Brett Betts

SMARM - SMS Implementation and Triennial Review

- Welcome / Purpose of SMS in SMARM
  - Why SMARM? - Open forum for discussion of SMS implementation status, coordination, development needs
  - What is Triennial Review? - Public review/comment process, public hearing opportunities
  - SMS Rule Background, Current Needs, SMARM, Post SMARM
- SMS Rule Background
  - Developed over 6-7 years
  - Adopted March 27, 1991
  - Public request for immediate implementation support - training, guidance, technical development

SMARM - SMS Implementation and Triennial Review

- SMARM - Review of Latest Scientific Knowledge and policy developments as identified by PSDDA
  - Reviewed record of past 6 ARMs
  - Participated/reviewed changes to PSEP Protocols
  - Review ongoing regional/national policy developments
- SMARM Joint PSDDA/SMS Issue Papers
  - Benthic Infauna - Reference / Endpoints
  - Microtox
  - Status of New AETs
  - Regional and National Issues
  - Sediment Cleanup Workgroup Recommendations
  - Grays Harbor/Willapa Harbor Special Study Implementation Status

Overhead 5-3

SMARM - SMS Implementation and Triennial Review

- SMS Rule Background - Pre-SMS Rule Adoption Development Needs (Commitments to Ecological Commission/Public before adoption of SMS)
  - Key Technical Issues
    - Human health sediment criteria
    - Chronic effects - benthos, bioaccumulation, bioassays
    - Chemical criteria - freshwater, EPA, dioxin, tributyltin
    - WASP model improvements/verification;
  - Key Policy Issues
    - Sediment impact zone review
    - Training - permit and site managers
    - Liability management plan - including DNR MOU
    - Antidegradation (w/WQP)
- SMS Rule Background - Intent was coordinated sediment management, i.e., "Regulatory Beauty";
  - PSDDA
  - Source Control
  - Cleanup

Overhead 5-4

SMARM - SMS Implementation and Triennial Review

- Current SMS Development/Review Needs
  - Consistency with PSDDA (6 ARMs) revisions, where appropriate
    - Technical developments, methods, protocols
    - Implementation/coordination procedures
    - Policy developments
  - Triennial Review - an Ecology listening exercise; May 3 - June 30, 1995
    - Clean Water Act requirement per EPA approval of SMS rule as federally approved water quality standards for Washington State
    - Handout available,
    - Public comments, 1993 Annual Review (Handout available), 1995 SMARM & Hearings
    - Technical developments - latest scientific knowledge
    - SMS Implementation - source control/cleanup needs

Overhead 5-5

SMARM - SMS Implementation and Triennial Review

- SMARM - Triennial Review
  - Bioassays - Amphipod, Juvenile polychaete, Larval
  - Net Pen Infaunal Studies
  - Chemical Summing Protocol
  - Detection Limits and TOC Normalization
  - Freshwater Sediment Criteria Development
  - Holding Time Protocol
  - Human Health Criteria Development
- Post SMARM SMS Activities (September 1995)
  - Triennial review summary, with
  - Ecology plan for SMS revision
  - Address ongoing rule development activities for:
    - Net Pens - 1995
    - Human Health/Freshwater Criteria - 1996

Overhead 5-6

Implementation of the State's Sediment Mgmt. Standards

- *Sediment Specialists Assigned to Regions March 1993*
- *Known Sediment Sites*
  - *51 Northwest Region*
  - *13 Southwest Region*
  - *? Eastern Washington*
- *Environment*
  - *38 Marine*
  - *8 Estuarine*
  - *18 Freshwater*

Overhead 6-1

Current Site Activities

Regulatory Lead and Status

Reg. Lead	Site ID	Work Plan	RI/FS	Remed Design	Remed Action	Monit.	NFA
MTCA	1	4	3	3	-	1	-
CERCLA	-	1	7	2	2	2	-
Other	12	2	9	4	-	2	9

Overhead 6-2

Characterization and Cleanup Technologies

- *Investigation Methods*

Chemistry Only	*24*
Chemistry & Bioassays	*34*
Bioaccumulation	*11*

- *Cleanup Technologies*

Natural Recovery	*2*
Enhanced Nat. Rec.	*3*
Capping	*5*
Dredging - In-Water Disp.	*4*
- Uplands Disp.	*7*
Benef. Uses - Recycling	*2*
- Hab. Rest'n	*3*
Institutional Controls	*2*

Future Actions for SMS Implementation

- *Integration of Sediments Site Register and Cleanup Program Site List (SIS)*
- *Additional Sediments Implementation Staff*
- *Limited Enforcement*
- *Cost-Recovery/Technical Assistance*
- *Technical Guidance Materials/Documents*

WASHINGTON STATE DEPARTMENT OF ECOLOGY

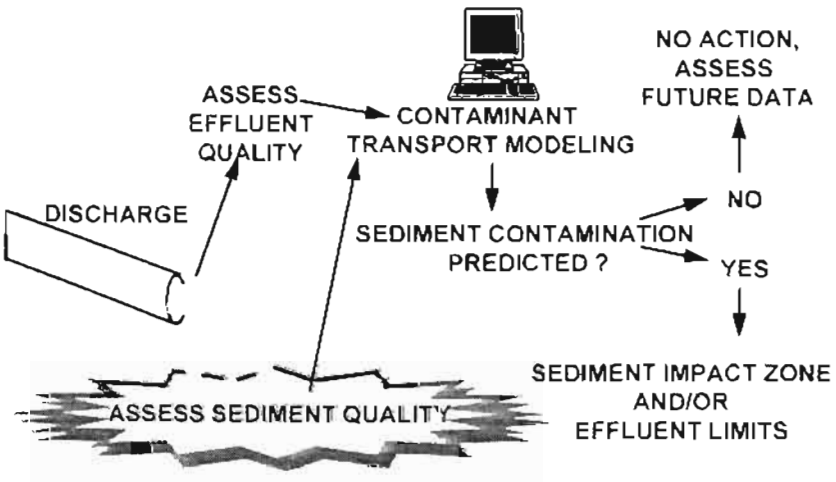
Sediment Source Control Update

Sediment Management Standards Triennial Review

presented by Brenden McFarland

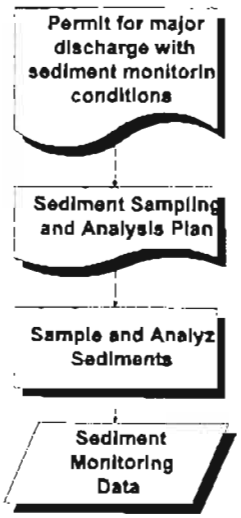
Overhead 7-1

Conceptual View of Sediment Source Control Process



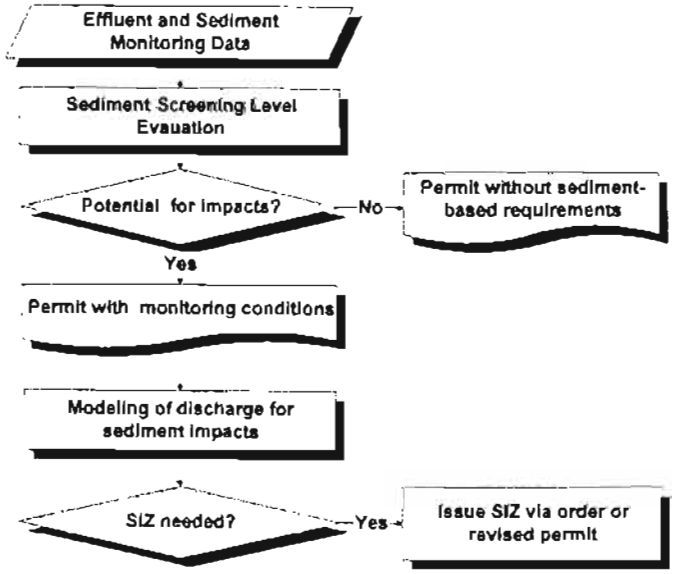
Overhead 7-2

Sediments and NPDES Permits Prior to 1993



Overhead 7-3

Sediment Source Control Process



Overhead 7-4

Program Development

- 1991 to present
- Commitment-based and need-based
- Sediment Source Control Standards User Manual (SCUM1)
- WASP Model
- Permit manager training
- Sampling and Analysis Plan Guidance

Overhead 7-5

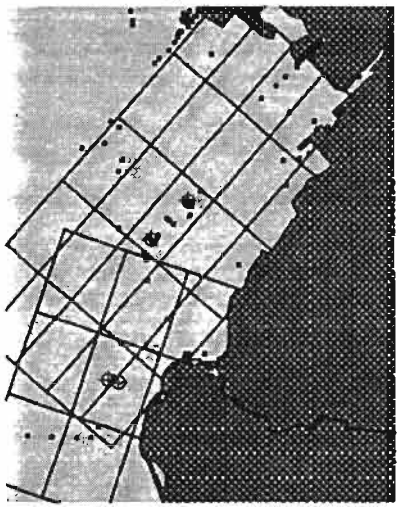
Contaminant Transport Model Improvements

- WASP model
  - *Modeling process faster, easier to understand, pictorial representation of results*
- GIS Segmentation Tool
  - *Uses ARC/INFO coverages (shoreline, bathymetry, outfall, sampling stations)*
- ARC/INFO to WASP Data Conversion Program
  - *Prompts modeler for additional parameter values to create a WASP input file*
- ArcView
  - *Presents empirical and theoretical results of modeled area*

Overhead 7-6

Sediment Contaminant Transport Modeling

- Example of modeled area using ArcView
- Model divides receiving waterbody into segments
- Model determines sediment concentration in each segment
- Model determines future sediment concentration [SMS: t = 10 years]



Overhead 7-7

Program Implementation

- 1993 to present
- Some prior implementation
  - *monitoring in previous NPDES permits*
- Through NPDES permits
  - *Issued by Water Quality Program, Industrial Section, and Toxics Cleanup Program*
  - *Technical assistance provided by Environmental Review and Sediments Section*

Overhead 7-8

Technical Assistance for Sediment Source Control

- 51 dischargers/facilities
- 30 sampling plans
- 26 data reports
- 14 screening evaluations
- 7 modeled
- 6 NPDES permit language

Overhead 7-9

Monitoring and Modeling Results

- *10 of 26 monitored show SQS or SIZmax/CSL exceedance*
- *2 of 7 modeled show SIZmax/CSL exceedance*

Overhead 7-10

Lessons Learned

- **Sediment Source Control Process**
  - *weak link exists between screening evaluation and modeling*
  - *screening very conservative*
  - *the general model is more time intensive than envisioned*
- **Stormwater**
  - *we need to find a way to address stormwater*
  - *does not fit within current process methodology*

Overhead 7-11

What next?

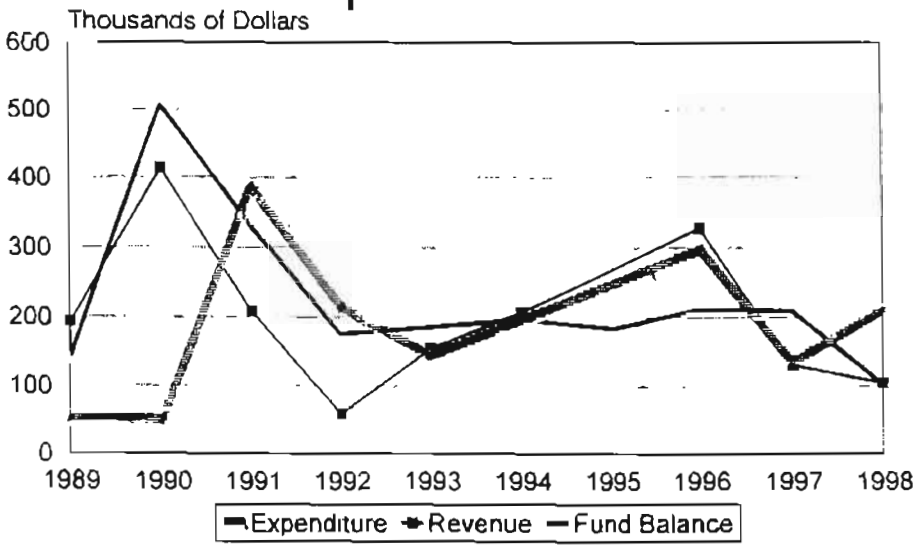
- **Waiting for results from recently approved SAPs**
- **Revised equation to bridge gap between screening evaluation and model**
- **Develop effluent goals (storm and point)**
- **Permits will include sediment-related requirements other than direct sediment sampling**

Overhead 7-12

SITE	PERMIT APPROVAL DATE	PERMIT END DATE
1. Anderson/Ketron	January 1995	January 2000
2. Bellingham Bay	August 1994	August 1999
3. Commencement Bay	September 1993	September 1998
4. Elliott Bay	March 1994	March 1999
5. Port Angeles	July 1994	July 1999
6. Port Gardner	January 1994	January 1999
7. Port Townsend	September 1994	September 1999
8. Rosario Strait	June 1994	June 1999

Overhead 8-1

PSDDA Revenue and Expenditures



Years 1996-1998 are projections

Overhead 9-1

Small Project Cost Relief

Stephanie Stirling
Dredged Material Management Office
Corps of Engineers

Current Small Project No Test Guidelines

- Low ranked areas 8,000 cubic yards
- Low- moderate ranked areas 500 cubic yards
- Moderate ranked areas 500 cubic yards

Table 1. Cost data for small projects from DY91 to DY93

Project	Year	Rank	Volume	Cost per CY	Total Cost
Chevron USA	1991	M	9600	$3.51	$33,703
Hurlen Construction	1991	H	4000	$3.27	$13,075
Redmond et.al.	1991	LM	378		no test
Tristar Marine	1991	H	5500	$4.20	$23,104
Day Island Yacht Club	1992	M	9000	$2.85	$25,613
LaConner Boatworks	1992	L	4200		no test
LOTT Olympia Outfall	1992	H	7975	$3.91	$31,210
Morton Marine	1992	H	4000	$3.59	$14,362
South Park Marina	1992	H	8000	$1.60	$12,802
Navy Keyport KB Dock	1992	M	7400	$1.48	$10,969
Pratt/Todd Moorage	1993	M	700		no test
Indian Cove Marina	1994	M	8000	$3.79	$30,314
Port of Brownsville	1994	M	10000	$2.47	$24,652
Average cost				$3.06	
Average cost (including no test)				$2.35	

Some projects are omitted due to lack of cost data.

Proposed Program Modifications

- Raise no test volume to 1,000 cubic yards for low-moderate and moderate areas
- QA2 not required for projects less than 8,000 cubic yards
- Case by case reduction in chemicals of concern for projects under 8,000 cubic yards

Small Project Cost Data

- DY91 - DY93 average cost for projects under 8,000 cubic yards was $3.12 per cubic yard
- Cost was $2.18 per cubic yard if no test projects are excluded
- Average cost for DY89 - DY93 was $0.49 per cubic yard

STATUS REPORT

EPA PROPOSED RULE: REFERENCE SEDIMENT APPROACH AND DEFINITION

- Proposed rule appeared in Federal Register/Vol. 60 No. 2, Wednesday, January 4, 1995
- Comment period closed March 6, 1995

Justification:

- Potential cumulative impact assessment
- Consistent dredged material regulation under the Clean Water Act and the Marine Protection, Research, and Sanctuaries Act

Status of Work:

Preamble drafted -- early May
Final rule -- July

Bottom Line:

This definition makes the national reference sediment definition more consistent with the current PSDDA program.

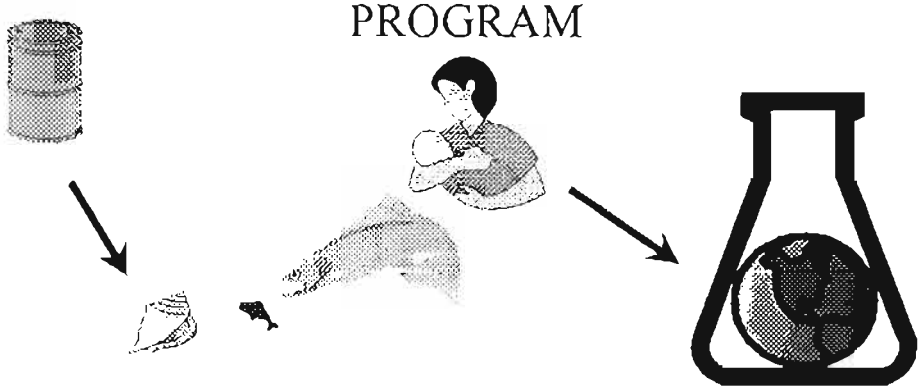
At this time the PSDDA agencies do not anticipate any changes to the PSDDA program's reference sediment definition.

Proposed rule defines "reference sediment" as:

> ...sediment that reflects the conditions at the disposal site had no dredged material disposal ever occurred there. Reference sediment serves as a point of comparison to identify potential environmental effects of a discharge of dredged material. Reference sediment shall be collected taking into account the following considerations: (1) to obtain physical characteristics, including grain size, as similar as practicable as the dredged material proposed for discharge, (2) to avoid areas in the immediate vicinity of, including depositional zones of, spills, outfalls, or other significant sources of contaminants, and (3) to be as close as practicable to, and subject to the same hydrologic influences as, the disposal site, but removed from areas which are subject to sediment migration of previous dredged material discharges.

