PUGET SOUND DREDGED DISPOSAL ANALYSIS (PSDDA):

DREDGED MATERIAL SAMPLING, TESTING, AND DISPOSAL GUIDELINES APPLICATION REPORT

FINAL REPORT

December 1989

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I. INTRODUCTION.

This document constitutes the first annual report prepared by the Seattle District Corps of Engineers according to the 1988 PSDDA/Management Plan Report (MPR) requirements to summarize dredged material sampling, testing, and disposal guidelines results for all projects tested during each dredging year. This report will be used by the Department of Ecology in preparing their Annual Assessment Report, and to focus issues for discussion and resolution at the PSDDA Annual Review Meeting to be held during February each year.

With the completion of the PSDDA Phase I Final Environmental Impact Statement (FEIS) in June 1988 and the filing of the Record of Decision (ROD) in December 1988, implementation of PSDDA commenced in the Phase I area. The Port Gardner Disposal Site was opened on September 30, 1988, followed by Commencement Bay Site on October 1, 1988, and the Elliott Bay site on February 5, 1989. Through the period covered by this report (June 16, 1988 - June 15, 1989) only the Commencement Bay site received dredged material, and that was from a single 7,000 cubic yard project (i.e., Blake Island State Park). Projects tested under the PSDDA Program include Section 404 permit applications, Federal navigation channel maintenance projects, and Federal/non-federal cost-shared Planning Studies. The following section summarizes those projects tested under the PSDDA program by category.

II. PROPOSED DREDGING PROJECTS TESTED DURING 1989 DREDGING YEAR (June 16, 1988 - June 15, 1989).

During the 1989 dredging year, Seattle District Corps of Engineers processed five non-Corps section 404 permit applications for PSDDA disposal. Completion of the Quality Assurance (QA1) review of test data, allowing decisions on the suitability of the dredged material for disposal at a PSDDA openwater unconfined site, were accomplished for only three of the projects. While sampling and testing for the Navy Homeport Project and Manchester Fuel Pier Project were initiated during the 1989 dredging year, data submittal was not completed until October 24, 1989 for the Manchester Fuel Pier Project; whereas the combined PSDDA agency QA1 review/Suitability Decision for the Navy Homeport Project was not completed prior to the June 15,

TABLE 1. PROJECTS TESTED BETWEEN JUNE 16, 1988 AND JUNE 15, 1989*

PROJECT NAME	AREA RANKING	VOLUME TESTED	VOLUME PASSING	PERCENT PASSING	PSDDA DISPOSAL SITE	VOLUME DISPOSED	PERMIT PROCESSING TIME
SEC. 404 PROJECTS:							
Blake Island State Park	LM	7,000 cy	7,000 cy	100%	CB	7,000 cy	45 DAYS
Duwamish Yacht Club	H	17,000 cy	14,000 cy	82%	EB	pending	61 DAYS
Port of Everett: (a)	M	64,600 cy	60,300 cy	93%	PG	pending	pending
(b)	M	3,200 cy	3,200 cy	100%	PG	pending	pending
FEDERAL NAVIGATION PROJECTS:							
Swinomish Channel (Maintenance)	L	93,000 cy	93,000 cy	100%	RS	pending	N/A
PLANNING STUDY:							
Olympia Harbor Navigation Improvement Feasibility Study: (TOTAL FC)**	(LM-H)	(535,185 cy)	(526,185 cy)	(98%)	N/A	N/A	
	LM	424,500 cy	424,500 cy	100%			
	M	55,500 cy	55,500 cy	100%			
	H	55,185 cy	46,185 cy	84%			
TOTAL:		719,985 cy	703,685 cy	98%		7,000 cy	

* Includes only projects with completed QA1 review and Dredged Material Suitability Decision prior to June 15, 1989.
** Summary of Total Project, with breakout of total volumes characterized within each ranked area listed below.

Legend:
Port of Everett (a) Marina: (b) Jetty Island (single permit action)
CB = Commencement Bay
EB = Elliott Bay
PG = Port Gardner
RS = Rosario Straits (anticipated opening December 1989)
N/A = Not Applicable
L = Low
LM = Low-Moderate
M = Moderate
H = High

1989 dredging year cut off date. Therefore, a discussion of the data pertaining to these two projects has not been included in this report; but, will be included in the 1990 Dredging Year Applications Report. Information on the three Section 404 projects tested completing both QA1 reviews and suitability decisions prior to June 15, 1989 is summarized in Table 1.

A single Corps of Engineers navigation maintenance dredging project was tested during the 1989 dredging year. This was for maintenance of the Swinomish Channel. Dredging is expected to take place during the winter of 1990. Information on this project is summarized in Table 1.

Sediment characterization was conducted for the Olympia Harbor Navigation Improvement Feasibility Study. Information on this study is summarized in Table 1. This proposed project would widen the entrance channel and turning basin and would require the dredging and disposal of an estimated 535,185 cubic yards of material from the harbor. The feasibility study and proposed project is being cost shared with the Port of Olympia, and is not expected to go into construction until 1993.

A. Dredging Area Ranking/Sampling and Testing Requirements for Partial and Full characterization.

1. Sampling.

Sampling and analysis requirements under the PSDDA program are fully explained in the 1988 Phase I Evaluation Procedures Technical Appendix (EPTA) and the Management Plan Report (MPR). Under these guidelines the initial appraisal of a proposed dredging project requires a careful examination of all existing sediment quality data within the dredging area to establish an initial area ranking based on a "reason to believe" that chemicals of concern may or may not be in the project area. PSDDA has generally ranked areas based on existing sediment data or awareness that sources of contamination are known to exist, thereby establishing a "reason to believe" that an area is likely to be clean or contaminated. If data are absent, regulatory personnel from the Corps, Department of Ecology, and the Environmental Protection Agency establish an initial ranking that is generally on the conservative side based on guidance contained in the Phase I and Phase II documents (Phase I MPR: page A-6; EPTA: page II-40; Phase II MPR: page A-10). PSDDA guidelines allow for a reconsideration of the initial ranking if the dredger/applicant conducts a Partial Characterization (PC) as described in EPTA (pages II-63 to II-65) to survey surface sediments in the project area for the PSDDA chemicals of concern (COC). If the PC chemistry data support a lower ranking using criteria stipulated in EPTA (pages II-63 to II-65), sampling and analysis requirements for surface and subsurface sampling may be reduced during the Full Characterization (FC) commensurate with

the revised ranking requirements. Of the five projects discussed in this report, only one, the Olympia Harbor Navigation Improvement Feasibility Study conducted a PC for the purposes of evaluating the initial ranking for possible downranking consideration for the Full Characterization (FC).

a. Section 404 Permit Applications. Sampling methods used to date to collect sediment samples varied as shown in Table 2. Diver operated cores were particularly effective, where project dredging depth was relatively shallow (i.e., 4 feet or less) as for the Port of Everett Project. Because of the shallow dredging prism within the Blake Island State Park dredging area, a Van Veen grab was utilized as an effective means of obtaining a single composited sample from the four subsampling areas. A Livingston Core sampler was utilized to remove samples from the seven foot deep dredging prism in the Duwamish Yacht Club project area.

Area rankings established in the Phase I and II documents range from low-moderate to high within the three project areas discussed. Areas ranking high require one sample and one analysis for every four thousand cubic yards for the upper four feet of the dredging cut. The Duwamish Yacht Club Project area was ranked high requiring five uncomposited samples and five analyses to characterize the dredged material. The marina portion of the Port of Everett dredging was ranked moderate. PSDDA evaluation procedures specify collection of one sample for every four thousand cubic yards and one analysis for every sixteen thousand cubic yards for moderate areas, with five composited samples/analyses called for in the marina dredging area. However, a misunderstanding regarding the number of samples recommended by the PSDDA guidelines for moderate concern areas resulted in five discrete samples being collected rather than the seventeen specified using the Phase I MPR sampling guidelines. Discrete analyses provide a more conservative interpretation of chemical test results, where dilution of local "hot spots" areas with other sediments due to compositing, may lower or dilute the high chemistry values. Although, this was a deemed a variation from PSDDA sampling/analysis guidelines, the required number of analyses were performed to characterize the dredged material, and the PSDDA agencies judged the variation to be acceptable with the more conservative discrete evaluation of the dredged material within the project area. The Port of Everett's Snohomish River/Jetty Island dredged material (3,200 cubic yards) was ranked moderate and characterized by one uncomposited sample and analysis (see Table 2). The Blake Island State Park dredging project was ranked low-moderate and four samples were composited for a single analysis (within a low-moderate surface area PSSDA calls for one sample for every eight thousand cubic yards and one analysis for every thirty-two thousand cubic yards). None of the three Section 404 permit projects elected to perform a Partial Characterization for the downranking option.

TABLE 2. PROJECT SAMPLING REQUIREMENTS FOR TESTING UNDER PSDDA GUIDELINES*

PROJECT NAME		AREA RANKING	VOLUME TESTED	SAMPLING EQUIPMENT	# SAMPLES/ CHEM.ANAL.	DREDGING DEPTH	# BIOASSAY ANALYSES	REFERENCE AREA
SEC. 404 PROJECTS:								
Blake Island State Park		LM	7,000	Van Veen Grab	4/1	< 4 ft	0	N/A
Duwamish Yacht Club		H	17,000	Livingston Corer	5/5	< 7 ft	5	Livingston Bay Port Susan
Port of Everett:	(a)	M	64,600	Diver Operated	5/5	< 6 ft	5	None
	(b)	M	3,200	Corer	1/1	< 6 ft	0	
FEDERAL NAVIGATION PROJECTS:								
Swinomish Channel (Maintenance)		L	93,000	Bucket Dredge	12/4	< 6 ft	0	None
PLANNING STUDY:								
Olympia Harbor Navigation Improvement Feasibility Study:	PC	M/H	535,185	Van Veen Grab	9/9	< 4 ft	N/A	N/A
	FC	LM	424,500	Vibracore	53/11	15 ft	1	Sequim Bay
	FC	M	55,500	"	15/4	15 ft	4	" "
	FC	H	55,185	"	14/8	15 ft	8	" "
TOTAL:			719,985		118/48		27	

* includes only projects with Dredged Material Suitability Decision prior to June 15, 1989.

Legend:
Port of Everett (a) Marina: (b) Jetty Island (single permit action)
N/A = Not Applicable
L = Low
LM = Low-Moderate
M = Moderate
H = High
PC = Partial Characterization
FC = Full Characterization

b. Corps Operations and Maintenance Dredging Projects. Sampling for the proposed fiscal year 1990 Swinomish Channel Operations and Maintenance Dredging was accomplished during ongoing maintenance dredging of the channel during the Summer and Fall of 1988. Samples were taken by Corps of Engineers' employees as instructed by the Environmental Resources Section, directly from the bucket of the clamshell dredge. Sampling dredged material directly out of the bucket of a clamshell dredge is not specifically covered in EPTA as an acceptable sampling method. However, the proposed sampling method was fully coordinated with the PSDDA agencies for approval prior to initiating field operations, and was viewed as an acceptable departure from EPTA using best professional judgement (BPJ) in this particular case. In the future, it is anticipated that established sampling protocols/methods (PSEP/EPTA) will be used to collect sediment samples from Federal maintenance dredging areas. This project received a Low area ranking based on Phase II MPR (page A-11) established by past chemical testing data demonstrating the general high quality of the sediments found within the Swinomish Channel. PSDDA guidelines for surface characterization areas ranked low specify collection of one sample for every eight thousand cubic yards and one analysis for every thirty-two thousand cubic yards. To characterize the dredged material (93,000 cubic yards) four composited samples were analyzed, each composited sample consisting of three subsamples collected within the dredging area (Table 2).

c. Planning Studies. Sampling for the Olympia Harbor Navigation Improvement Feasibility Study was conducted in two phases, a PC and a FC. The PC was conducted to provide data to consider the option of down ranking the turning basin from Moderate to Low-Moderate and the entrance channel from High to Low-Moderate for the FC. Samples for PC were collected with a Van-Veen Grab, whereas FC samples were collected with a Vibracore Sampler off the Corps Vessel "Puget". The PC sampling was conducted similarly to the FC except nine single (i.e., uncomposited) samples were obtained from the upper portion of the dredging prism as described in EPTA (pages II-63-65). Results of PC sediment characterization resulted in reranking the entrance channel and turning basin portions of the proposed project. The entrance channel was subdivided into a low-moderate (274,500 cy) and moderate (55,500 cy) rank, whereas the turning basin was reranked into a low-moderate (150,000 cy) and high (55,185 cy) area. Sampling conducted during the FC characterized material throughout the dredging prism (up to 15 feet deep) by collecting a total of 26 vibracore samples within the two areas. Each core sample was separated into 4 foot lengths resulting in 82 subsamples from the entire project area. Table 2 depicts the number of samples and analyses required cumulatively within each ranked area. Samples were composited within the same depth

intervals across stations within each ranked area as specified under the PSDDA sampling and analysis guidelines. A total of 23 composited samples were analyzed during the FC to characterize the proposed dredged material.

2. Chemical Characterization.

Chemical analyses performed for the three Section 404 permit applications, Swinomish Channel maintenance project, and the Olympia Harbor Navigation Improvement Feasibility Study consisted of a total of 12, 4 and 32 analyses respectively. Of the 48 analyses conducted among the five projects, 4 of 48 were found to be unacceptable for unconfined open-water disposal (UCOWD), due to bioassay testing results. Table 3 summarizes the number of chemicals of concern (COC) exceeding PSDDA screening level (SL) and maximum level (ML) guidelines for each project (see Appendix I for Project/station specific chemistry). The number of COC exceeding the (SL + ML)/2 is also noted as a qualitative check on Area Ranking considerations noted in the 1988 Evaluation Procedures Technical Appendix (pages II-64) for Partial Characterization guidelines (see Appendix II for 1988 guidelines and Appendix III for 1989 guidelines relative to maximum observed values). Under these guidelines a High = any COC greater than ML; Moderate = one or more COC greater than (SL + ML)/2 and less than ML; Low-moderate = one or more COC greater than SL and less than (SL + ML)/2; Low = all COC below SL. Data summarized support a low ranking for both the Blake Island State Park and the Swinomish Channel maintenance dredging projects for future sediment characterization (note that there are no exceedences of the 1989 Nickel SL). Additionally, the chemistry data for the Port of Everett Marina project generally supported a low-moderate ranking. However, failure to achieve PSDDA required detection limits for 10 of the 58 COC evaluated, suggest caution in reranking this area for future characterization.

The chemistry results clearly demonstrate that the Duwamish Yacht Club dredging area is a High concern area, and will remain so for the foreseeable future. Chemical characterization generally showed that 22 COC exceeded the SL and 2 exceeded the ML. Those exceeding the ML were Nickel (155 ppm) and Benzoic Acid (1100 ppb); both occurring at the same station proximal to a METRO combined sewer overflow (CSO). Two of the five samples tested were found unacceptable for unconfined open-water disposal (UCOWD), and accounted for 3,000 cy of material near the METRO (CSO) and boat ramp area (Appendix I).

Lastly, results from the FC for the Olympia Harbor Navigation Improvement Feasibility Study generally supported a Low-Moderate area ranking for future dredged material testing. However, some elevated chemicals were noted during the PC within the uncomposited samples collected within the surface sediment layer. The highest chemical noted was 4-methylphenol, where a

TABLE 3. PROJECT SPECIFIC SUMMARY OF CHEMISTRY EXCEEDENCES OF PSDDA GUIDELINES*

PROJECT NAME		AREA RANKING	TOTAL # ANALYSES	# CHEM. > SL	# CHEM. > BT**	# CHEM. > ML	# CHEM. > (SL+ML)/2	# CHEM. UND > SL
SEC. 404 PROJECTS:								
Blake Island State Park		LM	1	1#	1	0	0	0
Duwamish Yacht Club		H	5	22	1	2	3	12
Port of Everett (a + b)		M	6	11	1	0	0	10
FEDERAL NAVIGATION PROJECTS:								
Swinomish Channel (Maintenance)		L	4	0	0	0	0	0
PLANNING STUDY:								
Olympia Harbor Navigation Improvement Feasibility Study:	PC	M/H	9	9	0	1	1	0
	FC	LM-H	23	8	1	0	0	0

Legend:
Port of Everett (a) Marina; and (b) Jetty Island (Single permit action)
PC = Partial Characterization
FC = Full Characterization
SL = Screening Level
BT = Bioaccumulation Trigger Value
ML = Maximum Level
UND = Undetected
L = Low
LM = Low-Moderate
M = Moderate
H = High

* Numbers depicted represent total number relative to COC list (n = 60).

** The only BT exceedence was for Nickel using 1988 BT (43 ppm). There were no exceedences of 1989 Nickel BT (504 ppm)

\# Exceedence of 1988 SL for Nickel, no exceedence of 1989 SL (140 ppm).

single analysis in the PC exceeded the ML (117 percent) and approached it in another sample (92 percent) from the south end of the turning basin (this area subsequently ranked "high" for FC); but, subsequent analyses of project sediments during FC failed to document a problem with this chemical in uncomposited samples. The differences noted in analyses conducted during PC and FC from the south end of the turning basin surface sediment layer suggest caution in reranking at this time.

Noteworthy is that Nickel exceedences of the 1988 SL and the 1988 Bioaccumulation Trigger (BT) have been documented throughout Puget Sound, including Reference Areas, and are due to high crustal abundances of this metal. Re-evaluations of the sediment quality values (PTI, 1988b) supported eliminating the ML for Nickel (see Phase II MPR, page 5-6) and raising the SL to 140 ppm and BT to 504 ppm. With the current revised Nickel guidelines, the 48 analyses would have resulted in only one exceedence of the SL and no exceedence of the BT for all 48 analyses. Because of the universally high values documented throughout Puget Sound, the PSDDA agencies exercised best professional judgement (BPJ) during the dredged material suitability decisions for each project on a case by case basis for Nickel, and set aside Nickel SL and BT values.

On the whole SL was exceeded in 32 out of 48 analyses among all five projects, including samples of Sequim Bay Reference sediment and West Beach Control sediment tested for the Olympia Harbor Project (not included in project specific test data summary). The 1988 bioaccumulation trigger (BT) for Nickel was exceeded in 11 analyses among 4 projects (except Swinomish Channel). The maximum Nickel value observed in sediments judged acceptable for PSDDA disposal among the five projects was 69 ppm, well below the current SL value of 140 ppm.

Table 4 generally summarizes the specific 29 COC exceeding the 1988 PSDDA Guidelines for SL, ML, undetected greater than SL, and BT, and Figure 1(a-i) illustrate the highest concentration observed for each COC among the five projects totaling 48 analyses. The data illustrate that the COC were generally well below the ML for 57 of the 60 COC (i.e., 58 COC + total LPAH and HPAH), except for Nickel (previously noted), Benzoic Acid, and 4-methylphenol. Problem chemicals generally observed were metals (i.e., Antimony, Copper, Nickel, Cadmium, Lead, Mercury, Silver, Zinc), Low PAH's (Polycyclic Aromatic Hydrocarbons), and High PAH's, PCB's, phenols (phenol, 2-methylphenol, 4-methylphenol), miscellaneous extractables (Benzyl alcohol, Benzoic acid, Dibenzofuran), and dimethylphtalate.