COPLANAR PCB CONGENER ANALYSIS

FUTURE IMPLEMENTATION TO PSDDA PROGRAM



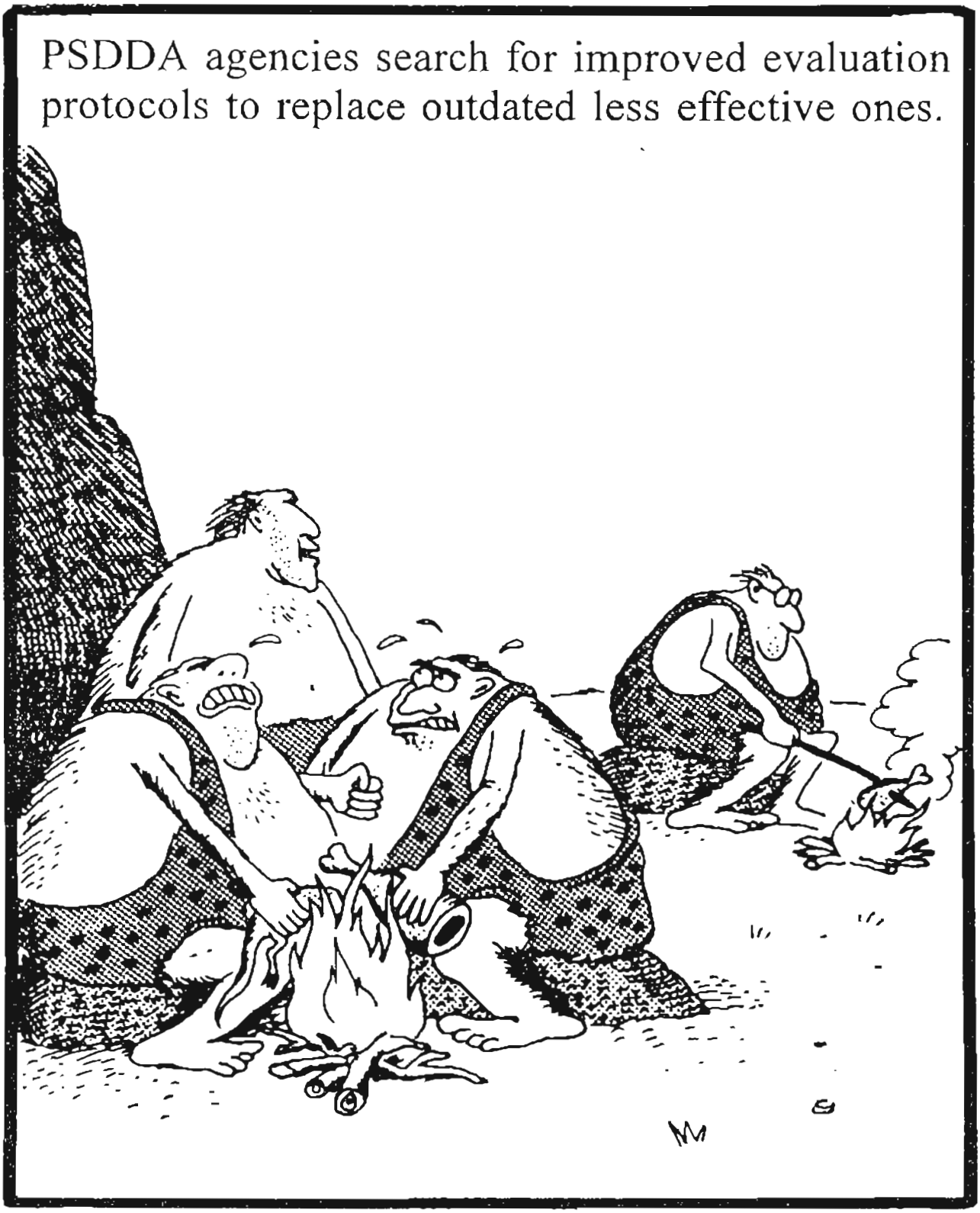
Overhead 12-1

Problem Identification

- PSDDA program currently focuses on quantitating total PCBs using methods elucidating Aroclor mixtures
  - This relatively inexpensive method allows PCBs to be analyzed with pesticides
  - Summation of Total PCBs does not distinguish between highly toxic PCBs and those with little or no know toxicity
  - False negatives due to quantification errors and matrix interference problems
- Current national guidance in Corps/EPA " Draft 404 Inland Testing Manual" recommends quantifying individual PCB congeners
  - More expensive and time consuming analysis methods
  - Allows quantification of toxic congeners (non-ortho, mon-ortho substituted congeners in tetra, penta, and hexachlorobiphenyl groups), which exhibit dioxin-like toxicity properties.

Overhead 12-2

PSDDA agencies search for improved evaluation protocols to replace outdated less effective ones.



"Hey! Look what Zog do!"

Appendix A. Numbering of Polychlorinated Biphenyl Congeners.[a]

No.	Structure	No.	Structure	No.	Structure	No.	Structure
	Monochlorobiphenyls		Tetrachlorobiphenyls		Pentachlorobiphenyls		Hexachlorobiphenyls
1	2	52[b]	2,2';5,5'	105[b]	2,3,3';4,4'	161	2,3,3';4,5';6
2	3	53	2,2';5,6'	106	2,3,3';4,5	162	2,3,3';4';5,5'
3	4	54	2,2';6,6'	107	2,3,3';4';5	163	2,3,3';4';5,6
		55	2,3,3';4	108	2,3,3';4,5'	164	2,3,3';4';5';6
	Dichlorobiphenyls	56	2,3,3';4'	109	2,3,3';4,6	165	2,3,3';5,5';6
		57	2,3,3';5	110	2,3,3';4';6	166	2,3,4,4';5,6
4	2,2'	58	2,3,3';5'	111	2,3,3';5,5'	167[b]	2,3';4,4';5,5'
5	2,3	59	2,3,3';6	112	2,3,3';5,6	168[b]	2,3';4,4';5';6
6	2,3'	60	2,3,4,4'	113	2,3,3';5';6	169[b]	3,3';4,4';5,5'
7	2,4	61	2,3,4,5	114[b]	2,3,4,4';5		
8	2,4'	62	2,3,4,6	115	2,3,4,4';6		Heptachlorobiphenyls
9	2,5	63	2,3,4';5	116	2,3,4,5,6		
10	2,6	64	2,3,4';6	117	2,3,4';5,6	170[b]	2,2';3,3';4,4';5
11	3,3'	65	2,3,5,6	118[b]	2,3';4,4';5	171	2,2';3,3';4,4';6
12	3,4	66	2,3';4,4'	119[b]	2,3';4,4';6	172	2,2';3,3';4,5,5'
13	3,4'	67	2,3';4,5	120	2,3';4,5,5'	173	2,2';3,3';4,5,6
14	3,5	68	2,3';4,5'	121	2,3';4,5';6	174	2,2';3,3';4,5,6'
15	4,4'	69	2,3';4,6	122	2';3,3';4,5	175	2,2';3,3';4,5';6
		70[b]	2,3';4';5	123[b]	2';3,4,4';5	176	2,2';3,3';4,6,6'
	Trichlorobiphenyls	71	2,3';4';6	124	2';3,4,5,5'	177[b]	2,2';3,3';4';5,6
		72	2,3';5,5'	125	2';3,4,5,6'	178	2,2';3,3';5,5';6
16	2,2';3	73	2,3';5';6	126[b]	3,3';4,4';5	179	2,2';3,3';5,6,6'
17	2,2';4	74[b]	2,4,4';5	127	3,3';4,5,5'	180[b]	2,2';3,4,4';5,5'
18[b]	2,2';5	75	2,4,4';6			181	2,2';3,4,4';5,6
19	2,2';6	76	2';3,4,5		Hexachlorobiphenyls	182	2,2';3,4,4';5,6'
20	2,3,3'	77[b]	3,3';4,4'			183[b]	2,2';3,4,4';5';6
21	2,3,4	78	3,3';4,5	128[b]	2,2';3,3';4,4'	184	2,2';3,4,4';6,6'
22	2,3,4'	79	3,3';4,5'	129	2,2';3,3';4,5	185	2,2';3,4,5,5';6
23	2,3,5	80	3,3';5,5'	130	2,2';3,3';4,5'	186	2,2';3,4,5,6,6'
24	2,3,6	81[b]	3,4,4';5	131	2,2';3,3';4,6	187[b]	2,2';3,4';5,5';6
25	2,3';4			132	2,2';3,3';4,6'	188	2,2';3,4';5,6,6'
26	2,3';5		Pentachlorobiphenyls	133	2,2';3,3';5,5'	189[b]	2,3,3';4,4';5,5'
27	2,3';6			134	2,2';3,3';5,6	190	2,3,3';4,4';5,6
28	2,4,4'	82	2,2';3,3';4	135	2,2';3,3';5,6'	191	2,3,3';4,4';5';6
29	2,4,5	83	2,2';3,3';5	136	2,2';3,3';6,6'	192	2,3,3';4,5,5';6
30	2,4,6	84	2,2';3,3';6	137	2,2';3,4,4';5	193	2,3,3';4';5,5';6
31	2,4';5	85	2,2';3,4,4'	138[b]	2,2';3,4,4';5'		
32	2,4';6	86	2,2';3,4,5	139	2,2';3,4,4';6		Octachlorobiphenyls
33	2';3,4	87[b]	2,2';3,4,5'	140	2,2';3,4,4';6'		
34	2';3,5	88	2,2';3,4,6	141	2,2';3,4,5,5'	194[b]	2,2';3,3';4,4';5,5'
35	3,3';4	89	2,2';3,4,6'	142	2,2';3,4,5,6	195	2,2';3,3';4,4';5,6
36	3,3';5	90	2,2';3,4';5	143	2,2';3,4,5,6'	196	2,2';3,3';4,4';5,6'
37[b]	3,4,4'	91	2,2';3,4';6	144	2,2';3,4,5';6	197	2,2';3,3';4,4';6,6'
38	3,4,5'	92	2,2';3,5,5'	145	2,2';3,4,6,6'	198	2,2';3,3';4,5,5';6
39	3,4';5	93	2,2';3,5,6	146	2,2';3,4';5,5'	199	2,2';3,3';4,5,6,6'
		94	2,2';3,5,6'	147	2,2';3,4';5,6	200	2,2';3,3';4,5';6,6'
	Tetrachlorobiphenyls	95	2,2';3,5';6	148	2,2';3,4';5,6'	201[b]	2,2';3,3';4,5,5';6'
		96	2,2';3,6,6'	149	2,2';3,4';5';6	202	2,2';3,3';5,5';6,6'
40	2,2';3,3'	97	2,2';3';4,5	150	2,2';3,4';6,6'	203	2,2';3,4,4';5,5';6
41	2,2';3,4	98	2,2';3';4,6	151[b]	2,2';3,5,5';6	204	2,2';3,4,4';5,6,6'
42	2,2';3,4'	99[b]	2,2';4,4';5	152	2,2';3,5,6,6'	205	2,3,3';4,4';5,5';6
43[b]	2,2';3,5	100	2,2';4,4';6	153[b]	2,2';4,4';5,5'		
44	2,2';3,5'	101[b]	2,2';4,5,5'	154	2,2';4,4';5,6'		Nonachlorobiphenyls
45	2,2';3,6	102	2,2';4,5,6'	155	2,2';4,4';6,6'		
46	2,2';3,6'	103	2,2';4,5';6	156[b]	2,3,3';4,4';5	206	2,2';3,3';4,4';5,5';6
47	2,2';4,4'	104	2,2';4,6,6'	157[b]	2,3,3';4,4';5'	207	2,2';3,3';4,4';5,6,6'
48	2,2';4,5			158[b]	2,3,3';4,4';6	208	2,2';3,3';4,5,5';6,6'
49[b]	2,2';4,5'			159	2,3,3';4,5,5'		
50	2,2';4,6			160	2,3,3';4,5,6		Decachlorobiphenyl
51	2,2';4,6'					209	2,2';3,3';4,4';5,5';6,6'

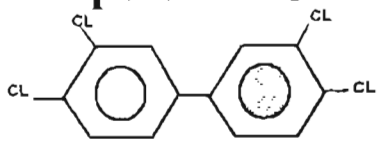
[a]See Stalling et al. (*11*).
[b]Congeners listed in Table 2.

TOXIC CONGENERS

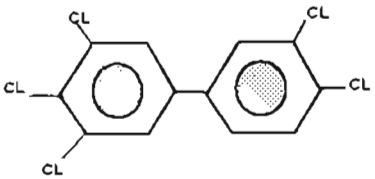
- 209 potential PCB congeners
  - Most toxic are sterically similar to 2,3,7,8-TCDD
    - 3,3',4,4'-tetrachlorobiphenyl (congener 77)
    - 3,3',4,4',5-pentachlorobiphenyl (congener 126)
    - 3,3',4,4',5,5'-hexachlorobiphenyl (congener 169)
  - Non-ortho coplanar (dioxin-like) and mono-ortho chlorobiphenyl congeners should be focus of environmental PCB contamination

Overhead 12-5

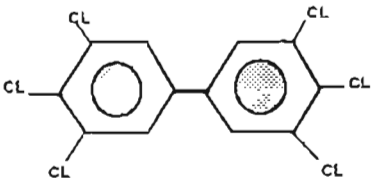
Non-ortho coplanar PCB congeners



3,3',4,4'-tetrachlorobiphenyl (congener 77)



3,3',4,4',5-pentachlorobiphenyl (congener 126)



3,3',4,4',5,5'-hexachlorobiphenyl (congener 169)

Overhead 12-6

Table 1. Proposed TEFs for the Toxic Halogenated Aromatics.

Congener	TEF
A. PCDDs	
2,3,7,8-TCDD	1.0
1,2,3,7,8-pentaCDD	0.5
1,2,3,4,7,8-hexaCDD	0.1
1,2,3,6,7,8-hexaCDD	0.1
1,2,3,7,8,9-hexaCDD	0.1
1,2,3,4,6,7,8-heptaCDD	0.01
OCDD	0.001
B. PCDFs	
2,3,7,8-TCDF	0.1
2,3,4,7,8-pentaCDF	0.5
1,2,3,7,8-pentaCDF	0.1
1,2,3,4,7,8-hexaCDF	0.1
2,3,4,6,7,8-hexaCDF	0.1
1,2,3,6,7,8-hexaCDF	0.1
1,2,3,7,8,9-hexaCDF	0.1
1,2,3,4,6,7,8-heptaCDF	0.1
1,2,3,4,7,8,9-heptaCDF	0.1
OCDF	0.001
C. Brominated and bromo/chloro dibenzo-*p*-dioxin and dibenzofurans	
Same as described above in A and B	
D. PCBs	
Coplanar	
3,3',4,4',5-pentaCB	0.1
3,3',4,4',5,5'-hexaCB	0.05
3,3',4,4'-tetraCB	0.01
Monoortho Coplanar	
2,3',4,4',5-pentaCB	0.001
2,3,3',4,4'-pentaCB	0.001
2',3,4,4',5-pentaCB	0.001
2,3,4,4',5-pentaCB	0.001
2,3,3',4,4',5-hexaCB	0.001
2,3,3',4,4',5'-hexaCB	0.001
2,3',4,4',5,5'-hexaCB	0.001
2,3,3',4,4',5,5'-heptaCB	0.001
Dioortho Coplanar PCBs	0.00002
E. PBBs	
Same values as described above for the PCBs	
F. PCDEs	
Coplanar and monoortho coplanar congeners	0.001

Future Proposed Action / Modification

- In low PCB concern area, conduct aroclor analysis for total PCBs. If screening level exceeded, conduct congener specific PCB analysis.
- In high PCB concern area, conduct congener specific analysis first to quantify toxic congeners.

Overhead 12-8

Outstanding Issues PSDDA agencies must resolve prior to implementation

- Identify appropriate methods for elucidating and quantifying non-ortho, mono-ortho coplanar congeners of PCBs.
- Identify appropriate QA/QC necessary to insure the data integrity and quality
- Identify appropriate regulatory interpretation guidance (?).
    - Develop interim screening level and bioaccumulation trigger guidance.
    - Sum the individual congeners based on toxicity equivalency factors (TEF) and compare to interim regulatory guidance?

Overhead 12-9

1993 REPORT CONCLUSION

Procedures presently used to determine if the concentrations of chemicals of concern have increased at perimeter locations surrounding PSDDA disposal sites in Elliott Bay and Port Garner have led to conclusions that are not supported by the results of physical and biological monitoring.

A critical analysis of these chemistry evaluation procedures leads to a suggestion that the statistical foundation underlying the current approach is flawed and responsible for indications that dredged material disposal activities have increased chemical concentrations outside of the disposal sites

Overhead 13-1

STATISTICAL PROCEDURES RECOMMENDATION

Replace the method with a classical hypothesis testing approach. Carry out the testing chemical-by-chemical, but combine significance levels for an overall test of the null hypothesis that the dredged material has not moved, and that concentrations have not increased.

Overhead 13-2

STATISTICAL PROCEDURES RECOMMENDATION

Carry out a statistical test (e.g., t-test) comparing baseline and post-disposal concentrations. Determine the significance level (p value).

Combine p-values for a test of the global null hypothesis that the changes across chemicals are due to chance.