Failure to achieve PSDDA required detection limits at the SL level were noted for two of the three Section 404 permit projects (Table 3). Those chemicals undetected above the PSDDA SL are noted in Table 4. For those two projects, the regulatory

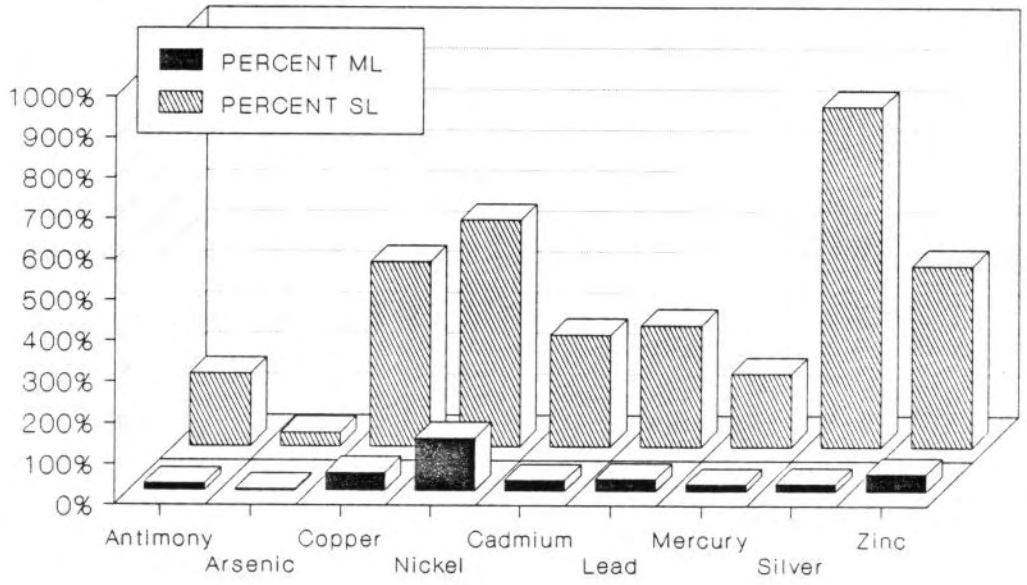
TABLE 4. PSDDA TESTING - CHEMICAL ANALYSES SUMMARY*

CHEMICAL	TOTAL # D > SL	PROJECT freq	TOTAL # D > ML	TOTAL # U > SL**	PROJECT freq	TOTAL # D > BT**	PROJECT freq
METALS:							
Antimony	2	1					
Copper	8	3					
Nickel***	32	5	1			11	4
Cadmium	22	2					
Lead	2	1					
Mercury	7	1		5	1		
Zinc	3	1					
ORGANIC CHEMICALS							
Phenol	2	1					
2-Methyphenol	2	1		11	2		
4-Methylphenol	9	2	1				
2-4-Dimethylphenol				11	2		
Pentachlorophenal				8	2		
Naphthalene	1	1					
Anthracene	1	1					
Acenaphthene	2	2					
Fluorene	2	2					
Phenanthrene	5	2					
LPAH (total)	3	2					
Chrysene	1	1					
Benzofluoranthenes	2	1					
Ideno(1,2,3-c,d)pyrene	5	1					
Dibenzo(a,h)anthracene	3	1					
Fluoranthene	3	1					
Pyrene	7	3					
HPAH (total)	7	3					
Benzyl Alcohol	4	1		11	2		
Benzoic Acid			1	10	2		
Dibenzofuran	2	2					
Hexaclorobutadiene				5	1		
N-Nitrosodiphenylamine				5	2		
Dimethyl Phthalate	2	1					
Diethyl Phthalate	1	1					
1,4-Dichlorobenzene				3	1		
1,2-Dichlorobenzene				7	2		
1,2,4-Trichlorbenzene	1	1		11	2		
Hexachlorobenzene				10	2		
Chlordane				6	1		
PCB's	6	2					
Total # analyses:	48		48	48		48	
Total # Projects:		5			5		5

LEGEND:
# D > SL (number detected > PSDDA Screening Level Value)
# D > ML (number detected > PSDDA Maximum Level Value)
# U > SL (number undetected > PSDDA Screening Level Value)
freq = Number of Projects with observed COC guideline exceedence
# D > BT (number detected > 1988 PSDDA bioaccumulation trigger)

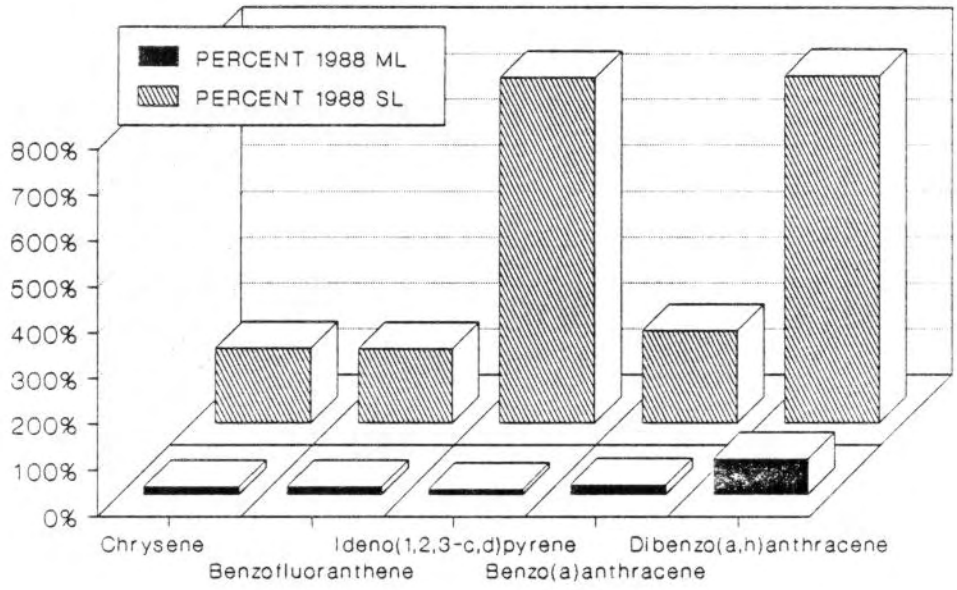
* Sediment Quality Guidelines Values (SL/ML/BT) based on 1988 Evaluation Procedures Technical Appendix.
** Denotes number of exceedences of PSDDA required detection limit for each COC (i.e., > SL).
*** Only one exceedence with current SL (140 ppm) and none with BT (504 ppm)(Phase II Management Plan).

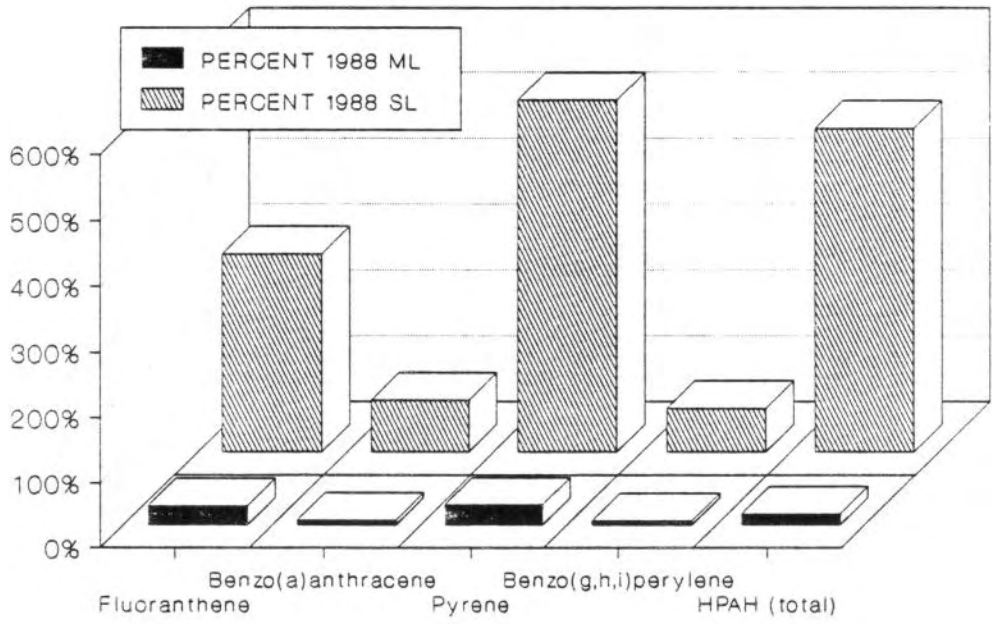
FIGURE 1. PSDDA TESTING: (a) METALS MAXIMUM OBSERVED VALUE*



* 1988 EPTA SL/ML VALUES; 48 ANALYSES

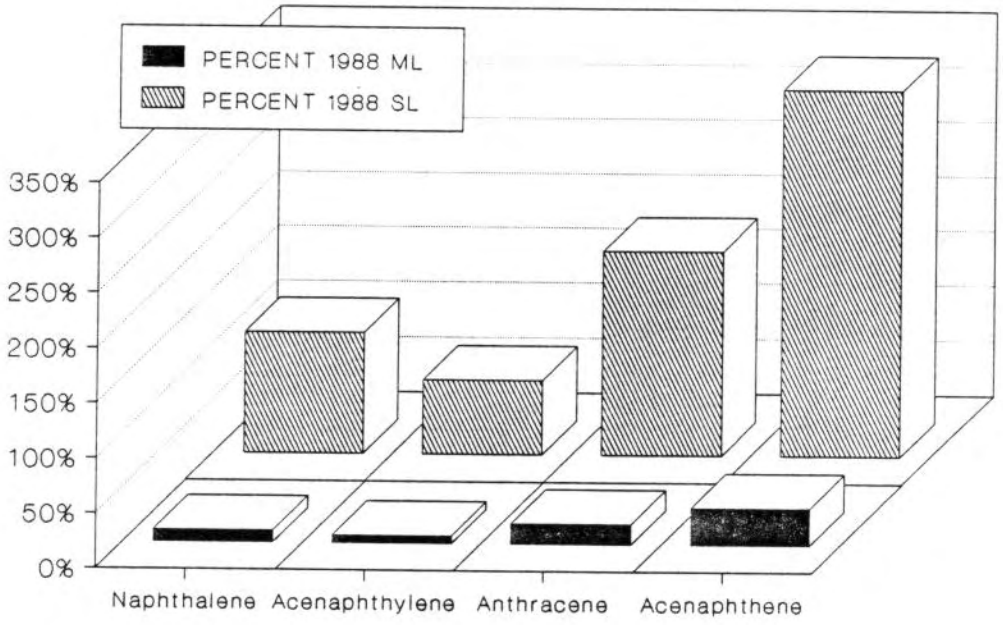
(b) HPAH'S
MAXIMUM OBSERVED VALUE*

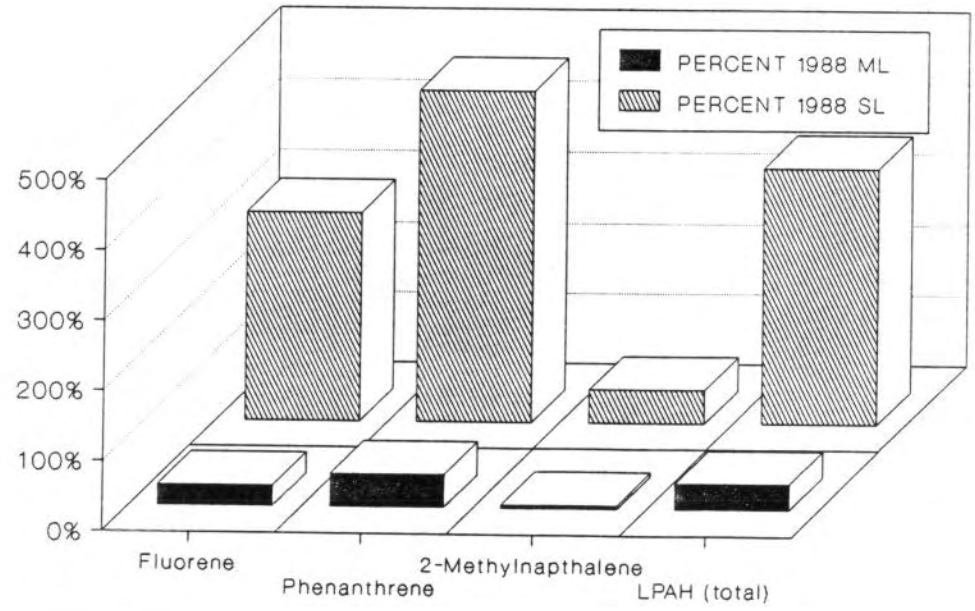




* 48 ANALYSES

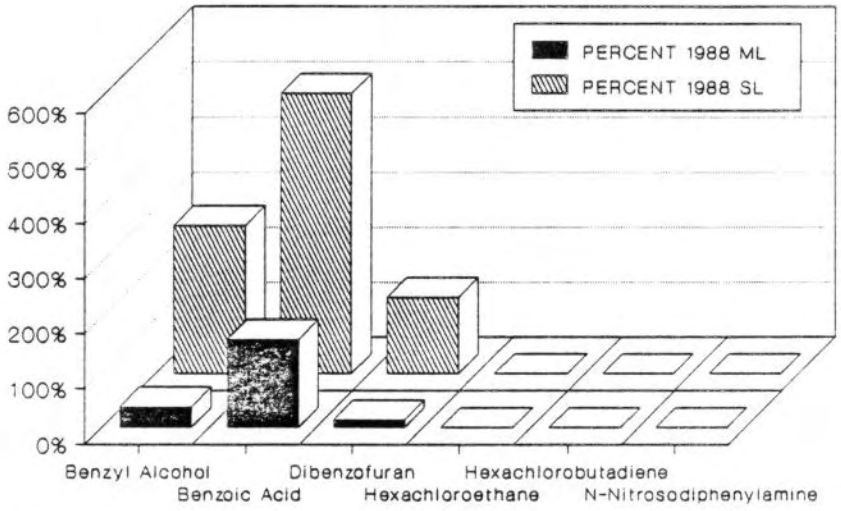
(c) LPAH'S MAXIMUM OBSERVED VALUE*





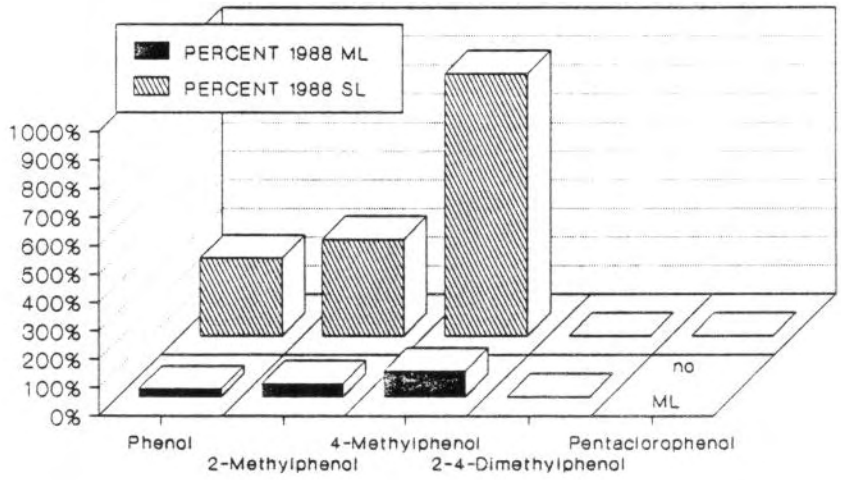
* 48 ANALYSES

(d) MISCELLANEOUS EXTRACTABLES
MAXIMUM OBSERVED VALUE*



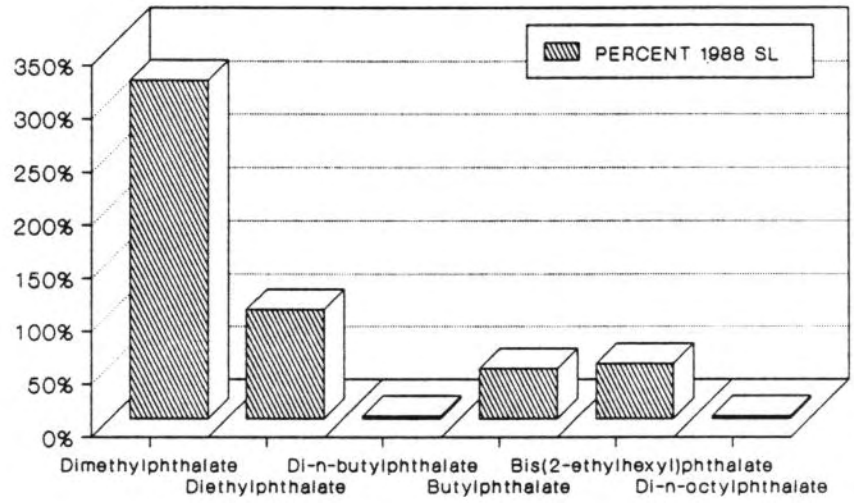
* 48 ANALYSES

(e) PHENOLS
MAXIMUM OBSERVED VALUE*



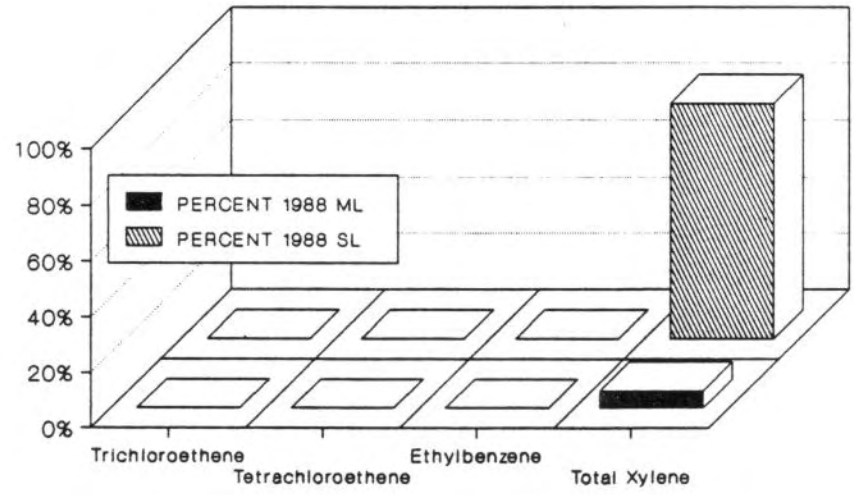
* 48 ANALYSES

(f) PHTHALATES
MAXIMUM OBSERVED VALUES*



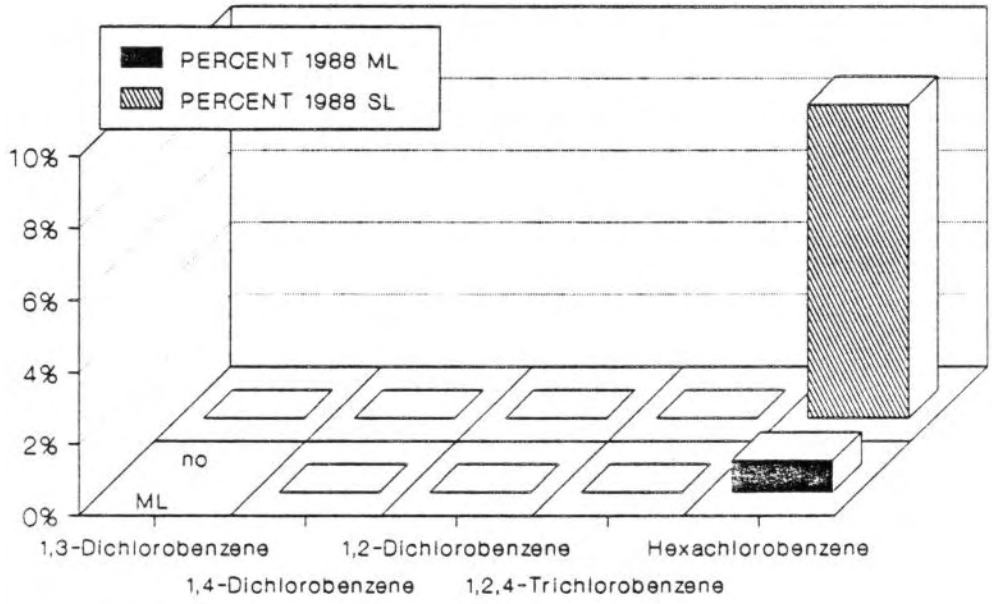
* NO ML VALUES ESTABLISHED; 48 ANALYSES

(g) VOLATILE ORGANICS
MAXIMUM OBSERVED VALUES*



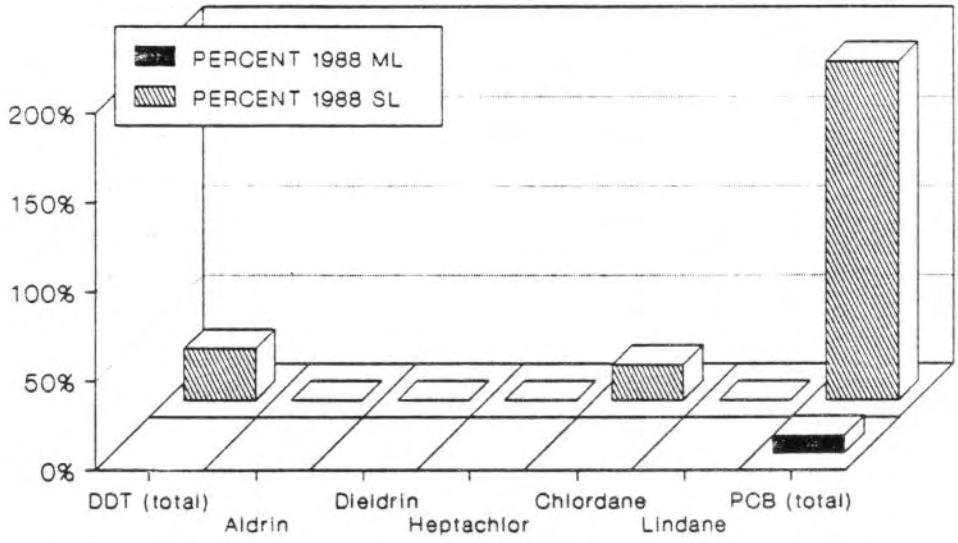
* 48 ANALYSES

(h) CHLORINATED HYDROCARBON MAXIMUM OBSERVED VALUE*



* 48 ANALYSES

(i) PESTICIDES AND PCB'S MAXIMUM OBSERVED VALUE*



* NO ML VALUES ESTABLISHED FOR PESTICIDES; 48 ANALYSES

decision was not impacted because bioassays were run concurrently with chemical analyses for project sediments tested. Initial expectations were that some problems would be experienced by laboratories performing chemical analyses for the first projects to undergo PSDDA testing due to unfamiliarity with PSDDA protocols and the lower detection limits required by the PSDDA program. Although PSDDA strongly recommends use of the Isotope Dilution Technique for organic chemical analyses, laboratories conducting organic chemical analyses for the five projects discussed in this report opted to use modified EPA Contract Lab Program (CLP) methods. These methods were endorsed as acceptable by the 1986 Puget Sound Estuary Program Protocols. The EPA/CLP methods however, may have difficulty in achieving PSEP recommended and PSDDA required detection limits (i.e., < SL) for some of the organic compounds on the PSDDA COC list (see Phase II MPR, pages 5-27-29; Table 5.3).

Another Quality Control problem documented for two of the five projects tested was unacceptably high method blank contamination for several COC. In this case concentrations measured for benzyl alcohol and 2-methylphenol exceeded the PSDDA ML and SL respectively in method blanks. This QA/QC problem has been brought to the attention of the lab involved, and they have taken corrective action to insure that this problem does not reoccur.

3. Biological Testing.

Of the five projects tested under the 1988 PSDDA guidelines, three required biological testing in the form of acute toxicity bioassays to evaluate the suitability of the dredged material for unconfined open-water disposal. PSDDA guidelines called for four acute bioassays for each sample tested. The 1988 bioassays prescribed by PSDDA were the amphipod bioassay, the sediment larvae bioassay, saline extract Microtox bioassay, and the juvenile bivalve bioassay (note: this bioassay is now called the juvenile infaunal bioassay). PSDDA temporarily suspended the requirement to run the juvenile bivalve bioassay during Section 404 evaluations of dredged material using the geoduck, because of documented problems with the test protocol and the general unreliability of the test (see discussion below). Generally, of the three bioassays in use during the early PSDDA implementation period for the Phase I sites (Central Puget Sound), the amphipod bioassay and the saline microtox provided the most consistently reliable tests. These bioassays provided acceptable data for regulatory decisionmaking on the suitability of the dredged material for unconfined open-water disposal. Results from these two bioassays generally compared well with high chemistry results observed from the high ranked Duwamish Yacht Club project area and for one composited sample from the high ranked area within the turning basin for the Olympia Harbor Navigation Improvement Feasibility Study. Dredged material characterized within these

management units failed the PSDDA disposal guidelines for unconfined open-water disposal.

PSDDA initially recommended use of the oyster larvae bioassay as the preferred sediment larvae bioassay, although substitution of either the mussel larvae bioassay or the Echinoderm larvae bioassay was allowed. High control mortalities in the oyster larvae bioassay have routinely been experienced by laboratories over the past year or so, and have resulted in a shift to the Echinoderm embryo bioassay (primarily the Sand Dollar, Dendraster excentricus., and Purple Sea Urchin, Strongylocentrotus purpuratus) by laboratories performing the sediment larval test. Initial attempts at running the Echinoderm embryo bioassay were not successful for either the Duwamish Yacht Club or the Olympia Harbor Navigation Improvement Feasibility Study, due to high mortalities in the reference and control sediments, thereby invalidating the tests for regulatory decision making. Inoculation times recommended in the PSEP protocols