WASHINGTON STATE DEPARTMENT OF ECOLOGY

AMPHIPOD BIOASSAY

Sediment Management Standards Triennial Review

presented by Brett Betts

SMS Triennial Review Paper Amphipod Bioassay *Rhepoxynius abronius*

- Problem statement
  - Grain size sensitivity for *Rhepoxynius* bioassay (DeWitt) - results in false positives
  - Additional bioassay needed for low salinity sediments, e.g., rivers/intertidal sediments (<25ppt)
- PSDDA Program Approach
  - Fifth ARM (June 1993)- species substitution for the 10-day Amphipod Bioassay (*Ampelisca/Eohaustorius*)
  - Sixth ARM (June 1994) - Use of Alternate Technologies under the SMS
- PSEP Protocols Revision
  - Grain size sensitivity of *Rhepoynius*
  - Recommended use of *Ampelisca, Eohaustorius*

SMARM - Amphipod Bioassay

- SMS Recommendations
  - Species substitution
  - Rule language
    - Definition of Amphipod
    - Confirmatory bioassay tests - include additional species

WASHINGTON STATE DEPARTMENT OF ECOLOGY

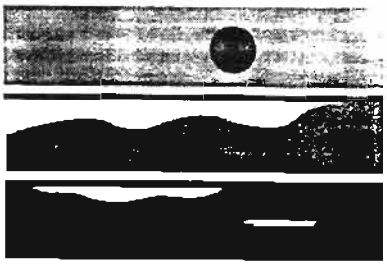
JUVENILE POLYCHAETE BIOASSAY

Sediment Management Standards Triennial Review

presented by Brett Betts

SMS Triennial Review Paper Juvenile Polychaete Bioassay *Neanthes arenaceodentata*

- Problem statement
  - Recent literature (Dillon/Moore 1993) promotes use of growth endpoint
  - The PSDDA program implemented growth endpoint in 1994 (Sixth ARM)
  - WES and PSDDA recommendations for ammonia and sulfides testing
  - The PSEP Protocols are being revised to include the growth (rate) endpoint and to recommend ammonia and sulfides testing
- SMS Recommendations
  - Protocol revision
    - Per SMS section 600 (3) and (4)
    - Follow PSEP Protocols requirement
  - Rule language
    - Confirmatory tests
    - Performance standards for control and reference
    - Sediment quality standards, SIZ and CSL/MCUL standards (320, 420, 520)



LARVAL BIOASSAY

Sediment Management Standards Triennial Review

presented by Pamela Sparks-McConkey

Overhead 16-1

PURPOSE:

TO PROPOSE MODIFICATIONS TO THE SMS LARVAL BIOASSAY RULE LANGUAGE

MODIFICATIONS WILL INCLUDE:

PUGET SOUND ESTUARY PROGRAM (PSEP) REVISIONS, AND/OR

RESULTS OF PREVIOUS PUGET SOUND DREDGED DISPOSAL ANALYSIS (PSDDA) ANNUAL REVIEW MEETINGS

Overhead 16-2

RULE MODIFICATIONS

SEAWATER CONTROL PERFORMANCE

SMS LARVAL BIOASSAY: CURRENTLY RECOMMENDS A 50% EFFECTIVE MORTALITY

OPTIONS:

PSEP: STANDARD OF NOT MORE THAN 30% COMBINED MORTALITY/ABNORMALITY

PSDDA: REVISED THE STANDARD TO 30% COMBINED MORTALITY/ABNORMALITY

RULE MODIFICATIONS (CONT.)

REFERENCE PERFORMANCE

SMS LARVAL BIOASSAY: CURRENTLY RECOMMENDS TO REJECT ANY COMBINED EFFECTIVE MORTALITY RESULTS BASED ON SIGNIFICANTLY HIGH VARIABILITY

OPTIONS:

PSEP: NO STANDARD IMPLEMENTED DUE TO THE VARIABLITY FACTOR EXHIBITED IN THE MORTALITY ENDPOINT

PSDDA: ESTABLISHED A 35% EFFECTIVE MORTALITY STANDARD INCLUDES A STATISTICAL SIGNIFICANCE REQUIREMENT

RULE MODIFICATIONS (CONT.)

TEST PERFORMANCE

SMS LARVAL BIOASSAY:

SQS - LESS THAN 85% MEAN NORMAL SURVIVORSHIP WITH AN ALPHA LEVEL OF $P \leq 0.05$

SIZ MAX - LESS THAN 70% MEAN NORMAL SURVIVORSHIP WITH AN ALPHA LEVEL OF $P \leq 0.05$

OPTIONS:

PSEP: DOES NOT RECOMMEND NOR IMPLEMENT REGULATORY STANDARDS

PSDDA: ESTABLISHED INTERIM GUIDANCE THAT ADJUSTED THE ALPHA LEVEL FROM $P \leq 0.05$ TO $P \leq 0.10$ WHILE THE TEST STANDARD REMAINED THE SAME

Overhead 16-5

RULE MODIFICATIONS (CONT)

BIOASSAY TEST SPECIES

SMS LARVAL BIOASSAY: CURRENTLY DOES NOT DEFINE *Strongylocentrotus drobachiensis* FOR USE IN THE LARVAL BIOASSAY

OPTIONS:

PSEP: RECOMMEND THE USE OF *Strongylocentrotus drobachiensis*

PSDDA: RECOMMEND THE USE OF *Strongylocentrotus drobachiensis*

Overhead 16-6

RULE MODIFICATIONS (CONT)

REVISIONS TO PROTOCOLS

- √ TEMPERATURE CHANGED TO 15 FROM 12 C°
- √ A 48 HOUR MINIMUM TEST DURATION
- √ CONTROL - 90% PLUTEUS LARVAE GROWTH & NOT MORE THAN 10% ABNORMALITY AT TIME-FINAL
- √ IDENTIFIED TEST TERMINATION PROCEDURES
- √ ESTABLISHING WARNING LIMITS FOR AMMONIA IN THE OVERLYING WATER LAYER
- √ MONITORING OF DISSOLVED AMMONIA & SULFIDES AS BEING AN OPTIONAL REQUIREMENT

Overhead 16-7

PROPOSED SMS MODIFICATIONS

SMS RULE REQUIRES THE USE OF PSEP PROTOCOLS

- √ AMMONIA & SULFIDES MONITORING AND REPORTING **SHALL BE REQUIRED.**

SMS PROPOSED RULE LANGUAGE

- √ IMPLEMENT LARVAL CONTROL PERFORMANCE STANDARD
- √ RECOMMEND USING *Strongylocentrotus drobachiensis* IN MARINE SEDIMENT BIOLOGICAL TESTS

SMS RULE DOES NOT PROPOSE MODIFICATIONS TO:

- √ LARVAL REFERENCE SEDIMENT PERFORMANCE STANDARD
- √ LARVAL BIOLOGICAL EFFECTS CRITERIA
- √ LARVAL SIZ MAX BIOLOGICAL EFFECTS CRITERIA
- √ LARVAL CLEANUP BIOLOGICAL EFFECTS CRITERIA

Overhead 16-8

WASHINGTON STATE
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ECOLOGY

Holding Time Protocols

Sediment Managemnt Standards Triennial Review

presented by
Rachel Friedman-Thomas

Overhead 17-1

Bioassay Holding Time

- **Definition: Storage time of sediment samples prior to initiation laboratory bioassay testing.**
- **1986 PSEP Bioassay Protocols: Not to exceed 2 weeks for sediments stored at 4°C**
- **Protocol based on regional expert best professional judgment**

Overhead 17-2

Proposed Changes

- PSEP Bioassay Protocol revisions add flexibility to sediment holding times
- Recommend storing sediment for as short a time as possible
- 2 week holding time considered the minimum that can be routinely achieved
- Tiered testing under PSDDA and SMS has created the need to extend holding time

Overhead 17-3

Proposed Changes cont'd

- Acknowledge the PSDDA approach but advocate minimal holding time
- Without compelling reasons, maximum holding time of 2 weeks is recommended for Puget Sound
- Each study should report holding times with study result

Overhead 17-4

Ecology's Proposed Actions

- **After PSEP Bioassay Protocols are finalized, accept up to 8 week holding time**
- **Holding conditions and times must be submitted**
- **Until PSEP Bioassay Protocols are finalized, 8 week holding time may be approved on case-by-case basis**

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

SEDIMENT MANAGEMENT STANDARDS
CHEMICAL SUMMING METHOD

Sediment Management Standards
Triennial Review

Kathryn Bragdon-Cook

CHEMICAL GROUP SUMS

LPAHs:	Naphthalene Acenaphthylene Acenaphthene Fluorene Phenanthrene Anthracene
HPAHs:	Fluoranthene Pyrene Benz(a)anthracene Chrysene Benzo(a)pyrene Indeno(1,2,3-c,d)pyrene Dibenzo(a,h)anthracene Benzo(g,h,i)perylene
	TOTAL BENZOFLUORANTHENES ("b", "j", and "k" isomers)
TOTAL PCBs:	Aroclor® mixtures

CHEMICAL GROUP CONSTITUENTS:

- ALL ANALYTES DETECTED
- A MIXTURE OF DETECTED AND UNDETECTED ANALYTES

  (eg. ONLY LPAH CHEMICALS DETECTED WERE FLUORENE and ANTRACENE)

- ALL ANALYTES UNDETECTED

Overhead 18-3

UNDER CURRENT SMS CHEMICAL SUMMING METHOD

[DETECTED CHEMICAL CONCENTRATIONS]
\+ DETECTION LIMITS FOR UNDETECTED CHEMICALS

SUM EXCEEDS SMS CRITERIA

DETECTION LIMIT FOR UNDETECTED CHEMICAL
DETECTION LIMIT FOR UNDETECTED CHEMICAL
\+ DETECTION LIMIT FOR UNDETECTED CHEMICAL

SUM EXCEEDS SMS CRITERIA

Overhead 18-4

CHEMICAL SUMMING METHOD OPTIONS

WHEN ALL CHEMICALS IN A GROUP ARE UNDETECTED, TO CALCULATE A GROUP SUM:

1. USE THE HIGHEST DETECTION LIMIT REPORTED FOR AN INDIVIDUAL ANALYTE*
2. ADD VALUES OF ONE-HALF THE DETECTION LIMIT FOR EACH ANALYTE
3. USE THE LOWEST DETECTION LIMIT REPORTED FOR AN INDIVIDUAL ANALYTE
4. ADD THE DETECTION LIMITS FOR ONLY PREDOMINANT CHEMICALS AT THE SITE
5. REPORT A DETECTION LIMIT RANGE FOR EACH GROUP
6. ADD DETECTION LIMITS FOR ALL ANALYTES**

*current PSDDA method **current SMS method

Overhead 18-5

CHEMICAL SUMMING METHOD OPTIONS

WHEN ONE OR MORE CHEMICALS IN A GROUP ARE DETECTED, TO CALCULATE A GROUP SUM:

1. ADD ONLY THE DETECTED CHEMICAL CONCENTRATIONS*
2. ADD THE DETECTED CHEMICAL CONCENTRATIONS TO THE DETECTION LIMITS FOR THE UNDETECTED CHEMICALS**

*current PSDDA method **current SMS method

Overhead 18-6

SEND INPUT TO:

Kathryn Bragdon-Cook

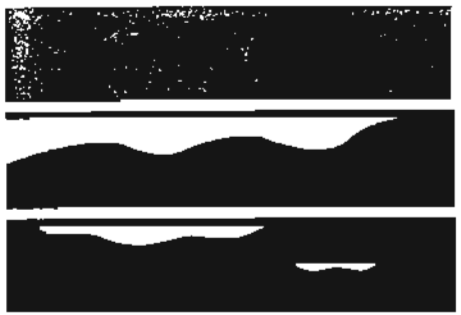
Department of Ecology

Sediment Management Unit

P. O. Box 47703

Olympia, Washington 98504-7703

Overhead 18-7



SEDIMENT MANAGEMENT STANDARDS DETECTION LIMITS

Sediment Management Standards Triennial Review

Kathryn Bragdon-Cook

TABLE 3. 1988 PUGET SOUND AET FOR SELECTED CHEMICALS (normalized to total organic carbon)[a]

Chemical	Amphipod AET[b]	Oyster AET[c]	Benthic AET[d]	Microtox AET[e]
Nonionic Organic Compounds (mg/kg organic carbon; ppm)				
Low molecular weight PAH	2,200	370	780	>530
Naphthalene	220	99	170	>170
Acenaphthylene	66	>27	66	>27
Acenaphthene	200	16	57	>57
Fluorene	360	23	79	>71
Phenanthrene	690	120	480	>160
Anthracene	1,200	>79	220	>79
2-Methylnaphthalene	>120	---	64	---
High molecular weight PAH	5,300	960	7,600	1,500
Fluoranthene	3,000	160	1,200	>190
Pyrene	1,000	>210	1,400	>210
Benz(a)anthracene	270	110	650	>160
Chrysene	460	110	850	>200
Benzofluoranthenes	450	230	1,500	>430
Benzo(a)pyrene	210	99	>1,300	>140
Indeno(1,2,3-c,d)pyrene	88	33	900	>87
Dibenzo(a,h)anthracene	47	120	89	33
Benzo(g,h,i)perylene	78	31	>1,200	>67
Chlorinated benzenes				
1,3-Dichlorobenzene	>15	>15	>15	>15
1,4-Dichlorobenzene	9	3.1	16	>16
1,2-Dichlorobenzene	>58	2.3	2.3	2.3
1,2,4-Trichlorobenzene	1.8	2.9	---	0.81
Hexachlorobenzene (HCB)	4.5	9.6	0.38	2.3
Total PCBs	190	>46	65	12
Phthalates				
Dimethyl phthalate	53	>22	53	>19
Diethyl phthalate	>110	>5.3	61	>5.3
Di-n-butyl phthalate	260	260	1,700	220
Butyl benzyl phthalate	42	>9.2	64	4.9
Bis(2-ethylhexyl)phthalate	78	60	60	47
Di-n-octyl phthalate	58	>57	4,500	--
Miscellaneous Extractables				
Dibenzofuran	>170	15	58	>58
Hexachlorobutadiene	6.2	11	6.9	3.9
N-nitrosodiphenylamine	>11	>11	11	>11

TABLE 2. 1988 PUGET SOUND AET
FOR SELECTED CHEMICALS (normalized to dry weight)[a]

Chemical	Amphipod AET[b]	Oyster AET[c]	Benthic AET[d]	Microtox AET[e]
Organic Compounds (ug/kg dry weight; ppb)				
Low molecular weight PAH	24,000[g]	5,200	13,000[f,g]	5,200
Naphthalene	2,400[g]	2,100	2,700[g]	2,100
Acenaphthylene	1,300[g]	>560	1,300[f,g]	>560
Acenaphthene	2,000[f,g]	500	730[g]	500
Fluorene	3,600[g]	540	1,000[f,g]	540
Phenanthrene	6,900[f,g]	1,500	5,400[f,g]	1,500
Anthracene	13,000[f,g]	960	4,400[f,g]	960
2-Methylnaphthalene	1,900[g]	670	1,400[g]	670
High molecular weight PAH	69,000[f,g]	17,000	69,000[f,g]	12,000
Fluoranthene	30,000[f,g]	2,500	24,000[f,g]	1,700
Pyrene	16,000[f,g]	3,300	16,000[f,g]	2,600
Benz(a)anthracene	5,100[f,g]	1,600	5,100[f,g]	1,300
Chrysene	9,200[f,g]	2,800	9,200[f,g]	1,400
Benzofluoranthenes	7,800[g]	3,600	9,900[f,g]	3,200
Benzo(a)pyrene	3,000[g]	1,600	3,600[f,h]	1,600
Indeno(1,2,3-c,d)pyrene	1,800[f,g]	690	2,600[f,h]	600
Dibenzo(a,h)anthracene	540[f,g]	230	970[f,h]	230
Benzo(g,h,i)perylene	1,400[f,g]	720	2,600[f,h]	670
Chlorinated organic compounds				
1,3-Dichlorobenzene	>170	>170	>170	>170
1,4-Dichlorobenzene	120[h]	120	110[h]	110
1,2-Dichlorobenzene	>110[h]	50	50	35
1,2,4-Trichlorobenzene	51	64		31
Hexachlorobenzene (HCB)	130	230	22[h]	70
Total PCBs	3,100[f,g]	1,100	3,000[h]	130
Phthalates				
Dimethyl phthalate	>1,400[g]	160	>1,400[g]	71
Diethyl phthalate	>1,200[g]	>73	200[g]	>48
Di-n-butyl phthalate	1,400[h]	1,400	>5,100	1,400
Butyl benzyl phthalate	900[g]	>470	900[g]	63
Bis(2-ethylhexyl)phthalate	>3,100	1,900	1,300[h]	1,900
Di-n-octyl phthalate	>2,100[g]	>420	6,200[h]	--
Miscellaneous Extractables				
Dibenzofuran	1,700[g]	540	700[g]	540
Hexachlorobutadiene	180[h]	270	11[h]	120
N-Nitrosodiphenylamine	48[h]	130	28[h]	40

Overhead 19-3

Table 1

Marine Sediment Quality Standards
---Chemical Criteria[1]

CHEMICAL PARAMETER	MG/KG DRY WEIGHT (PARTS PER MILLION (PPM) DRY)
ARSENIC	57
CADMIUM	5 1
CHROMIUM	260
COPPER	390
LEAD	450
MERCURY	0 41
SILVER	6 1
ZINC	410

CHEMICAL PARAMETER	MG/KG ORGANIC CARBON (PPM CARBON)[2]
LPAH[3]	370
NAPHTHALENE	99
ACENAPHTHYLENE	66
ACENAPHTHENE	16
FLUORENE	23
PHENANTHRENE	100
ANTHRACENE	220
2-METHYLNAPHTHALENE	38