for the oyster larvae test (i.e., within 10 seconds) were found to induce high mortalities in the Echinoderm embryo test due to the generally heavier eggs which have a gelatinous coating making them more susceptible to entrainment by suspended fine material. After several attempts to meet PSDDA guidelines for acceptable Control sediment mortalities (i.e., 30 percent) using the PSEP recommended inoculation time for the Duwamish Yacht Club Project, the lab requested and was given permission by the PSDDA agencies to extend the holding time to a maximum of 24 hours. This allowed settlement of the fine material in suspension. However, the control sediment mortalities remained unacceptably high. Therefore, results from this bioassay were invalid and could not be used in the regulatory decision on dredged material suitability. A later section of this report discusses protocol changes for the sediment larvae bioassay, which have been formally instituted through the Phase II MPR to alleviate problems discussed above.

The species initially selected for the juvenile bivalve bioassay was the geoduck (Panope generosa). The protocol for this bioassay however, was not well defined. Results confirmed that it was an unreliable bioassay (PTI, 1988a). PSDDA regulatory agencies, therefore, temporarily suspended the requirement to run this bioassay for Section 404 permit evaluations. Further protocol development with the Geoduck bioassay was initiated during sediment characterization testing for the Olympia Harbor Navigation Improvement Feasibility study. However, results from the geoduck testing of Olympia Harbor Project sediments could not be used for regulatory decision making because of general QA/QC problems. These included poor survival in the control sediment and general problems with the way the test was conducted (control sediment was not run concurrently with the test sediments). Mortalities observed during a test of control sediments, outside

the batch run with test sediments, were 17 percent, which were outside the required 10 percent. PSDDA specifically requires that for all bioassays a control sediment and a reference sediment be run with each batch of sediments tested, to provide "interpretative guidelines". PSDDA mandated performance standards stipulate that control sediment mortality must not exceed 10 percent for the amphipod and juvenile infaunal bioassay and 30 percent for the sediment larvae bioassay (1988 guidelines), whereas reference sediment mortalities must not exceed 20 percent absolute over control sediment values.

Several departures from the PSDDA guidelines occurred in the conduct of bioassays used to assess the Port of Everett project sediments, due largely to the applicant's lack of familiarity with the PSDDA bioassay requirements. First, no reference sediment was run with the test sediments for the amphipod bioassay and the oyster larvae bioassay; so sediment grain size effects could not be taken into account during the test evaluation. Accordingly, the PSDDA agencies used a more conservative interpretation of the results, whereby each test sediment was compared directly with the control sediment (i.e., failure = mortalities greater than 20 percent absolute over control sediment and statistically significant relative to control sediment) rather than comparisons with reference sediment (i.e., <u>double hit failure</u> = two bioassay species exhibiting mortalities greater than 20 percent absolute over control sediment and statistically significant relative to reference; <u>single hit failure</u> = one bioassay species (except Microtox) with mortalities greater than 20 percent absolute over control sediment and greater than or equal to 30 percent absolute over reference sediment and statistically significant relative to reference sediment). In this case the control sediment was treated as the reference sediment during test interpretation, using the control sediment guidelines however. Secondly, the control sediment mortalities for the oyster larvae bioassay were slightly outside the PSDDA recommended guideline of 30 percent mortality (i.e., 32.6 percent and 33.9 percent). Because of the high control mortalities being reported from other laboratories attempting to run this bioassay, the control mortalities and the data were judged acceptable for decision making by the PSDDA regulatory agencies (PSDDA allows for best professional judgement (BPJ) when interpreting bioassay test data (EPTA, page II-106, Phase I MPR, pages A-17 and A-25)). Data from this test however were qualified for reporting purposes as exceeding the PSDDA control limits for the sediment larvae bioassay. It should be noted that PSDDA has currently adopted a 50 percent Seawater Control mortality standard, and relaxed the requirement to run a sediment control for the sediment larvae bioassay (see Phase II MPR).

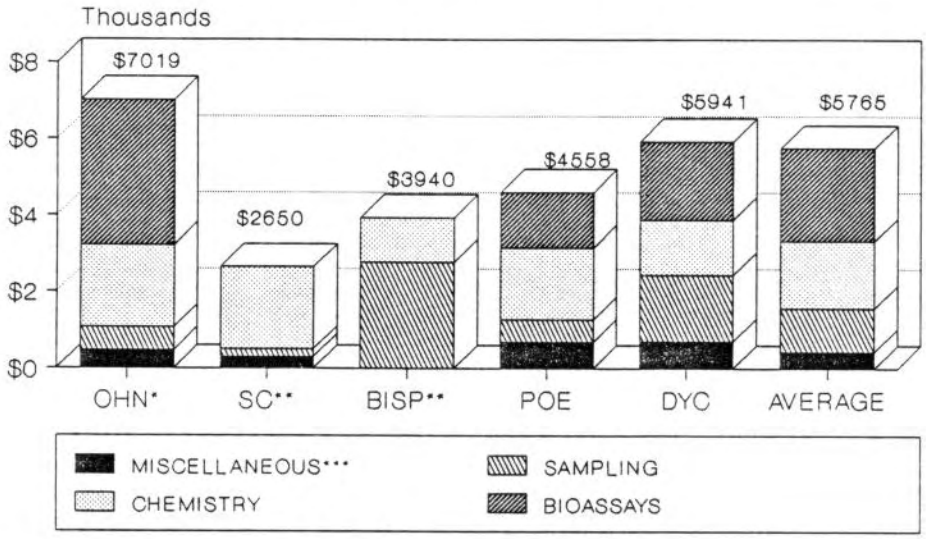
No significant problems were encountered with the saline Microtox bioassays for the three projects requiring bioassay testing. However, problems with the comparisons of dilution series responses of test sediments and reference sediments have necessitated some adjustments to the protocol in order to properly interpret the bioassay responses relative to the PSDDA guidelines. These protocol changes are discussed in a later section. Samples of West Beach control sediment and Sequim Bay reference sediment were tested with the microtox bioassay for the Olympia Harbor Feasibility Study. Results for these bioassays showed an apparent "anomalous" hit for the West Beach control sediment, which did not correspond with chemical test results, showing generally clean sediments.

PSDDA bioassay interpretation utilizes both a "single hit" and a "double hit" failure, whereby the magnitude of the test sediment response observed relative to the control sediment and the reference sediment influences the interpretation outcome (see previous page and Phase I MPR: pages A-2 to A-4; EPTA: page II-114; Phase II MPR: pages A-3 to A-7). Of the three projects tested, the bioassay two hit rule resulted in failure for two out of five sediments tested for the Duwamish Yacht Club Project and one of thirteen tested for the Olympia Harbor Navigation Improvement Feasibility Study. High mortalities observed in the Oyster larvae bioassay (i.e., 83 percent) and significantly higher abnormality relative to the control sediment resulted in the single hit rule failing one of the five sediments tested for the Port of Everett project.

B. Partial And Full Characterization Sampling and Testing Costs. Sampling and testing costs normalized per analysis and unit values are summarized in Figures 2 (a-b) for all five projects, demonstrating a wide disparity in costs between projects. Costs were influenced by the size of the project, area ranking, and the dredging depth. The range in unit costs between projects suggests there is quite a bit of cost variability between labs for the same tests. There is insufficient data at this time to evaluate whether the lower unit costs are also associated with higher QA/QC failures. It is anticipated that the 1990 Dredged Material Sampling, Testing, and Disposal Guidelines Activity Report will examine to a greater extent the relationship between unit sampling/analysis cost and the rate of QA/QC failure. Figures 2 (c-d) show that normalized average testing cost per cubic yard is generally keyed to area rank and project size (including dredging depth because characterization of dredged material below four feet allows greater compositing of material per analysis). These average testing costs ranged between $0.11 per cubic yard and $1.75 per cubic yard, averaging $0.62 per cubic yard. The average cost range is within the sampling and testing cost forecast by the PSDDA agencies of between $0.26 and $1.00 per cubic yard, averaging $0.65 per cubic yard (1988 EPTA, page D-15).

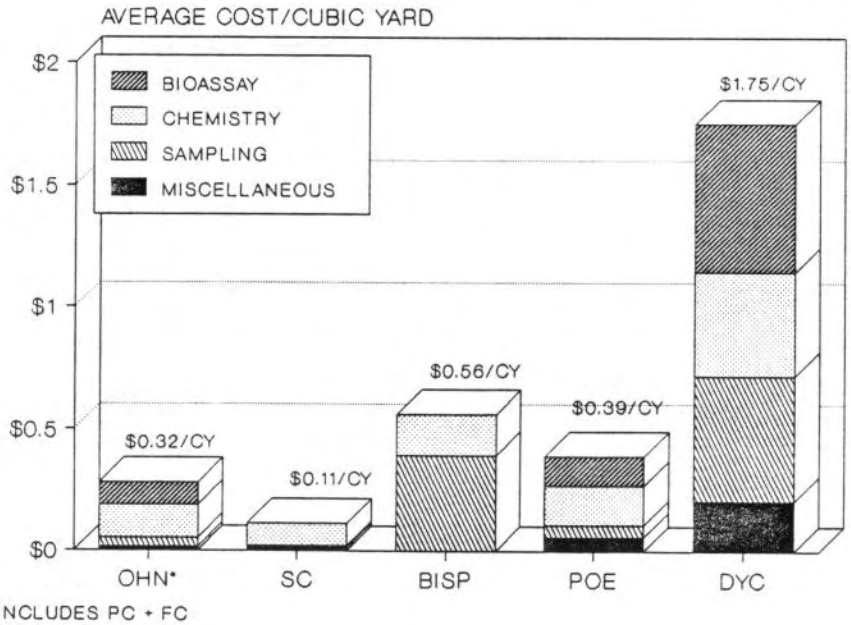
FIGURE 2. PSDDA TESTING COST ANALYSIS

(a) PER ANALYSIS COST



* BIOASSAYS ON 13/23 FC SAMPLES.
** NO BIOASSAYS.
*** REPORT, ETC.

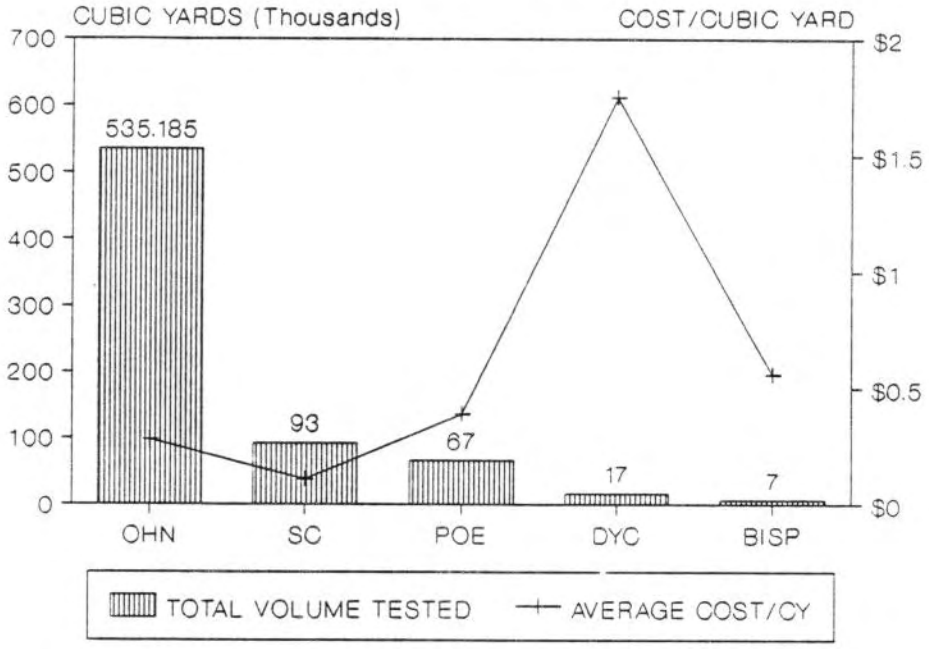
(b) BREAKOUT ON UNIT VOLUME COSTS



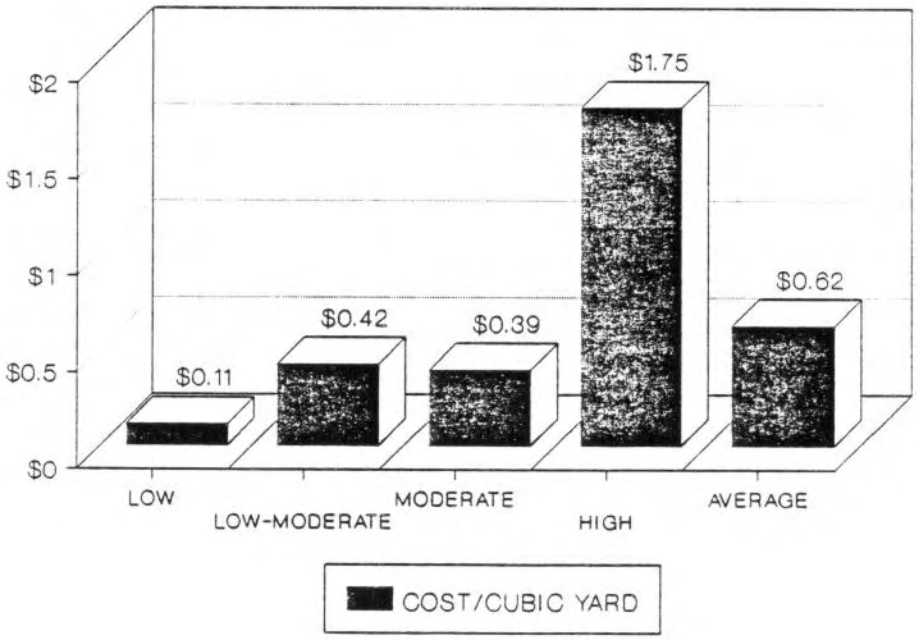
* INCLUDES PC + FC

LEGEND: OHN = Olympia Harbor Navigation Study; SC = Swinomish Channel O&M
BISP = Blake Island State Park; POE = Port of Everett Proj.
DYC = Duwamish Yacht Club Project