CHEMICAL PARAMETER	MG/KG ORGANIC CARBON (PPM CARBON)
HPAH[4]	960
FLUORANTHENE	160
PYRENE	1000
BENZ(A)ANTHRACENE	110
CHRYSENE	110
TOTAL BENZOFLUORANTHENES[5]	230
BENZO(A)PYRENE	99
INDENO (1,2,3,-C,D) PYRENE	34
DIBENZO (A,H) ANTHRACENE	12
BENZO(G,H,I)PERYLENE	31
1,2-DICHLOROBENZENE	2 3
1,4-DICHLOROBENZENE	3.1
1,2,4-TRICHLOROBENZENE	0 81
HEXACHLOROBENZENE	0.38
DIMETHYL PHTHALATE	53
DIETHYL PHTHALATE	61
DI-N-BUTYL PHTHALATE	220
BUTYL BENZYL PHTHALATE	4.9
BIS (2-ETHYLHEXYL) PHTHALATE	47
DI-N-OCTYL PHTHALATE	58
DIBENZOFURAN	15
HEXACHLOROBUTADIENE	3.9
N-NITROSODIPHENYLAMINE	11
TOTAL PCB'S	12

CHEMICAL PARAMETER	UG/KG DRY WEIGHT (PARTS PER BILLION (PPB) DRY)
PHENOL	420
2-METHYLPHENOL	63
4-METHYLPHENOL	670
2,4-DIMETHYL PHENOL	29
PENTACHLOROPHENOL	360
BENZYL ALCOHOL	57
BENZOIC ACID	650

Overhead 19-4

COMMON TOC RANGE in PUGET SOUND

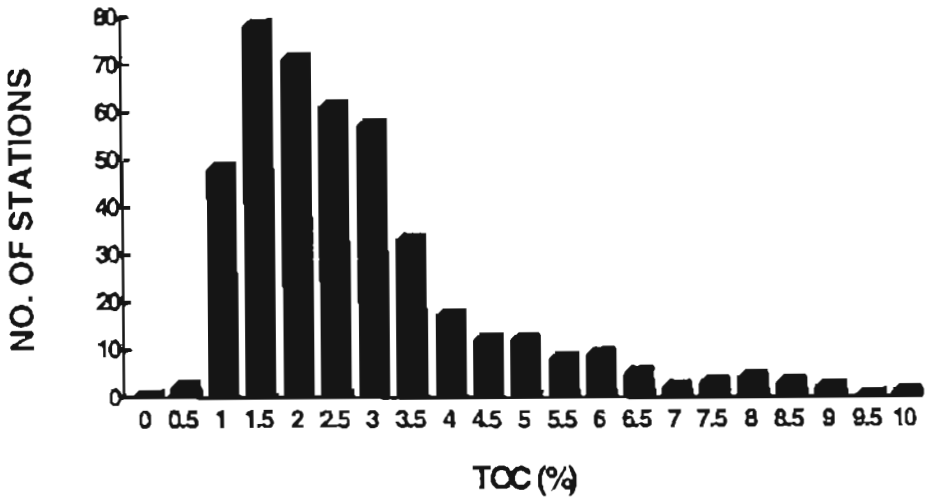
TOC CONTENT OF SURFACE SAMPLES FOR A GROUP OF 443 STATIONS LOCATED THROUGHOUT PUGET SOUND:*

- Below the 5th percentile TOC levels ranged between 0% and 0.3%
- In the 95th percentile TOC levels ranged from 5.5% to 13%
- The median value for TOC content was 1.8%
- The average value for TOC content was 2.1%

*Represents approximately 22% of database; stations located from north to south Puget Sound including all urban bays

Overhead 19-5

TOC DISTRIBUTION IN PUGET SOUND SEDIMENTS



Overhead 19-6

WET to DRY WEIGHT NORMALIZATION

$$\frac{\text{[chemical concentration] mg}}{\text{kg wet weight}} \div \frac{\text{kg dry}}{\text{kg wet}} = \frac{\text{[chemical concentration] mg}}{\text{kg dry weight}}$$

(decimal % solids) ("ppm dry")

TOTAL ORGANIC CARBON NORMALIZATION

$$\frac{\text{[chemical concentration] mg}}{\text{kg dry weight}} \div \frac{\text{kg TOC}}{\text{kg dry wt}} = \frac{\text{[chemical concentration] mg}}{\text{kg TOC}}$$

(decimal % TOC) ("ppm carbon")

Overhead 19-7

WHEN TOC NORMALIZATION IS INAPPROPRIATE

FALSE POSITIVE RESULT:

DRY WEIGHT CHEMICAL CONCENTRATION	÷	% TOC TOO LOW	=	ARTIFICIALLY HIGH CHEMICAL CONCENTRATION

FALSE NEGATIVE RESULT:

DRY WEIGHT CHEMICAL CONCENTRATION	÷	% TOC TOO HIGH	=	ARTIFICIALLY LOW CHEMICAL CONCENTRATION

Overhead 19-8

CHLORINATED HYDROCARBONS

CHLORINATED AROMATIC HYDROCARBONS (BENZENES):

1,2-DICHLOROBENZENE

1,4-DICHLOROBENZENE

1,2,4-TRICHLOROBENZENE

HEXACHLOROBENZENE

CHLORINATED ALIPHATIC HYDROCARBON:

HEXACHLOROBUTADIENE

Overhead 19-9

AT 2 % TOC:

DRY WEIGHT DL EXCEEDS CRITERIA WHEN TOC NORMALIZED:

$$\frac{[10\ \mu g\ HCB]}{kg\ dry\ weight} \div [(1000)ppb/ppm]\ [(0.02\ TOC)] = 0.50\ ppm\ carbon$$

DRY WEIGHT DL NEEDED TO MEET CRITERIA:

$$\frac{[7.6\ \mu g\ HCB]}{kg\ dry\ weight} \div [(1000)ppb/ppm]\ [(0.02\ TOC)] = 0.38\ ppm\ carbon$$

AT 1 % TOC: DRY WT DL NEEDS TO BE 3.8 µg/kg TO MEET CRITERIA

AT 0.5 % TOC: DRY WT DL NEEDS TO BE 1.9 µg/kg TO MEET CRITERIA

Overhead 19-10

SUGGESTIONS for REDUCING DETECTION LIMITS

- COORDINATE TOC AND ORGANIC CHEMICAL ANALYSES
- INCREASE SAMPLE SIZE
- USE SMALLER EXTRACT VOLUME FOR GC/MS ANALYSES
- PERFORM SAMPLE CLEAN-UP PROCEDURE TO REDUCE MATRIX INTERFERENCE
- USE EPA METHOD 8260 (VOLATILES) FOR ANALYSIS OF THE DI- AND TRI- CHLOROBENZENES
- USE EPA METHOD 8080 (PESTICIDES, PCBs) FOR ANALYSIS OF HEXACHLOROBENZENE AND HEXACHLOROBUTADIENE

CHLORINATED HYDROCARBON GROUP:

- ATTEMPT TO REDUCE DRY WEIGHT DLs TO MEET CRITERIA.
- REPORT LOWEST DLs ACHIEVED.
- PROVIDE EXPLANATION OF EFFORTS MADE.

ECOLOGY WILL ACCEPT DLs WHICH EXCEED CRITERIA WHEN CARBON NORMALIZED *FOR THIS GROUP* -- IF AT OR BELOW THE PSEP RECOMMENDATION -- PROVIDED JUSTIFICATION.

(ECOLOGY WILL THEN DETERMINE WHETHER DATA WILL BE EVALUATED USING THE TOC NORMALIZED CRITERIA OR DRY WEIGHT LAET CRITERIA -- GIVEN THE TOC RANGE AND OTHER SITE SPECIFIC CONCERNS.)

ALL NONIONIZABLE ORGANICS and LOW TOC:

CONTACT YOUR REGIONAL TECHNICAL EXPERT OR THE SEDIMENT MANAGEMENT UNIT FOR ASSISTANCE WHEN:

- ↓ UNUSUALLY LOW TOC IS EXPECTED OR MEASURED (below the 5th percentile, or below 0.5%)
- ↑ UNUSUALLY HIGH TOC IS EXPECTED OR MEASURED (within the 95th percentile, or above 4%)

IN THESE CASES, ECOLOGY WILL DETERMINE WHETHER SEDIMENT CHEMISTRY DATA SHOULD BE EVALUATED ON A DRY WEIGHT BASIS.

- ▸ WHEN APPROPRIATE: PSEP RECOMMENDED DLs MAY BE USED AND DRY WEIGHT CHEMICAL DATA EVALUATED USING THE DRY WEIGHT LAET CRITERIA.

FRESHWATER SEDIMENT CRITERIA DEVELOPMENT

Sediment Management Standards Triennial Review

James Cubbage and David Batts

Overhead 20-1

Prepared for the Sediment Management Unit in cooperation with:

Brett Betts
Tom Gries

under a grant from

U.S. Environmental Protection Agency
Region 10
Seattle Washington

Washington State Department of Ecology
Environmental Investigations and Laboratory Services Program

Overhead 20-2

GOAL

Develop a combination of chemical criteria and biological test procedures for contaminants in freshwater sediment.

These criteria and procedures will be the basis to make recommendations for Washington State Freshwater Sediment Criteria which represent a "no adverse biological effects level to freshwater biological resources."

Overhead 20-3

METHODS

- Review criteria created by other states and governmental entities.
- Create freshwater sediment database of chemicals analysis and bioassay results.
- Review other bioassays for possible inclusion in recommended biological tests.
- Develop Apparent Effects Thresholds (AETs) for those bioassays with adequate data:
  Hyalella azteca
  Microtox®.
- Compare sensitivity and efficiency of AETs to each other and to other criteria.

Overhead 20-4

REVIEW CRITERIA

- Reviewed 13 sets of criteria and published 6 that currently are being proposed, supported or used by the releasing agency.

- Published FSEDCRIT version 2.

Overhead 20-5

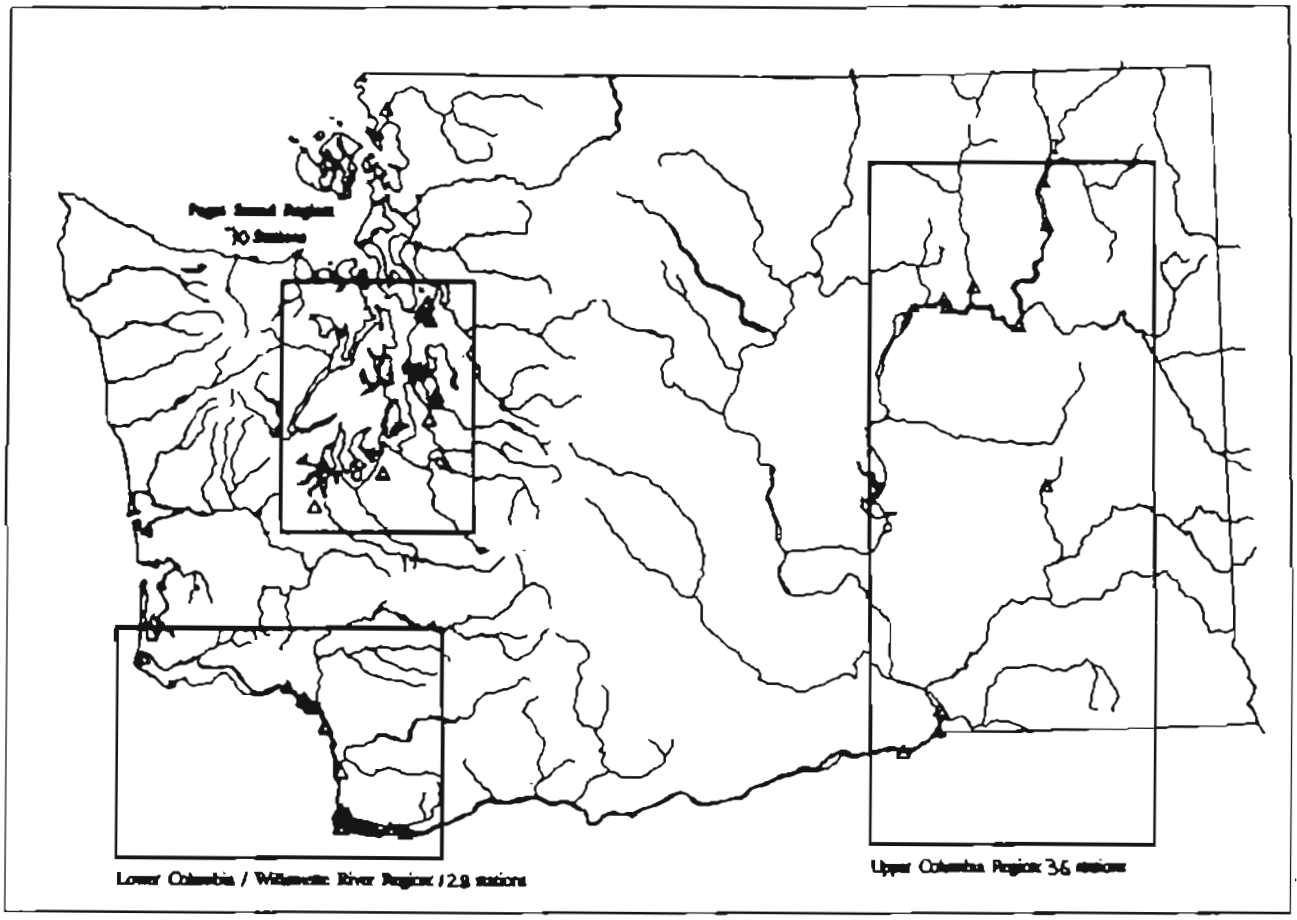
CREATE FRESHWATER SEDIMENT DATABASE

- All data were screened by examining Quality Assurance/Quality Control reported in each study. Based on that review they were accepted or rejected to be entered into the database.

- We collected and entered data from 36 synoptic studies that have chemistry and bioassay results in Washington and bordering areas of Oregon and British Columbia.

- A total of 239 sites were tested with *Hyalella* and 61 sites were tested with Microtox® bioassays.

Overhead 20-6



– Stations with Bioassay Testing

Overhead 20-7

REVIEW OTHER CANDIDATE BIOASSAYS

- *Chironomid* growth
- FETAX (frog embryo abnormalities)
- Do not use *Daphnia magna* for sediment studies

Overhead 20-8

DEVELOP APPARENT EFFECTS THRESHOLDS (AETs)

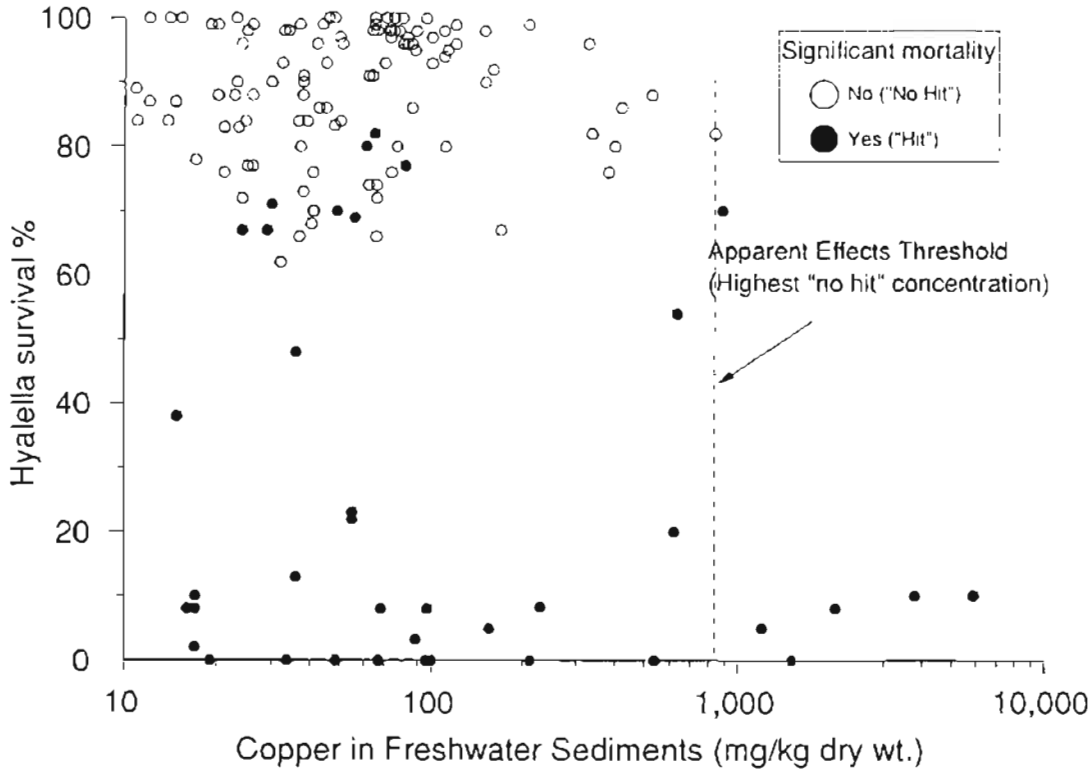
- Biological "hits" were defined and calculated
- AETs have been calculated and are being checked

Overhead 20-9

Table. Bioassay results in Freshwater Sediment Quality Database.

Bioassay	Endpoint	Sites	"Hits"
Ceriodaphnia dubia	mortality	8	1
Ceriodaphnia dubia	reproduction	30	10
Chironous tentans	emergence	8	1
Chironous tentans	growth	9	1
Chironous tentans	mortality	31	8
Daphnia magna	mortality	50	7
Daphnia pulex	mortality	2	0
Hexagenia limbata	mortality	8	1
Hyalella azteca	mortality	239	53
Microtox®	light reduction	61	25

Overhead 20-10



Hyalella Apparent Effects Threshold (AET) for copper.