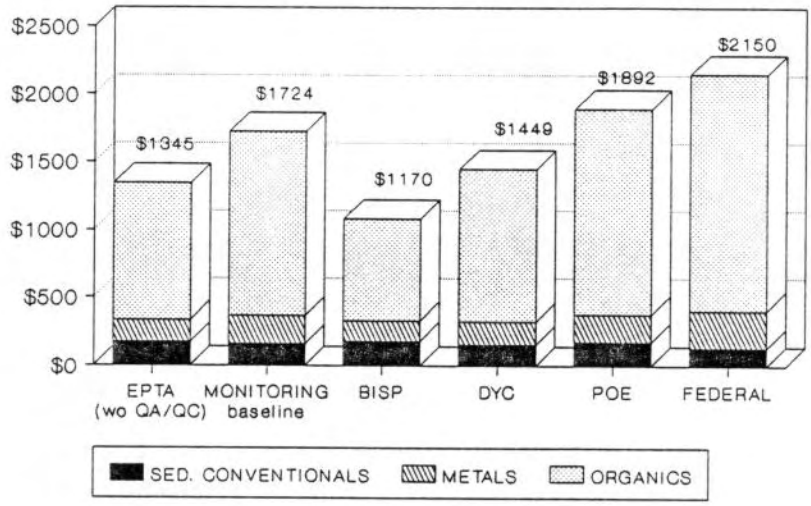
(c) PROJECT SIZE VERSUS UNIT COST



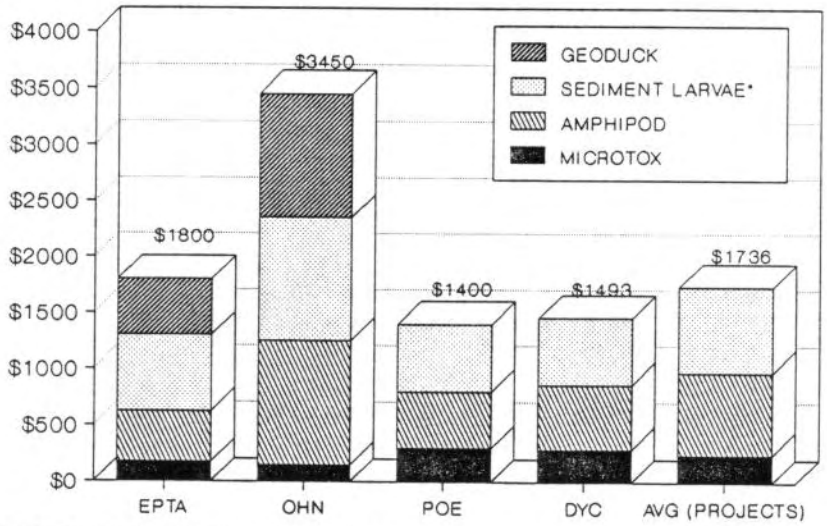
(d) AREA RANK VERSUS UNIT TESTING COSTS



(e) CHEMISTRY COST: UNIT TESTING COST PER ANALYSIS



(f) BIOASSAY COST: UNIT TESTING COST PER ANALYSIS



* OYSTER/MUSSEL/ECHINODERM LARVAE TEST

a. Sampling costs. Comparative unit sampling costs accounted for the largest absolute difference in total costs between projects as depicted in Figures 2 (a-b), ranging from $200 per composited sample for the Swinomish Channel maintenance dredging project to a high of $2770 per composited sample for the Blake Island State Park project. Samples were collected by Corps personnel directly from the dredge for the Swinomish Channel maintenance dredging project resulting in negligible sampling costs, whereas sampling costs accounted for over 70 percent of the total costs normalized per cubic yard for the Blake Island State Park dredging Project. Costs associated with taking core samples appear to be highly variable and dependent on equipment used, the total project size, and dredging prism depth.

b. Chemical testing costs. The total costs for conducting chemical analyses on sediments for the 6 sediment conventional parameters (i.e., Total Organic Carbon, Total Volatile Solids, percent solids, grain size, total sulfides, and ammonia), 9 metals and 49 organic chemicals (including total LPAH's and HPAH's) averaged $1505/sample for the three Section 10/404 permit projects and $2150/sample for the two Federal projects (Swinomish Channel Maintenance and Olympia Harbor Navigation Improvement Feasibility Study). These costs included QA/QC. The Evaluation Procedures Technical Appendix (EPTA) estimated a total cost of $1345 (without QA/QC), whereas the unit chemical costs (using isotopic dilution technique) for conducting baseline monitoring analyses at the Phase I disposal sites were $1724/sample. The costs observed among the three Section 404 permitted projects compare very favorably with those projected by PSDDA (1988 EPTA) and costs found for analyzing the baseline monitoring samples. Figure 2(e) shows the per sample costs for sediment conventionals, metals, and organics relative to PSDDA estimates and actual projects, including baseline monitoring. It demonstrates that sediment conventionals and metals make up a relatively small amount of the costs, whereas organic chemical analyses account for the bulk of the chemical costs.

c. Biological testing costs. Figure 2(f) depicts per sample costs for the PSDDA prescribed bioassays for the three projects tested during the 1989 dredging year, relative to forecasted costs (using 1987 prices) from the Evaluation Procedures Technical Appendix (EPTA). It shows that actual total costs per sample for doing the three PSDDA required bioassays (Microtox, Amphipod, and sediment larvae) averaged $1736/sample, compared with the $1300/sample estimated by EPTA. Actual costs for the three PSDDA required bioassays for the Port of Everett Marina Project totaled $1400/sample, which was slightly higher than the EPTA estimate of $1300/sample. The costs of bioassays were higher for the Olympia Harbor Navigation Improvement Feasibility Study than the other two projects tested. Of the

three PSDDA required bioassays, the saline Microtox test was the lowest in cost ranging between $150 and $300 per test, whereas the amphipod and sediment larvae test varied in cost among the three projects ranging from $500 to $1100 per test.

III. OVERALL ASSESSMENT OF DREDGED MATERIAL MANAGEMENT YEAR'S RESULTS..

A. Area Sediment Quality Trends / Reranking Considerations. Data reviewed during the Fiscal Year 1989 dredging year was not sufficient to fully evaluate general area quality trends or reranking considerations within any given subbasin. It is anticipated, that sufficient data may be forthcoming during the 1990 dredging year to enable an analysis of area quality trends within the Phase I Central Puget Sound areas. However, the data collected generally supported project specific area reranking from "low-moderate" to "low" for the Swinomish Channel Maintenance Dredging area and Blake Island State Park Project area (i.e., all COC less than 1989 SL's). The test results generally supported the assigned "high" rank for the Duwamish Yacht Club Project and "moderate" rank for the Port of Everett Project Marina Project area. The data collected for the Olympia Harbor Navigation Improvement Feasibility Study during the FC generally supported a "low-moderate" ranking in the entrance channel, but data were not spatially expansive enough to consider downranking the turning basin area from moderate to low-moderate. The PC data suggested that there are local "hot spots" of elevated chemistry within the turning basin dredging subarea. Until this area is better defined, the moderate ranking should stand for the turning basin dredging subarea.

B. Sampling and Testing Costs. Costs associated with sampling and testing sediment samples collected for regulatory decisionmaking on dredged material suitability appear to be generally within the cost ranges estimated by PSDDA. Costs are closely related to area ranking, project size and dredging depth, as discussed previously relative to the five projects analyzed under the PSDDA guidelines (see Figures 2(c-d)). Total average costs for sampling and testing on a per sample basis were highly variable, indicating that there is a relatively wide latitude in the costs various laboratories and engineering firms charge for these services (Table 5). There are insufficient data at this time to evaluate cost relative to QA/QC performance to judge whether the higher costs are justified by better quality data. There is a preliminary indication that the higher chemistry analysis costs for the Swinomish Channel maintenance dredging project and Olympia Harbor Navigation Improvement Feasibility Study resulted in data with fewer exceedences of PSDDA detection limits for undetected samples relative to the other projects tested (Table 3).

C. Chemicals greater than PSDDA Guidelines. Table 4 depicts the 29 chemicals exceeding PSDDA guideline values cumulatively for the five projects tested. Appendix II compares the highest concentration observed among the 48 analyses for the five projects with the 1988 PSDDA sediment quality guidelines (i.e., SL, BT, ML). Nickel exceeded the 1988 SL in 32 analyses out of

TABLE 5. SUMMARY OF SOME PROJECT SPECIFIC SAMPLING AND TESTING COST FACTORS

PROJECT	# CORES	# SAMPLES	# ANALYSES		SAMPLING AND TESTING COST PER SAMPLE	SAMPLING AND TESTING COST PER CUBIC YARD
PORT OF EVERETT MARINA	6	6	6		$4,367	$0.39
BLAKE ISLAND STATE PARK	4	4	1		$3,940	$0.56
DUWAMISH YACHT CLUB	5	5	5		$5,940	$1.75
SWINOMISH CHANNEL O & M	12**	12	4		$2,650	$0.11
OLYMPIA HARBOR STUDY: (PC)	9	9	9		$2,828	
(FC)	26	81	23		$4,988	$0.28 *
TOTAL:	62	117	48	AVRG:	$4,119	$0.62

* COST/CUBIC YARD BASED ON TOTAL PC AND FC COSTS
** SAMPLES TAKEN DIRECTLY FROM BUCKET DREDGE

48 total, but only exceeded the current 1989 SL (140 ppm) once (111 percent)(Appendix III). Of the metals, cadmium, copper, and mercury were notable among the projects tested, and were associated with sediments failing bioassays, although concentrations observed were well below the ML values. High and low molecular weight Polycyclic (polynuclear) Aromatic Hydrocarbons (HPAH's and LPAH's) were generally below SL for most sediments tested, with single exceedences from the Port of Everett Marina and the Olympia Harbor Navigation Improvement Feasibility Study, and all five analyses for the Duwamish Yacht Club. Highest concentrations at the Duwamish Yacht Club were observed in two failed sediments located near a METRO CSO and a boat ramp area (see Appendix I). Among the HPAH's, pyrene was the most common COC exceeding the SL, doing so in 7 out of 48 analyses among the three projects mentioned above. LPAH's exceeded PSDDA SL's in 1 out of 6 analyses at the Port of Everett Marina and in the two failed sediments at the Duwamish Yacht Club, with phenanthrene being the most frequent LPAH observed above SL (5/48 analyses). Organic chemicals exceeding PSDDA ML were 4-methylphenol (117 percent) at one station in the PC at the entrance channel for the Olympia Harbor Study, and Benzoic Acid (159 percent) in one failed sample near the CSO at the Duwamish Yacht Club. Total PCB exceedences of SL were limited among the 48 total analyses to 4 analyses of Duwamish Yacht Club sediments and 2 analyses in PC samples from the south end of the Turning Basin for the Olympia Harbor study.