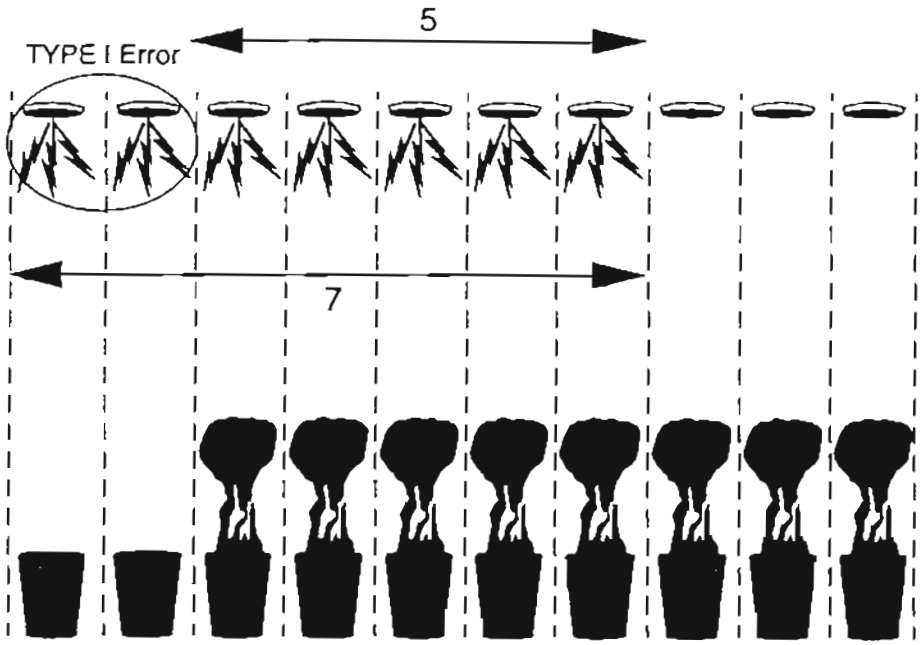
Overhead 20-11

TEST SENSITIVITY AND EFFICIENCY

- Sensitivity and efficiency of *Hyalella* and Microtox® AETs to each other and to other criteria proposed by other organizations are being measured.

- Based on these results, additional sediment effects calculations may be considered.

Overhead 20-12

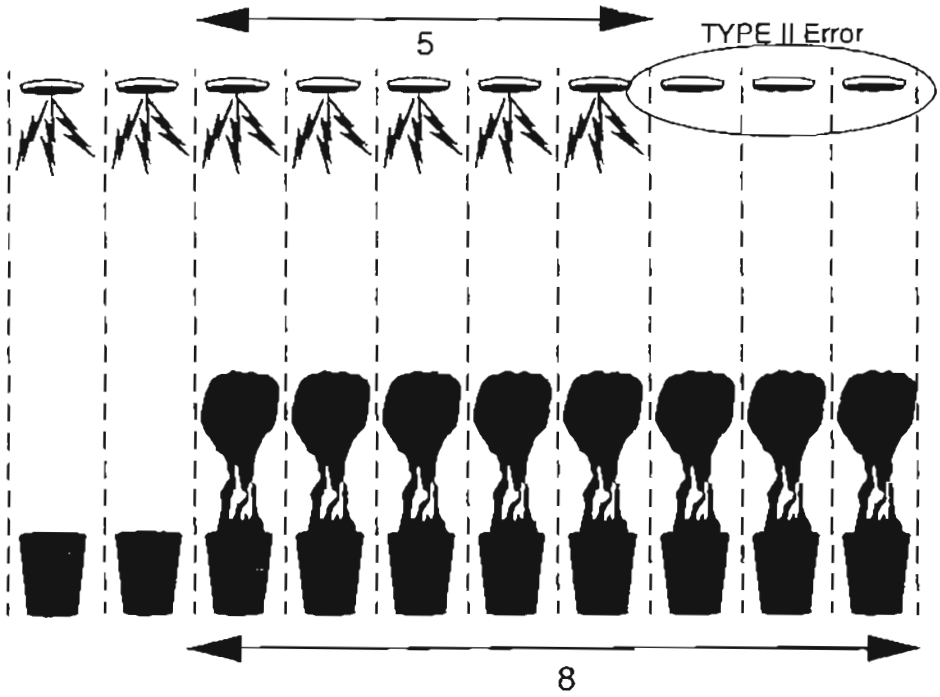


EFFICIENCY = Number of correctly predicted / number predicted

EFFICIENCY = 5/7 = 71%: The percent of alarms that were true.

The alarms displayed a TYPE I error 29% (2/7) of the time.

Overhead 20-13



SENSITIVITY = Number of correctly predicted / number of impacted

SENSITIVITY = 5/8 = 63%: The percent of fires detected.

The alarms displayed a TYPE II error 37% (3/8) of the time.

Overhead 20-14

Table. Sediment Quality Values (SQVs) Compared to Hit / No-Hit Data

SQV	Hit Type	Actual Hits	Predicted Hits	Correctly Predicted Hits	Sensitivity	Efficiency
Hyalella azteca AET	*Hyalella azteca* mortality	51	35	35	69	100
	Microtox ® light reduction	25	10	6	24	60
Microtox ® AET	*Hyalella azteca* mortality	51	131	36	71	27
	Microtox ® light reduction	25	21	21	84	100
Ontario Provincial SEL	*Hyalella azteca* mortality	51	86	33	65	38
	Microtox ® light reduction	25	22	16	64	73

AET = Apparent Effects Level
LEL = Lowest Effect Level
SEL = Severe Effect Level

Overhead 20-15

CONCLUSIONS

- Chemical criteria based on AETs can be derived for freshwater sediments in Washington State.
- We will have measures of sensitivity, efficiency and reliability of proposed criteria for consideration. A policy decision must be made as to what level of each is acceptable.
- Report will be out in draft form in 2 months.

Overhead 20-16

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

STATUS OF MARINE FINFISH REARING FACILITIES RULE
DEVELOPMENT ACTIVITIES

Sediment Management Standards
Triennial Review

presented by Pamela Sparks-McConkey

Overhead 21-1

PURPOSE: To adopt Net Pen source control biological sediment effects criteria

NET PEN FACILITY TYPES

- ✓ COMMERCIAL
- ✓ ENHANCEMENT
- ✓ RESEARCH

ENVIRONMENTAL CONCERNS

- ✓ ORGANIC ENRICHMENT
- ✓ USE OF CHEMICALS
- ✓ MANAGEMENT PRACTICES

Overhead 21-2

1993 LEGISLATIVE MANDATE - 90.48.220 RCW

REQUIRES ECOLOGY BY OCTOBER 1994:

TO ADOPT CRITERIA FOR ALLOWABLE SEDIMENT IMPACTS FROM ORGANIC ENRICHMENT DUE TO MARINE FINFISH REARING FACILITIES

STATUS

NET PEN ADVISORY WORKGROUP (NPAW)

- ✓ LOCAL, STATE, AND FEDERAL AGENCIES
- ✓ TRIBAL GOVERNMENTS
- ✓ INDUSTRY REPRESENTATIVE
- ✓ ENVIRONMENTAL GROUPS

IDENTIFIED ISSUES

- ✓ TECHNICAL - CHARACTERIZE RANGE OF SEDIMENT BIOLOGICAL EFFECTS
- ✓ POLICY - LEGAL RESTRICTIONS ON BIOLOGICAL EFFECT LEVELS FOR SEDIMENT MIXING ZONES

STATUS ON ISSUES - TECHNICAL

EVALUATING BIOLOGICAL EFFECTS

- ✓ SEDIMENT QUALITY STANDARDS
- ✓ SEDIMENT SOURCE CONTROL & CLEANUP REGULATORY LEVELS

DEVELOPING EFFECTIVE NET PEN STANDARDS

- ✓ ESTABLISH OTHER BENTHIC INFAUNA INDICES
- ✓ IDENTIFY AN ALTERNATE SEDIMENT EFFECTS CRITERIA
- ✓ EVALUATE THE USE OF NET PEN BACKGROUND SAMPLES AS REFERENCE
- ✓ IDENTIFY OTHER SUITABLE MONITORING REQUIREMENTS

STATUS ON ISSUES - LEGAL ANALYSIS

AN INFORMAL WRITTEN OPINION ON:

WHETHER THE FEDERAL AND STATE REGULATIONS LIMIT THE ALLOWABLE MAXIMUM BIOLOGICAL IMPACT FOR MIXING AND/OR DILUTION ZONES

EVALUATING FEDERAL LAW/REGULATIONS

- ✓ CLEAN WATER ACT

EVALUATING STATE LAW/REGULATIONS

- ✓ RCW 90.48 - WATER POLLUTION CONTROL ACT
- ✓ SEDIMENT MANAGEMENT STANDARDS

STATUS ON SMS RULE STUDIES

TECHNICAL STUDIES - RECOMMENDATIONS BY LATE-MAY 1995

LEGAL ANALYSIS - RECOMMENDATIONS BY LATE-JUNE 1995

CURRENT NET PEN OPTIONS:

- ✓ OPTION 1 - USE CURRENT SMS BIOLOGICAL EFFECTS CRITERIA
- ✓ OPTION 2 - ADOPT NEW NET PEN BIOLOGICAL EFFECTS CRITERIA
- ✓ OPTION 3 - USE LAND USE AUTHORIZATIONS

Overhead 21-7

SMS RULE AMENDMENT SCHEDULE

NPAW meeting to discuss recommendations on the technical/legal analyses	June 1995
Begin internal Ecology rule review	June 1995
Propose SMS rule amendment	late-August 1995
Adopt SMS rule amendment	late-October 1995

Overhead 21-8

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Human Health Sediment Criteria Development

Sediment Management Standards
Triennial Review

Laura B. Weiss, M.P.H (360) 407-7446

Overhead 22-1

Why Develop Health-Based Sediment Criteria?

Reasons for Concern

- *Elevated health risks in urban bays*
- *Lack of certainty and consistency*
- *Allow for more timely decision-making*
- *Ensure safe fish/shellfish*

Mandates

- *Water Pollution Control Act (RCW 90.48)*
- *Model Toxics Control Act (RCW 70.105D)*
- *Puget Sound Water Quality Act (RCW 90.70)*
- *Ecology committment*

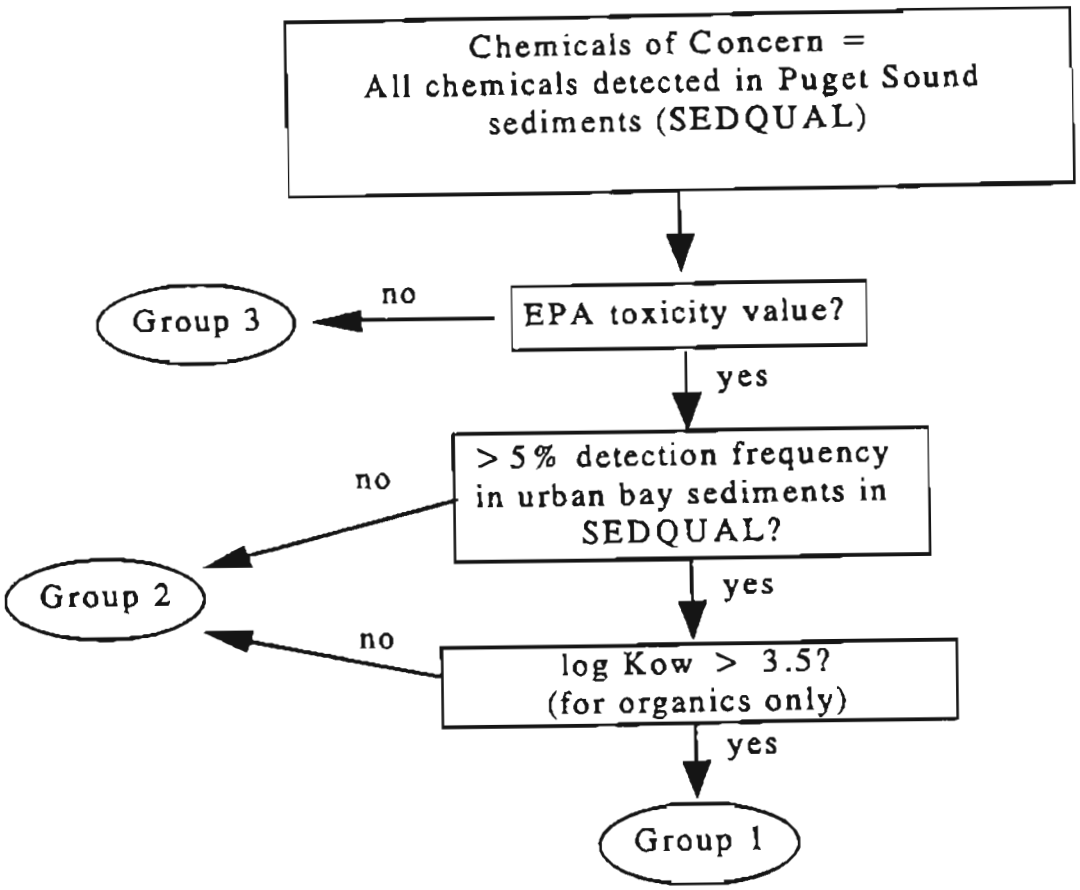
Overhead 22-2

What & Where? Health-Based Sediment Criteria

Criteria will be:

- *Applicable to Puget Sound marine sediments*
- *Developed for a short list of chemicals of concern*
- *Based on exposure via fish/shellfish consumption*
- *Applicable to source control and cleanup programs*

Overhead 22-3



Overhead 22-4

Human Health Chemicals of Concern (Group 1 Organics Only)

- Aldrin
- Benzo(a)pyrene (and associated HPAHs)
- DDD, DDE, and DDT
- Hexachlorobenzene
- Hexachlorobutadiene
- PCBs
- Pentachlorophenol
- Polychlorinated dibenzofurans
- Polychlorinated dibenzodioxins

(Note: This list includes only Group 1 chemicals with human health values that are likely to be below existing ecological criteria)

Overhead 22-5

How will Health-Based Criteria be Developed?

Methods and Approach

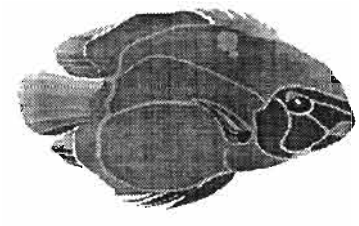
- *Use Biota-Sediment Accumulation Factor (BSAF) to predict accumulation from sediments to fish.*

- *Use risk assessment methods to calculate an "acceptable" fish tissue concentration.*

- *Focus is on cancer-causing compounds which are known to bioaccumulate in fish and/or shellfish.*

Overhead 22-6

Options for Development of Biota-Sediment Accumulation Factors



- ❖ Thomann Food-Web Model
  - Requires further data collection
  - Validation recommended
- ❖ Fish Tissue Database Validation
- ❖ Empirical, Literature-Based Values
  - » National, empirical data
  - » Mostly field data, from marine and freshwater
  - » 1,200 data points for trophic levels 3 & 4
  - Grouped by chemical class
    - » Too much variability among chemicals
  - Grouped by Kow and Chemical Class
    - » Accounts for important chemical characteristics

Overhead 22-7

DERIVATION OF RISK-BASED SEDIMENT QUALITY CRITERIA FOR CARCINOGENS:

$$\text{SEDIMENT CONCENTRATION} = \frac{\text{ACCEPTABLE CANCER RISK}}{\text{EXPOSURE} \times \text{POTENCY}}$$

More specifically:

$$\text{SEDIMENT CONCENTRATION} = \frac{\text{Risk} \times \text{BW} \times \text{Life} \times \text{UCF}}{\text{CPF} \times \text{BSAF} \times \text{FIR} \times \text{FL} \times \text{ED}}$$

Assumptions:

Risk = Acceptable cancer risk level of 1 in 1,000,000
BW = Average body weight of 70 kg
Life = Life expectancy of 75 years
UCF = Unit conversion factor of 1,000 ug/mg
CPF = Cancer Potency Factor as defined by EPA (IRIS)
BSAF = Biota-Sediment Accumulation Factor as defined by DOH
FIR = Fish Ingestion Rate of (26.1 or 95.1 grams/day)
FL = Fish Lipid Content of 4%
ED = Exposure duration of 30 years

Purpose: *To estimate the chemical concentration in sediment which represents no significant risk to human health.*

Overhead 22-8

When will Health-Based Criteria be Developed?

Schedule

❖ 1989 - today	Technical Development
❖ Summer 1995	Public Review and Workshops
❖ Winter 1995	Propose criteria and rule formally
❖ Spring 1996	Adopt rule

"The Puget Sound study concentrated on the chemical and biological data and used little or no physical data (currents, salinity, turbulence, and sediment characteristics) in the development of AET. **Until the effect of physical factors on AET is adequately studied, the present AET values could contain significant errors and the AET cannot be applied generically with confidence.** (emphasis added)."

EPA Science Advisory Board, July 1989. "Evaluation of the Apparent Effects Threshold (AET) Approach for Assessing Sediment Quality." SAB-EETFC-89-027. pg 11.

Overhead 23-1

The SAB report includes examples of factors that may give rise to biased relationships between the exposure and response variables. One of these factors was:

"**Bioassays conducted with homogenized sediments or with supernatants derived from agitated sediments as opposed to undisturbed sediments.**"(emphasis added)

EPA Science Advisory Board, July 1989. "Evaluation of the Apparent Effects Threshold (AET) Approach for Assessing Sediment Quality." SAB-EETFC-89-027. pg 13.

Overhead 23-2

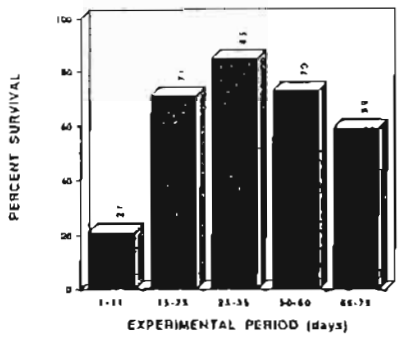


Figure 1.
STABILITY AND DISTURBANCE: MA-1U.

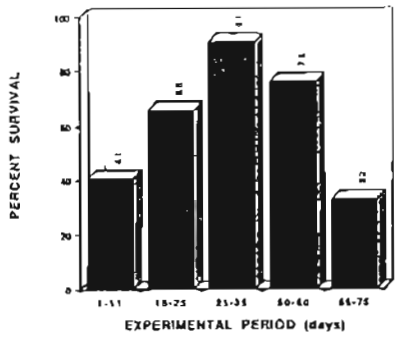


Figure 2.
STABILITY AND DISTURBANCE: SS-4L.

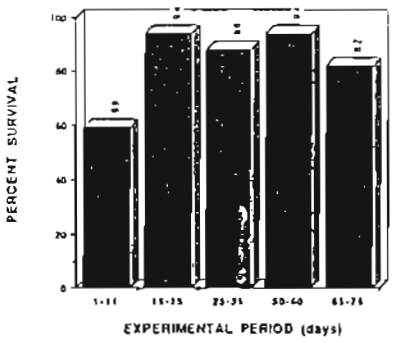


Figure 3.
STABILITY AND DISTURBANCE: C-4.

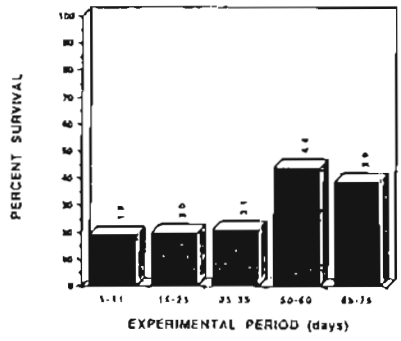


Figure 4.
STABILITY AND DISTURBANCE: MA1-L

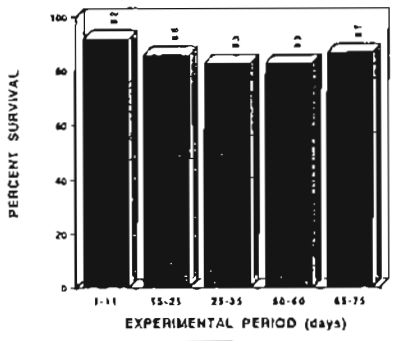


Figure 5.
STABILITY AND DISTURBANCE: SEQUIM BAY SEDIMENT.

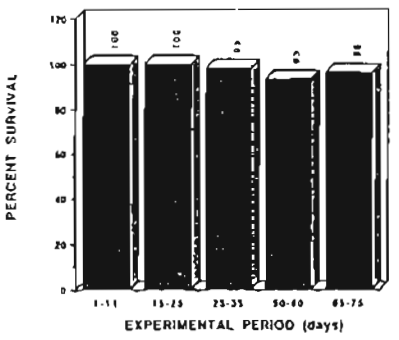


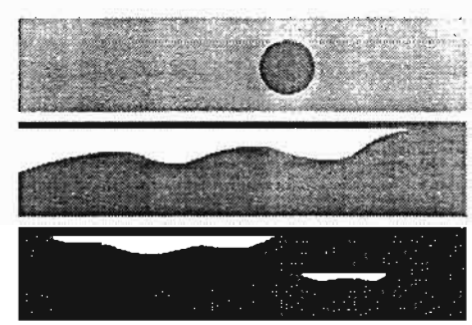
Figure 6.
STABILITY AND DISTURBANCE: WEST BEACH.

Overhead 23-3

"The use of flow-through exposure systems is preferred to **minimize the chances that stressful artifacts of experimental procedures will affect the results**; static renewal systems may be acceptable." (emphasis added)

EPA Office of Marine and Estuarine Protection, January 1990. Draft Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters (EPA-503-8-90/002)

Overhead 23-4



STATUS OF THE BENTHIC INFAUNA STUDIES

Sediment Management Standards Triennial Review

presented by Pamela Sparks-McConkey

Overhead 24-1

PURPOSE:

TO IMPROVE BIOLOGICAL EFFECTS CRITERIA

STUDY OBJECTIVES:

✓ EVALUATE SENSITIVITY AMONG BENTHIC ENDPOINTS

✓ EVALUATE STATISTICAL ANALYSES

✓ ESTABLISH DEFINITIVE REFERENCE CONDITIONS

Overhead 24-2

APPROACH:

- ✓ ESTABLISH HABITAT CATEGORIES
- ✓ DEVELOPMENT OF REFERENCE VALUES
- ✓ EVALUATING BENTHIC INDICES
- ✓ RECOMMENDATIONS

Overhead 24-3

ESTABLISH HABITAT CATEGORIES

- ✓ COMPILED SYNOPTIC CHEMICAL AND BIOLOGICAL DATA
- ✓ SMS CHEMICAL SEDIMENT QUALITY STANDARDS
- ✓ MATRICES SORTED INTO 16 HABITAT CATEGORIES
- ✓ < 150' WATER DEPTH SELECTED

Overhead 24-4

DEVELOPMENT OF REFERENCE VALUES

- ✓ VARIABILITY WITHIN HABITAT CATEGORIES
- ✓ DIFFERENCES AMONG HABITAT CATEGORIES
- ✓ GEOGRAPHIC VARIABILITY WITHIN SPECIFIC HABITAT CATEGORIES
- ✓ DIFFERENCES IN BENTHIC ENDPOINTS BETWEEN REFERENCE AND CONTAMINATED HABITAT CATEGORIES
- ✓ DIFFERENCES BETWEEN REFERENCE VALUES AND INDIVIDUAL CONTAMINATED STATIONS

Overhead 24-5

EVALUATING BENTHIC INDICES

- ✓ LOW VARIABILITY
- ✓ STATISTICALLY SIGNIFICANT SEPARATION AMONG HABITAT CATEGORIES
- ✓ LOW GEOGRAPHIC VARIABILITY
- ✓ SENSITIVITY TO DIFFERENTIATE BETWEEN CONTAMINATED & UNCONTAMINATED

Overhead 24-6

RECOMMENDATIONS

- ✓ POLYCHAETA RICHNESS
- ✓ SWARTZ DOMINANCE INDEX
- ✓ TOTAL RICHNESS
- ✓ H', ITI INDEX, & TOTAL ABUNDANCE
- ✓ USE OF SEVERAL BENTHIC ENDPOINTS
- ✓ USE RANGES FOR PAIR-WISE COMPARISONS
- ✓ STANDARDIZE PUGET SOUND TAXONOMY LIST
- ✓ UPDATE BENTHIC REFERENCE RANGES

PURPOSE:

TO EVALUATE THE EFFICIENCY OF BENTHIC INDICES IN IDENTIFYING DEGREES OF COMMUNITY IMPACT

STUDY OBJECTIVE:

ELLIOTT BAY ACTION PROGRAM (EBAP)

APPROACH - STATISTICAL ANALYSES

- ✓ COMPARISONS BETWEEN EBAP & PORT SUSAN
    1. COARSE AND FINE-GRAINED
    2. REFERENCE RANGES (4 CATEGORIES)
- ✓ COMPARISONS BETWEEN EBAP & REFERENCE RANGES
- ✓ COMPARISONS BETWEEN EVERETT HARBOR & REFERENCE RANGES
- ✓ AMONG STATION COMPARISONS BETWEEN EBAP & PORT SUSAN
- ✓ AMONG STATION COMPARISONS BETWEEN EBAP & REFERENCE RANGES

Overhead 24-9

APPROACH - MULTIVARIATE ANALYSIS

IDENTIFICATION OF SPECIES COMPOSITION (i.e., numerically dominant taxa) FOR EBAP AND PORT SUSAN

ENVIRONMENTAL STRESSORS

- ✓ ORGANIC ENRICHMENT
- ✓ CHEMICALLY IMPACTED
- ✓ PHYSCIAL EFFECTS

Overhead 24-10

RECOMMENDATIONS

- ✓ USE OF MULTIPLE BENTHIC ENDPOINTS:

  TOTAL RICHNESS,
  TAXA ABUNDANCE, &
  SWARTZ's DOMINANCE INDEX

- ✓ MAINTAIN SMS BENTHIC ABUNDANCE TEST STANDARD

- ✓ USE MULTIVARIATE ANALYSES TO IDENTIFY ENVIRONMENTAL STRESSORS

- ✓ USE ANOVA & DUNNETT'S METHODS VS T-TEST FOR COMPARISON TESTING

- ✓ CONTINUE CURRENT USE OF SITE-SPECIFIC REFERENCE METHODS

Overhead 24-11

STATUS ON RECOMMENDATION

PRESENTATION OF RECOMMENDATIONS TO THE PSDDA AGENCIES

DISCUSSION ON RECOMMENDATIONS BY THE PSDDA AGENCIES -- POST-SMARM

REPORTS TO BE COMPLETED - LATE-MAY '95

Overhead 24-12

STATUS REPORT

EVALUATION OF THE MICROTOX® BIOASSAY FOR USE IN PSDDA AND SMS

Therese Littleton
Dredged Material Management Office
Corps of Engineers, Seattle District

1995 PSDDA Annual Review
1995 Sediment Management Standards Triennial Review

Overhead 25-1

MICROTOX®

- Bioluminescent bacterial bioassay
- Widely used in aquatic toxicology
- Saline and solid phase tests available

Overhead 25-2

PROBLEM IDENTIFICATION

- Saline extract test effectiveness questionable:

  ⇒ Inability to interpret results
  ⇒ Apparent performance failures

- Regulatory use suspended until effectiveness is established

- Solid phase test might be more effective

Overhead 25-3

STATUS OF WORK

- PSDDA continuing side-by-side examination of saline and solid phase Microtox

- National 'round-robin' saline/solid phase comparison continuing:

  ⇒ Initial results indicate solid phase test shows greater response to bound toxicants

- Regulatory suspension to be extended through DY95

Overhead 25-4

"Okay, okay, okay . . . Everyone just calm down and we'll try this thing one more time."

Overhead 25-5

Progress Re-evaluating Puget Sound Apparent Effects Thresholds (AETs)

presented by
Tom Gries
Department of Ecology
(360) 407-7536

Overhead 26-1

Conclusions

- Some 1994 amphipod mortality AETs increased from the corresponding 1988 values
- New echinoderm larval abnormality AETs were often lower than corresponding 1986 oyster values
- Among the suite of Puget Sound AET types, many 1994 AET values represent new highest, second lowest and lowest AETs
- 1994 AETs have the potential to affect PSDDA guideline and Sediment Management Standards (SMS) criteria values

Overhead 26-2

Background

1986-1989 Puget Sound AETs developed and updated; PSDDA maximum and screening level guidelines (MLs and SLs) established; PSDDA agencies obtained sediment quality values database (SEDQUAL)

1990-1991 New synoptic sediment quality data or quality assurance information inadequate to recalculate AETs; seven new SLs adopted; Washington adopted Sediment Management Standards (SMS) rule (173-204 WAC) adopted

1992 Sediment quality values database expanded, characterized at PSDDA Annual Review Meeting (ARM); some consensus reached on AET methods

Background

1993 QA and entry of synoptic data concluded; early amphipod mortality and sediment larval abnormality AET results presented

1994 Interim amphipod mortality and echinoderm abnormality AETs presented; remaining work identified

1995 Volume I technical report on 1994 AETs completed

Objectives

Volume I:

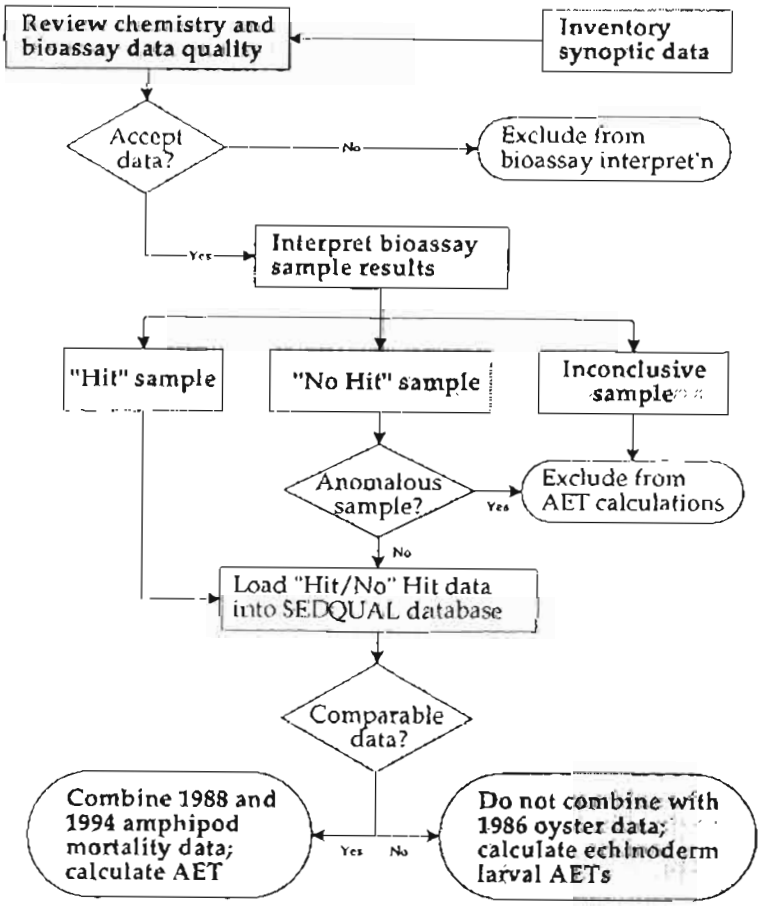
1. Recalculate and present new amphipod mortality AET values and their ability to correctly predict adverse biological effects (predictive reliability)

2. Calculate and present echinoderm larval AET values and their predictive reliability

3. Compile a list new AETs which might affect PSDDA ML and SL guidelines, SMS criteria

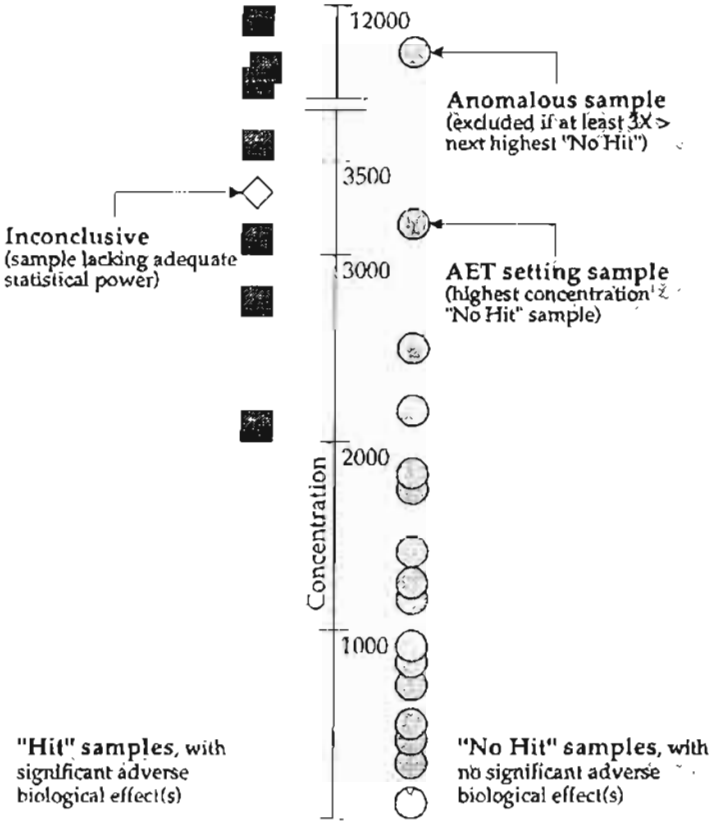
Overhead 26-5

Calculating 1994 Puget Sound AETs:
General approach



Overhead 26-6

Calculating 1994 Puget Sound AETs: Schematic



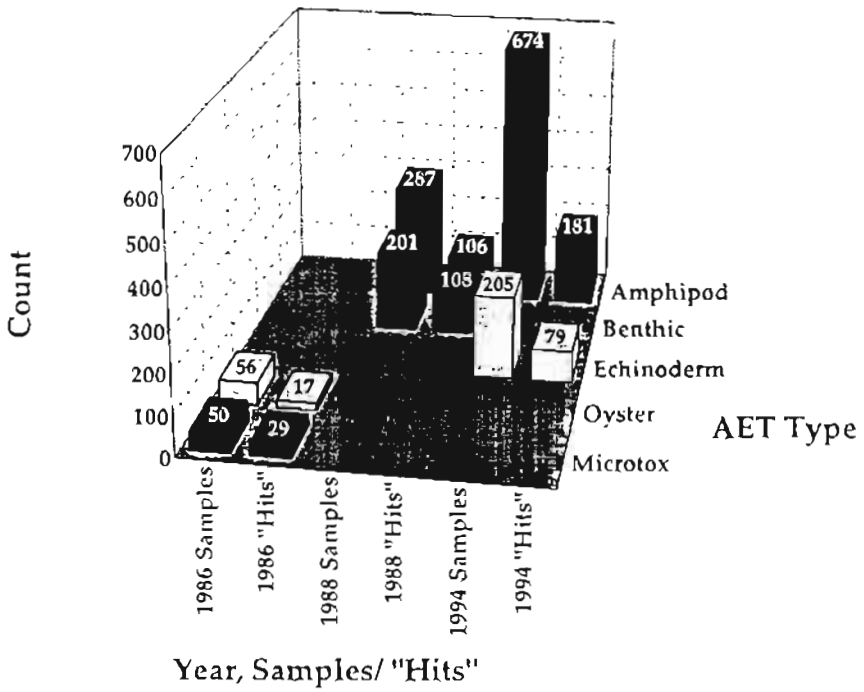
Overhead 26-7

Calculating 1994 Puget Sound AETs: Differences from 1988

- Used revised performance standards to screen bioassay reference sample results
- Used subsurface samples in 1994 AET calculations
- Used slightly modified statistical procedures to determine significant adverse effects ("Hit" samples)
- Used power analysis in determination of significant adverse effects in echinoderm larval bioassay

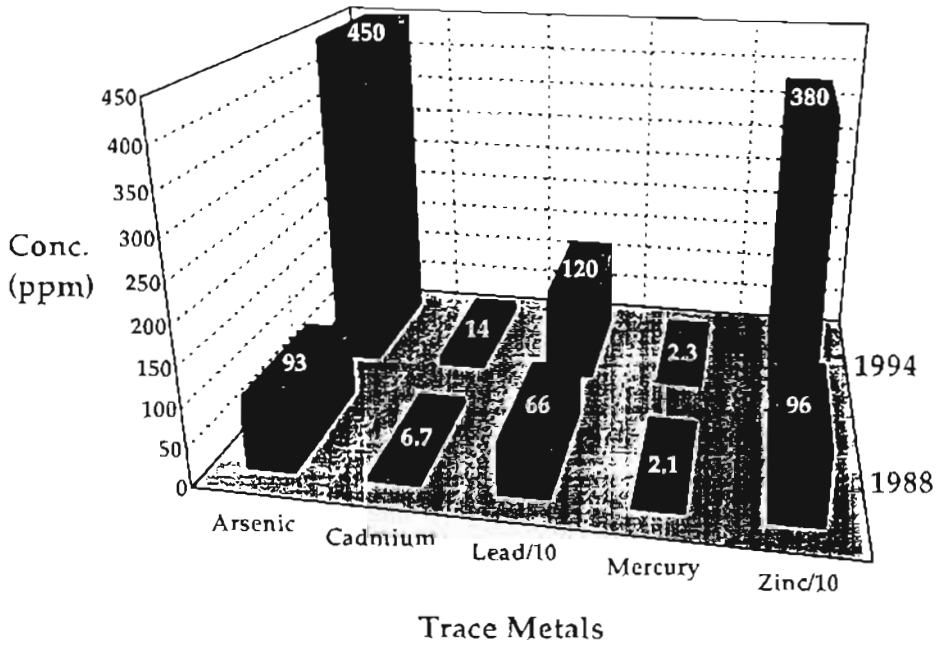
Overhead 26-8

The SEDQUAL Database



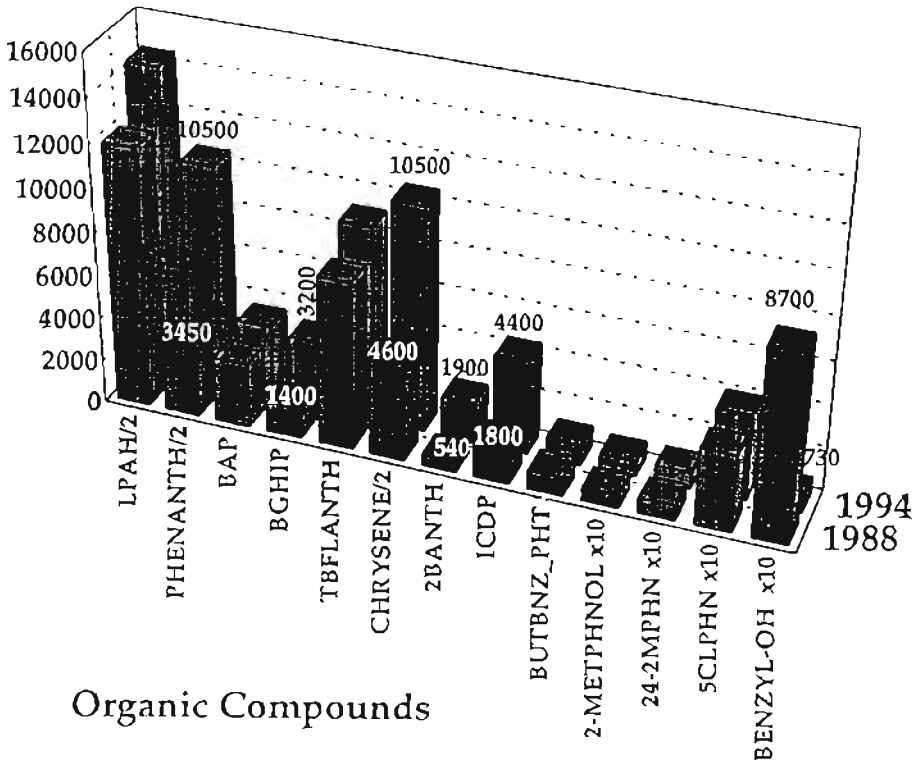
Overhead 26-9

Amphipod Mortality AETs
(dry weight)



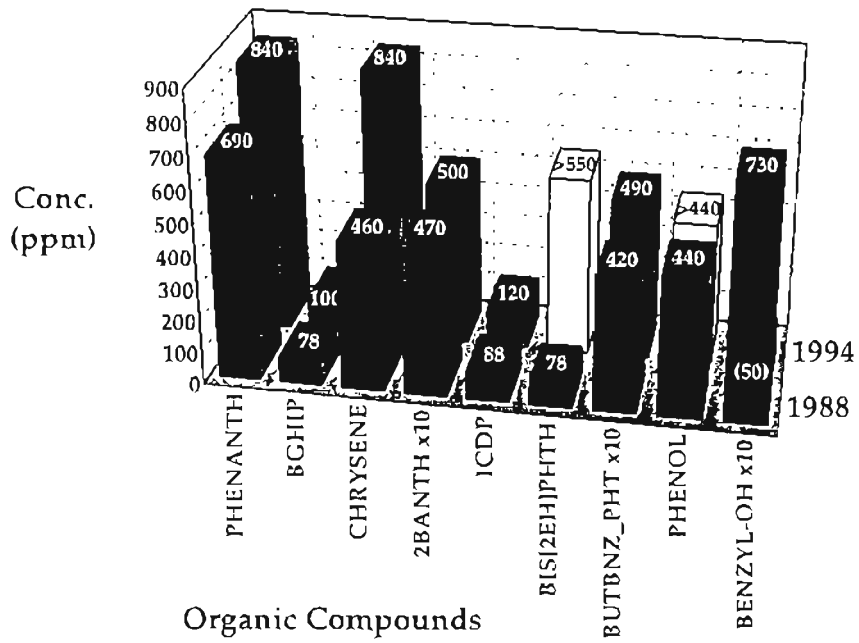
Overhead 26-10

Amphipod Mortality AETs
(dry weight)



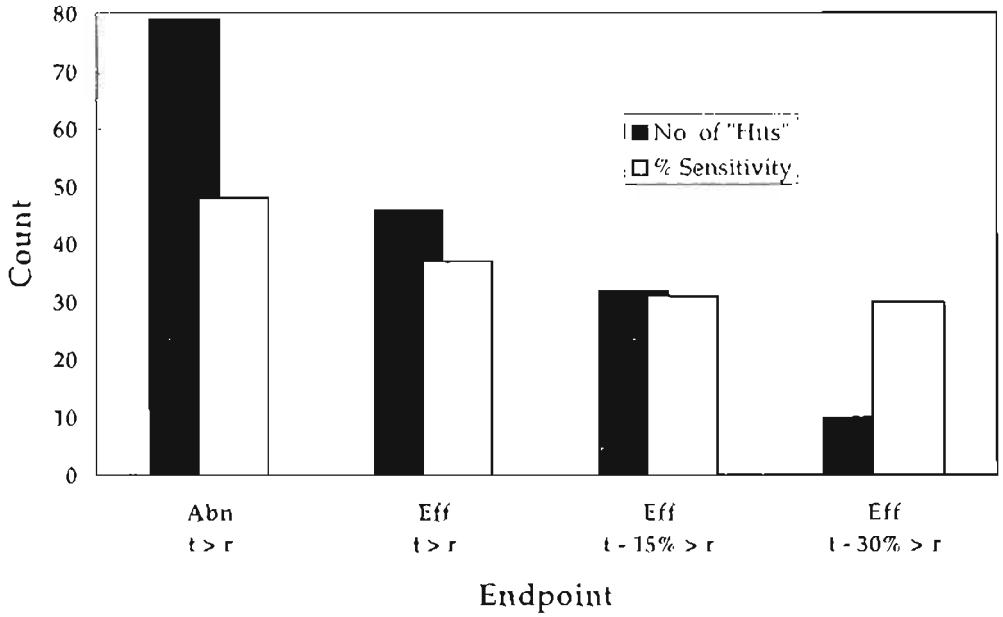
Overhead 26-11

Amphipod Mortality AETs
(organic carbon)



Overhead 26-12

Sensitivity of Echinoderm AETs



Overhead 26-13

Ratio of 1994 Echinoderm to 1988 Oyster AETS

		Normalization	
		Dry Wt.	Organic Carbon
Metals	N	6	—
	Mean Ratio	1.10	—
	Min. Ratio	0.19	—
	Max. Ratio	2.82	—
Organic Compounds	N	27	11
	Mean Ratio	0.60	1.82
	Min. Ratio	0.10	0.13
	Max. Ratio	2.00	3.80

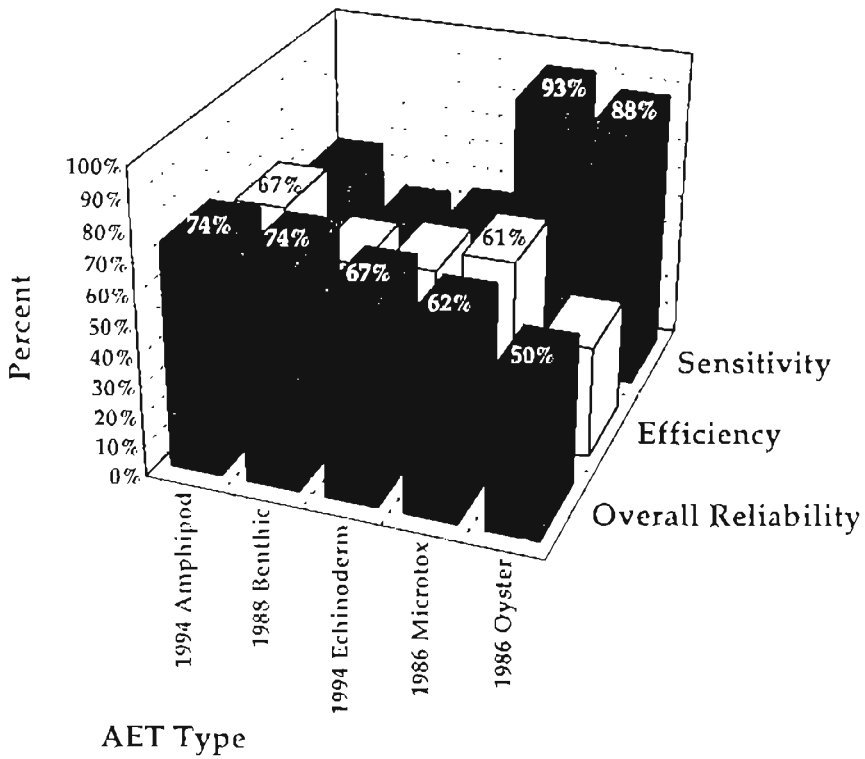
Overhead 26-14

Rank of 1994 AETs Among 5 Puget Sound AETs

AET Rank	Normalization: Dry Weight Increases	Dry Weight Decreases	Organic Carbon Increases	Organic Carbon Decreases
HAET	17	0	10	0
2AET	2	20	6	16
LAET	0	23	0	6

Overhead 26-15

Reliability of Dry Weight Puget Sound AETs



Overhead 26-16

Conclusions

- Many synoptic samples were excluded from 1994 AET calculations because they lacked one or more adequate references
- The 1994 Puget Sound SEDQUAL database has greatly expanded, is more representative?
- Some 1994 amphipod mortality AETs increased from the corresponding 1988 values
- Echinoderm larval AET and reliability values differed when calculated using different endpoints; echinoderm abnormality AETs were most sensitive

Overhead 26-17

Conclusions

- New echinoderm larval abnormality AETs were often lower than corresponding 1986 oyster values
- Among the suite of Puget Sound AET types, many 1994 AET values represent new highest, second lowest and lowest AETs
- The 1994 amphipod and echinoderm AETs relatively insensitive but relatively efficient

Overhead 26-18

Recommendations

- Incorporate the remaining peer comments into next draft of Volume I for public review
- Obtain public comments and finalize Volume I
- Convene the Regulatory Work Group (RWG)
- Conduct the technical and policy analyses recommended by the RWG
- Prepare draft and final Volume II

Overhead 26-19

Volume II Objectives

1. Document the PSDDA process for re-evaluating MLs and SLs which are based on AETs
2. Complete the analysis of reliability for the 1994 suite of Puget Sound AETs and PSDDA ML/SL guidelines
3. Assess the potential implications of new ML/SL values on dredging activities and the PSDDA program

Overhead 26-20

Recommendations

- Propose adoption of new PSDDA MLs and SLs, based in part on RWG recommendations

INITIAL ACCREDITATION REQUIREMENTS

Chemical Methods

for

Sediment Analyses

Overhead 27-1

Be Accredited for the Analogous Water Method

For example -

For semivolatile organics, the lab must be accredited for extractable organics in water by EPA Method 625, 8250 or 8270.

Overhead 27-2

Submit SOP Used by Lab

- The Standard Operating Procedure (SOP) should:
  - (1) describe in detail the procedure used
  - (2) include any modification to the method requested for accreditation.

- The QA Section will review the SOP and either approve or make recommendations for SOP improvement.

Analyze an Appropriate SRM

- Submit SRM results and data package for review and approval by the Quality Assurance Section.

- If a SRM is not available, submit a data package for environmental samples analyzed using the method.

SRM Analysis and Data Packages Requirements for Initial Accreditation

Method	Parameter	Requirement
EPA 8270	Extractable Organics	Analyze NIST* SRM 1941 (or 1941a). Submit data package.
EPA 8310	Polycyclic Aromatic Hydrocarbons (PAH)	Same as above.
EPA 8080	Pesticides	Same as above.
EPA 8010, 8020, 8240, 8260	Volatile Organics	Analyze environmental sample and submit data package for each method.
All	Trace Metals	Analyze NIST* SRM 1646 (or 1646a) and 2704. Submit data package for each method.

*NIST - National Institute of Standards and Technology

Overhead 27-5

On-Site System Audit

Undergo a successful on-site system audit of the lab's capability to analyze sediments by the methods requested for accreditation.

Overhead 27-6

ANNUAL REQUIREMENTS FOR MAINTAINING ACCREDITATION

Chemical Methods
for
Sediment Analyses

Overhead 27-7

Annual Requirements for Maintaining Sediment Accreditation

Method	Parameter	Requirement
EPA 8270	Extractable Organics	Analyze NIST* SRM 1941 (or 1941a). Submit report of results.
EPA 8310	Polycyclic Aromatic Hydrocarbons (PAH)	Same as above
EPA 8080	Pesticides	Same as above
EPA 8010, 8020, 8240, 8260	Volatile Organics	Analyze environmental sample; submit data package for each method requested.
All	Trace Metals	Analyze NIST* SRM 1646 (or 1646a) and 2704. Submit report of results for each method.

NIST - National Institute of Standards and Technology

These requirements are subject to change each year; requirements listed are for 1995.
Complete data package need not be submitted, but must be available for review during on-site audits.

Overhead 27-8

ACCREDITATION REQUIREMENTS FOR TOXICITY METHODS

Accreditation is based on on-site evaluation

SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING
MAY 1995

NATIONAL AND REGIONAL ISSUES UPDATE

NATIONAL

Sediment Quality Criteria:
- EPA workgroups formed to develop "Users Manual"
- Final Rule for 5 draft criteria - NST Spring 1996

Final Rule "Reference Sediment"

Inland Testing Manual
- Comments on Draft being addressed by Workgroup
- Final will closely follow final rule for "Reference Sediment"

National QA/QC Manual for Chemical Analysis
- Release coincident with or closely following ITM

Site Management Plan guidance (per WRDA 92)
- Being developed
- Schedule: Soon (this year?)

Site Management and Monitoring Manual
- Internal draft - temporarily on hold
- Schedule: Later (after Site Management Plan guidance)

Ocean Dumping Regulations Revisions
- EPA-Corps Discussions
- Schedule: draft this fall/winter

MARAD Report on Dredging Process
- Public release: January 1995
- EPA and Corps developing guidance to form
  - National Dredging Team
  - Regional Dredging Team

SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING
MAY 1995

NATIONAL - continued

ISSUE *DU JOUR*: BIOACCUMULATION
- Who?
- What?
- Why?
- How?
- So What?

Sept. 94: "National" Experts Meeting sponsored by Region I

Feb. 95: "National" Experts Meeting sponsored by Region II and EPA ORD

Aug. 95: National Workshop sponsored by EPA/COE focussing on dredged material (Denver)

Fall 95: National Bioaccumulation Conference sponsored by EPA (Chicago)

SEDIMENT MANAGEMENT ANNUAL REVIEW MEETING
MAY 1995

REGIONAL

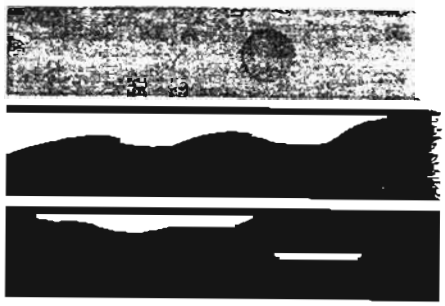
Regional Manuals/Programs
- Inland Testing Manual, MARAD, WRDA, etc.

Columbia River (Stephanie Sterling)
Grays Harbor & Willapa Bay Special Study Implementation (Steve Babcock)

Interagency/-governmental Agreement on Coordinated Sediment Management Program (May 94)
- Sediment Cleanup Workgroup (Rachel Friedman-Thomas)

- Beneficial Uses Workgroup
  Chaired by EPA (Justine Barton)
  Has met once.

- Multi-User Disposal Site(s) (MUDS) Workgroup
  Corps lead (Steve Babcock)
  Following Civil Works project procedure
    Reconnaissance Report (Nov 95/Jan 96)
    Feasibility Study (mid-96)



Sediment Cleanup Work Group Recommendations

PSDDA/SMS Joint Issue Paper

presented by
Rachel Friedman-Thomas
Department of Ecology

Interagency/Intergovernmental Agreement

- **Coordinated and cooperative program to address sediment management issues**
- **Signed by five agencies in May 1994**
- **Initial Joint Actions: Sediment Cleanup Strategy, Action Plan for Multiuser Confined Disposal Site(s), Policies for Beneficial Use of Dredged Material**

Sediment Cleanup Work Group

- Convened in July 1994 to develop a sediment cleanup strategy
- Focused on accomplishing cleanup within existing systems and with existing tools
- Composed of representatives of tribes, industry, environmental groups, ports, federal, state and local governments
- Charged to address four issues regarding management of contaminated sediments

Overhead 29-3

Work Group Charges

1. How can agencies facilitate sediment cleanup under the existing legal framework?
2. What should be the strategy for urban sediment cleanups?
3. What about agency roles, and possible funding sources to participate in sediment cleanup?
4. What are some possibilities for changing the legal scheme for cleanup of contaminated sediments?

Overhead 29-4

Consensus Recommendations

① The top priority is to manage sediment loading to prevent contamination and recontamination of sediments.

② All five agencies must work cooperatively and in a coordinated fashion on sediment cleanup issues.

③ Separate, ranked, and prioritized sediment site lists for each major bay in Puget Sound should be immediately established.

Overhead 29-5

Consensus Recommendations Cont'd

④ Agencies should institute a baywide approach to source control, sediment cleanup, dredging/disposal, and habitat restoration.

⑤ Agencies should focus on "hotspot" cleanups to accelerate cleanup at the worst sites.

⑥ Barriers should be reduced and incentives should be provided for voluntary cleanups.

⑦ Agencies should see that a multi-user disposal site(s) is built.

Overhead 29-6

Proposed Strategic Direction for Sediment Cleanup

- ✯ Interagency progress report drafted
- ✯ Addressed the recommendations directly and as part of a broader, more comprehensive approach
- ✯ Objectives: choose a limited number of initiatives and complete them on schedule, and carry out a coordinated interagency approach to cleanup and construction projects based on clear guidance
- ✯ Two phased approach proposed

GRAYS HARBOR AND WILLAPA BAY DREDGED DISPOSAL ANALYSIS

GOAL: PUBLICLY ACCEPTABLE GUIDELINES GOVERNING ENVIRONMENTALLY SAFE DISPOSAL OF DREDGED MATERIAL

Sediment Management Annual Review Meeting (SMARM)
May 3-4, 1995
Steven Babcock, Study Manager
Corps of Engineers (206) 764-3651

A COOPERATIVE FEDERAL - STATE EFFORT

- FOUR AGENCY TECHNICAL STEERING COMMITTEE
  - Corps of Engineers, Seattle District
  - Environmental Protection Agency, Region 10
  - Department of Ecology
  - Department of Natural Resources
  -
- PARTICIPATION BY OTHER INTERESTED PARTIES
  - Other federal, state, local agencies
  - Ports
  - Indian tribes
  - Industry and special interest groups

PROGRAM OBJECTIVES

- Consistent and objective evaluation procedures
- Focus primarily on unconfined, open-water disposal and beneficial uses
- Utilize existing designated multi-user estuarine and ocean disposal sites
- Document appropriate disposal site management considerations
- Assure consistency with applicable federal and state laws, regulations, and guidelines
- Public review and updating of program elements via SMARM

STUDY FRAMEWORK

- DEVELOPMENT OF CONSISTENT AND OBJECTIVE EVALUATION PROCEDURES
  - Sampling and analysis requirements
  - Tier I evaluation - site history
  - Tier II chemical testing
  - Tier III biological testing
  - Tier IV evaluation (special, non-routine)
  - Procedures for suitability determinations
- DEVELOPMENT OF DISPOSAL SITE MANAGEMENT PLANS
  - Permits for site use
  - Permit compliance inspection
  - Violations
  - Site monitoring

STATUS

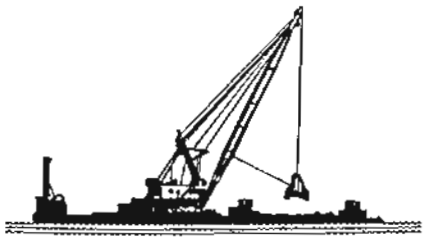
- 1991 - Interagency Study Initiated
- July 1992 - Interim Evaluation Guidelines
- Fall 1994 - Public Review of Draft Manual
- April 1995 - Final Manual to Agency Heads
- May 1995 - Joint EPA/Corps Public Notice
- May 1995 - Program Implementation

Overhead 30-5

US Army Corps of Engineers
Seattle District

DREDGED MATERIAL
EVALUATION PROCEDURES
AND
DISPOSAL SITE MANAGEMENT MANUAL

Grays Harbor and Willapa Bay, Washington



April 1995

EPA
Region 10

Natural Resources

Overhead 30-6

PUGET SOUND MULTI-USER DISPOSAL SITE (MUDS) STUDY

- PSDDA - Interagency effort identified unconfined, open-water disposal sites for relatively clean sediments
- Ecology - Conducted series of studies to identify need for establishing contaminated sediment disposal sites
- PSWQA - Adopted Ecology recommendations into Puget Sound Water Quality Management Plan, directing development of an Action Plan
- IAG - PSDDA agencies, plus PSWQA, signed an interagency agreement May 2, 1994 to address sediment management issues
- TODAY - Major interagency MUDS study now underway

Sediment Management Annual Review Meeting (SMARM)
May 3-4, 1995
Steven Babcock, Study Manager
Corps of Engineers (206) 764-3661

PRINCIPAL PARTICIPATING AGENCIES

- Corps of Engineers, Seattle District
- Environmental Protection Agency, Region 10
- Department of Ecology
- Department of Natural Resources
- Puget Sound Water Quality Authority
- Washington Public Ports Association

ACTION PLAN ELEMENTS

- Disposal siting process
- Site liability management
- Institutional site management
- Stakeholder and public participation
- Funding sources and mechanisms for planning, siting, construction, and operation

CORPS OF ENGINEERS STUDY

- Reconnaissance Phase
  - Congressionally authorized and federally funded
  - Reconnaissance Report (November 1995)
  - Project Study Plan (November 1995)
  - Feasibility Study Cost Sharing Agreement (Sign - 1996)
- Feasibility Phase
  - Cost shared 50-50 between Corps and non-federal sponsor
  - Would begin in 1996, subject to approval and funding

RECONNAISSANCE STUDY

- Identify federal and non-federal interest in follow-on feasibility study
- Define the siting process and related issues
- Identify needed siting studies and cost
- Develop agreement for follow-on cost shared feasibility study

APPENDIX D

Final Clarification Papers

CLARIFICATION PAPER (FINAL - 20 JULY 1995)

IN-BATCH TESTING FOR REFERENCE SEDIMENTS FOR PSDDA BIOASSAYS

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

INTRODUCTION

Reference sediments are collected from appropriate reference collection areas (i.e., removed from sources of contamination) and are similar in grain size characteristics to the material tested from the dredging area. The primary purpose of the reference is to determine the response of the bioassay organisms to sediments with physical characteristics similar to the proposed dredged material as a point of comparison for test responses. The reference sediment is compared directly with the test sediment response using a student t-test to evaluate whether there is a statistically significant difference in response. Any subtle difference in test conditions (e.g., temperature, dissolved oxygen, salinity, etc.) can influence the test outcome. For this reason, control and reference sediments should all be run within the same batch as the sediment being evaluated from any given dredging area. This will ensure that environmental conditions during the exposure period are similar for all exposures within any given batch. The PSDDA program clarified in-batch testing as a requirement for the saline Microtox bioassay at the second annual review meeting held in April 1990.

PROBLEM IDENTIFICATION

It has recently come to light that laboratories conducting PSDDA bioassays were unsure whether or not in-batch testing of reference sediment and test sediment is necessary to meet PSDDA program QA/QC requirements for the amphipod bioassay, sediment larval bioassay, and the 20-day *Neanthes* growth bioassay. The current PSEP (Puget Sound Estuary Program) bioassay protocols under revision do not explicitly state that in-batch testing of the above mentioned bioassays is required. The PSDDA program has consistently required in-batch analysis of test and appropriate reference sediments for all bioassays. This is necessary to ensure that reference sediments and test sediments are exposed to the same test conditions through the exposure period.

PROPOSED ACTION/MODIFICATION

This clarification is provided to specifically confirm that in-batch testing of test sediments and an appropriate reference sediment is required for all PSDDA bioassays. Statistical comparisons of reference and test sediment must be within batch. Failure to conduct in-batch testing of reference and test sediments may result in a requirement to retest as a quality control failure.

REFERENCES

PSDDA ARM. 1990. Second Annual Review Meeting Minutes. Prepared by the PSDDA agencies.

CLARIFICATION PAPER (FINAL - 20 JULY 1995)

INTERIM GROWTH RATE AND MORTALITY GUIDELINES FOR THE *NEANTHES* 20-DAY GROWTH BIOASSAY

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

INTRODUCTION

Reference and control performance standards are used to ensure the validity of bioassay test results. It is in the interest of the PSDDA agencies and SMS to be responsive to research indicating that performance standards may be modified to increase the real-world effectiveness of bioassays. *Neanthes arenaceodentata* 20-day growth test performance guidelines were clarified at the 1993 PSDDA Annual Review Meeting (Fox, 1993). This paper further clarifies *Neanthes* performance guidelines.

The PSDDA disposal site management guidelines allow "minor adverse effects, due to chemicals of concern in dredged material, on biological resources" at the disposal site (EPTA, 1988). The biological effects interpretative guideline fitting this definition is as follows: "Minor effects are defined as potential chronic sublethal effects, but no significant acute toxicity within the site, or its dilution zone." The same interpretative guidelines apply to dredged material characterized for unconfined open-water disposal.

In 1992, the *Neanthes* 20-day growth bioassay replaced the 10-day mortality test for use in the PSDDA program to assess toxic and chronic sublethal effects of sediments proposed for dredging and open-water disposal. The test is also approved under SMS. At the 1994 PSDDA Annual Review Meeting the endpoint for this bioassay was changed from biomass to growth (expressed in mg/dry weight/individual/day) (Kendall, 1994). Growth is a biologically important sublethal endpoint and is related to many other physiological functions of the polychaete worm. Worm mortality in this test is an expression of acute toxicity relating to contaminated sediments. When acute mortality is expressed, it can be assumed that the chronic sublethal performance endpoint has been affected and may no longer be valid.

PROBLEM IDENTIFICATION

Research accomplished by Johns and Ginn (1990) and the US Army Corps of Engineers, Waterways Experiment Station (Moore and Dillon, 1993) showed a relationship between growth rate and reproductive success for *Neanthes arenaceodentata*. The conclusions of the Corps research were that an individual somatic growth rate of $\geq$0.65 mg/ind/day resulted in no significant effects on survival or reproduction, and the authors suggest that this level can be used in interpreting the results of chronic sublethal sediment bioassays using *Neanthes*. Moore and Dillon also found that somatic growth rates below 0.45 mg/ind/day were associated with significantly reduced reproductive success.

In addition to the growth endpoint, a level of acceptable mortality in the bioassay control and reference is desirable to ensure adequate test performance. Mortality can be an indicator of contaminant effects, and can affect growth test results (dead worms provide an additional food source for survivors, etc.). We do not expect that a clarification of the *Neanthes* procedure quality guidelines will impact the amount of dredged material that qualifies for open-water disposal. The performance of the bioassay itself requires examination in light of new information linking chronic sublethal effects with individual somatic growth rate.

PROPOSED ACTION/MODIFICATION

A tiered approach is proposed to assess *Neanthes* 20-day growth bioassay results. First, worm mortality will be examined. The control mortality performance standard of 10% is reaffirmed, and a reference mortality performance guideline of 20% is proposed. If these guidelines are met, test mortality will be compared to reference mortality using a pairwise student's t-test to assess significance ($p \leq 0.05$).

Following examination of mortality, the *Neanthes* individual somatic growth rate endpoint will be evaluated. A bioassay minimum control performance guideline for individual growth rates $\geq$0.72 mg/ind/day is proposed. In cases when the interim performance standard is exceeded, the PSDDA agencies will use best professional judgment to evaluate the acceptability of the data for regulatory decision-making. In combination with the required initial worm size of 0.5 mg, this proposed guideline will help ensure that the *Neanthes* 20-day growth bioassay performs effectively and accurately.

Neanthes growth rate and mortality data to date in the Dredged Analysis Information System (DAIS) database (20 surveys total) were examined for control and reference sediments to determine if they met the proposed growth guidelines.

Nine surveys did not meet the initial worm size standard of 0.5 mg established at the 1993 PSDDA Annual Review Meeting. Eight of these nine surveys have control and/or reference growth rates below the proposed guidelines. Eleven surveys met the initial worm size standard. Five of these eleven surveys had control and/or reference growth rates below the proposed guidelines, with two of the five only slightly under the guidelines.

Initial worm weight appears to be an important factor in the growth rate of *Neanthes*. Figure 1 shows the mean control and reference growth rates of surveys which did and did not meet the 0.5 mg starting weight criteria implemented in 1993. The mean control growth rate for surveys meeting the initial weight standard is 0.72 $\pm$ 0.34 mg/ind/day (with a reference growth mean of 0.69 $\pm$ 0.27, or 96% of mean control). The control growth rate mean for surveys not meeting the weight standard is 0.38 $\pm$ 0.20 mg/ind/day (reference mean for these surveys is 0.39 $\pm$ 0.19, or 103% of control).

In an interlaboratory comparison and field validation of the *Neanthes* 20-day growth bioassay, Johns, et al (1991), found mean growth rates of 0.79 - 0.83 mg/ind/day, further supporting the proposed guideline growth rate.

Laboratories performing the *Neanthes* 20-day growth bioassay should ensure that their culture and/or supply of test animals is adequate to meet the performance standards in initial weight, and that feeding regimes are consistent with the established protocol to minimize variability in control and reference growth rate.

REFERENCES

1. Fox, David. 1993. "The *Neanthes* 20-day bioassay - Requirements for ammonia/sulfides monitoring and initial weight." Clarification Paper, PSDDA Annual Review Meeting. June 21, 1993.

2. EPTA. 1988. Evaluation Procedures Technical Appendix. Prepared by the PSDDA agencies (Corps, EPA Region 10, Washington Departments of Ecology and Natural Resources.

3. Kendall, David. 1994. "*Neanthes* 20-day bioassay - Interpretation clarifications: Adoption of growth endpoint; stimulatory effect and dispersive interpretation guidelines." Clarification Paper, PSDDA Biennial Report, Dredged Material Management Years 1992/1993. March 1994.

4. Johns, D.M. and T.C. Ginn. 1990. *Neanthes* long term exposure experiment - Relationshiip between juvenile growth and reproductive success. Puget Sound Estuary Program (PSEP 910/9-90-010).

5. Moore, D.W., and T.M Dillon. 1993. "Chronic sublethal effects of San Francisco Bay sediments on the polychaete *Nereis (Neanthes) arenaceodentata*; Interpretative guidance for a growth end point. Miscellaneous Paper D-93-5, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

6. Johns, D.M., J.E. Sexton and T.C. Ginn. 1991. Interlaboratory comparison of Neanthes 20-day sediment bioassay. Prepared by PTI Environmental Services for Washington Department of Ecology, Sediment Management Unit.

Figure 1. Mean *Neanthes* Growth Rates Relative to Starting Weight