Failure to achieve PSDDA required detection limits was found to be a problem for two of the three Section 10/404 permit projects tested as shown in Table 3. Achieving detection limits was generally not a problem for metals, except in the case of mercury analyses for the Port of Everett Marina sediment characterization. Twelve organic chemicals on the COC list demonstrated problems in achieving PSDDA detection limits (i.e., concentrations measured as undetected above the PSDDA SL's). Most were previously documented as problem chemicals for achieving PSSDA prescribed limits of detection (LOD) (i.e., the SL's) using EPA Contract Laboratory Program (CLP) and modified CLP methods (see Phase II MPR, pages 5-27 to 5-29)(Table 4). Laboratories are required to achieve LOD's below the SL's for all chemicals on the PSDDA COC list. Many of the organic chemicals on the COC list were undetected for any specific project, with sixteen organic chemicals undetected for all 48 analyses among the five projects (Appendix I), ranging from a low of 20 to a high of 39 (Table 3). Experience to date suggests, that as labs generally become more experienced in conducting PSDDA analyses and detection limit requirements, the number of QA/QC exceedences of detection limits should improve. At the present time, exceedences of PSDDA SL values including detection limits exceeding SL, triggers a requirement to either retest the analyte, or do bioassays.

Potential contamination of method blanks for benzyl alcohol was found to be a problem during sediment characterization analyses conducted for both the Swinomish Channel maintenance dredging and FC for the Olympia Harbor Navigation Improvement Feasibility Study. Method blanks exceeded the ML for Benzyl Alcohol for both projects and reflected a serious QA/QC problem for this analyte. This problem has been brought to the attention of the lab conducting both of these analyses, and corrective action has been taken to prevent a reoccurrence in the future.

Sediment holding times compared with PSEP/PSDDA requirements are summarized in Table 6 for the various chemical analyses conducted for each project. These data show that PSEP/PSDDA holding times were generally complied with except for volatile organics and mercury analyses for the Swinomish Channel and Olympia Harbor PC and FC Feasibility Study.

D. Bioassay performance. In general, the performance of two of the three required bioassays, i.e., the amphipod and saline microtox, was satisfactory and consistently provided data sufficient to make a regulatory decision on the suitability of the dredged material for unconfined open-water disposal. The oyster larvae bioassay provided qualified data (i.e., control mortalities slightly outside limits) sufficient to render a decision on the suitability of the dredged material for the Port of Everett Marina project. The echinoderm embryo bioassay was substituted for the oyster larvae bioassay for the Duwamish Yacht Club and Olympia Harbor Navigation Improvement Feasibility Study, although results from test runs were invalid due to high control sediment mortalities which were outside the PSDDA performance guidelines (i.e, 30 percent). Several problems surfaced during attempts to run the echinoderm embryo bioassay, which resulted in some adjustments and recommended clarifications to procedures to make the test perform satisfactorily. Problems noted were: selecting species outside their normal spawning cycles, test sediment inoculation time constraints with the 1986 PSEP protocol, and high sediment ammonia and total sulfide levels in test sediments, which individually and collectively may influence the test performance. A more complete evaluation of these problems and their resolutions are discussed in a later section dealing with protocol changes (see page 36). After making clarifications and adjustments in the protocol for the echinoderm embryo test, this test now appears to be working properly and recent tests have provided satisfactory and interpretable results. The saline Microtox provided consistently satisfactory results for the three projects tested. Some changes in the protocol were recommended and adopted by PSDDA (Phase II MPR) to allow the appropriate test sediment and reference sediment comparisons required for PSDDA bioassay interpretations. These changes to the protocol are discussed below. Bioassay holding times are depicted in Table 7 for the three projects conducting

TABLE 6. SEDIMENT HOLDING TIMES FOR CHEMICAL ANALYSES*

PROJECT	METALS	ORGANICS		
		SEMIVOLATILES	VOLATILES	PESTICIDES/PCB'S
PSEP/PSDDA REQUIREMENTS:	182/28**	365	14	365
PORT OF EVERETT MARINA	14/15/16	13/14/29	7/9	21/25
DUWAMISH YACHT CLUB	18	19	7/8	9
BLAKE ISLAND STATE PARK	7	9	2	7
SWINOMISH CHANNEL O & M	79	27	34	27
OLYMPIA HARBOR STUDY:				
PC	7	16	19	16
FC	5/140#	13	15	13

* Numbers depict batch specific holding time in days between sample collection and analysis.
** 182 day (6 month) holding time for all metals except mercury; 28 day holding time for mercury.
# Several samples were reanalyzed for mercury; thereby exceeding 28 day holding time.

TABLE 7. SEDIMENT HOLDING TIMES FOR BIOASSAYS*

PROJECT	AMPHIPOD	SEDIMENT LARVAE	MICROTOX	GEODUCK
PSDDA REQUIREMENTS:	42	42	42	42
PORT OF EVERETT MARINA	23	7	13/14/29	N/A
DUWAMISH YACHT CLUB	22	40	22/41	N/A
OLYMPIA HARBOR STUDY	20/41	41	32/36/37/42	20

* Numbers depict batch specific holding times in days between sample collection and analysis.

bioassays. They were all within the PSDDA mandated maximum holding time of 42 days.

E. Volumes passing/failing PSDDA (by Sub-basin). Table 8 summarizes the dredging volumes passing and failing the PSDDA disposal guidelines within each sub-basin. A total of 703,685 cubic yards of dredged material passed the PSDDA disposal guidelines for unconfined open-water disposal. Material tested

TABLE 8. DREDGING VOLUMES (cubic yards) PASSING/FAILING PSDDA (BY SUB-BASIN)

SUB-BASIN	VOLUME PASSING	VOLUME FAILING	DISPOSAL SITE
Elliott Bay/Duwamish River	21,000	3,000	EB
Port Gardner/Possession Sound	63,500	4,300	PG
Swinomish Channel	93,000	0	RS
Budd Inlet/Olympia	526,185	9,000	KI
TOTAL:	703,685	16,300	

Legend: EB = Elliott Bay PSDDA Site
PG = Port Gardner PSDDA Site
RS = Rosario Strait PSDDA Site (Dispersive)
KI = Ketron Island PSDDA Site

from the Swinomish Channel passed the more restrictive disposal criteria for dispersive sites, such as the Rosario Strait PSDDA site. A total of 16,300 cubic yards of dredged material (2.3 %) failed the disposal guidelines. The 3,000 cubic yards of material failing to pass PSDDA disposal guidelines for the Duwamish Yacht Club project is projected to go to an upland landfill site (Scalzo pit in King County, west of the intersection of S. 212th Street and 42nd Avenue S.). The 4,300 cubic yards of material failing the disposal guidelines for the Port of Everett Marina project will be left in place and not dredged. Projected dredging for the Olympia Harbor project is currently not scheduled to commence until 1993, and the disposition of material initially failing guidelines for UCOWD during the feasibility study has not yet been decided. Additional testing of the material prior to dredging is anticipated as the recency guidelines for the current tests will have been exceeded.

F. Permit Processing for Non-Corps Projects. The overall permit process for dredging and disposal for non-Corps applicants and Corps projects is outlined in Figure 3(a-b). Generally, the local shoreline permit process is initiated concurrently with the Section 10/404 process for non-Corps projects. The Corps serves as the single point of contact for all matters dealing with the Section 10/404 process, including scoping and coordination of requirements for dredged material testing and suitability determinations with the other PSDDA agencies (Ecology, WDNR, EPA) and matters dealing with the permit process itself. Initially, the dredger/applicant for a Section 10/404 permit fills out an application to the Corps outlining the proposed dredging activity, and location and scope of dredging, including detailed plan view and cross sectional views of the proposed work. The project plan is coordinated with PSDDA regulatory agencies for consensus on requirements for testing. Dredged material testing requirements are outlined in a letter back to the applicant, also requesting the preparation and submittal of a sampling and analysis plan prior to initiation of sampling and testing. This plan is circulated by the Corps for review by the PSDDA agencies, and after the plan has been approved, sampling may commence. However, experience to date has shown that sampling may not be initiated for some time after application submittal and sampling plan approval, which is the applicant's option. This is considered to be generally outside the control of the regulatory agencies and, therefore, the permit processing time assessment. The applicant submits the testing data to the Corps for PSDDA regulatory agency review. After a coordinated QA/QC review of the testing data, the Corps formalizes the PSDDA agency decision on dredged material suitability, thereby completing the permit application relative to the disposition of the dredged material. Once sampling and laboratory analysis commence, it may take from one to three months for testing to be completed and results to be delivered to the PSDDA agencies for review. After laboratory testing results are submitted to the PSDDA agencies for review, a consensus decision is made among the PSDDA agencies on the suitability of the dredged material for unconfined open-water disposal. The Corps then initiates the Public Notice process and the regulatory clock is started (Public Notice review process is normally 30 days) and a permit decision is made by the District Engineer after weighing and balancing all the environmental and economic factors. The permit processing times required after completing the application, public interest review, and environmental review (Section 404(b)1)) concluding with the permit decision, were 45 days and 61 days respectively for the Blake Island State Park and Duwamish Yacht Club projects. It should be noted that National Environmental Policy Act (NEPA) and State Environmental Policy Act (SEPA) review, may invoke the requirement to prepare an Environmental Impact Statement (EIS).

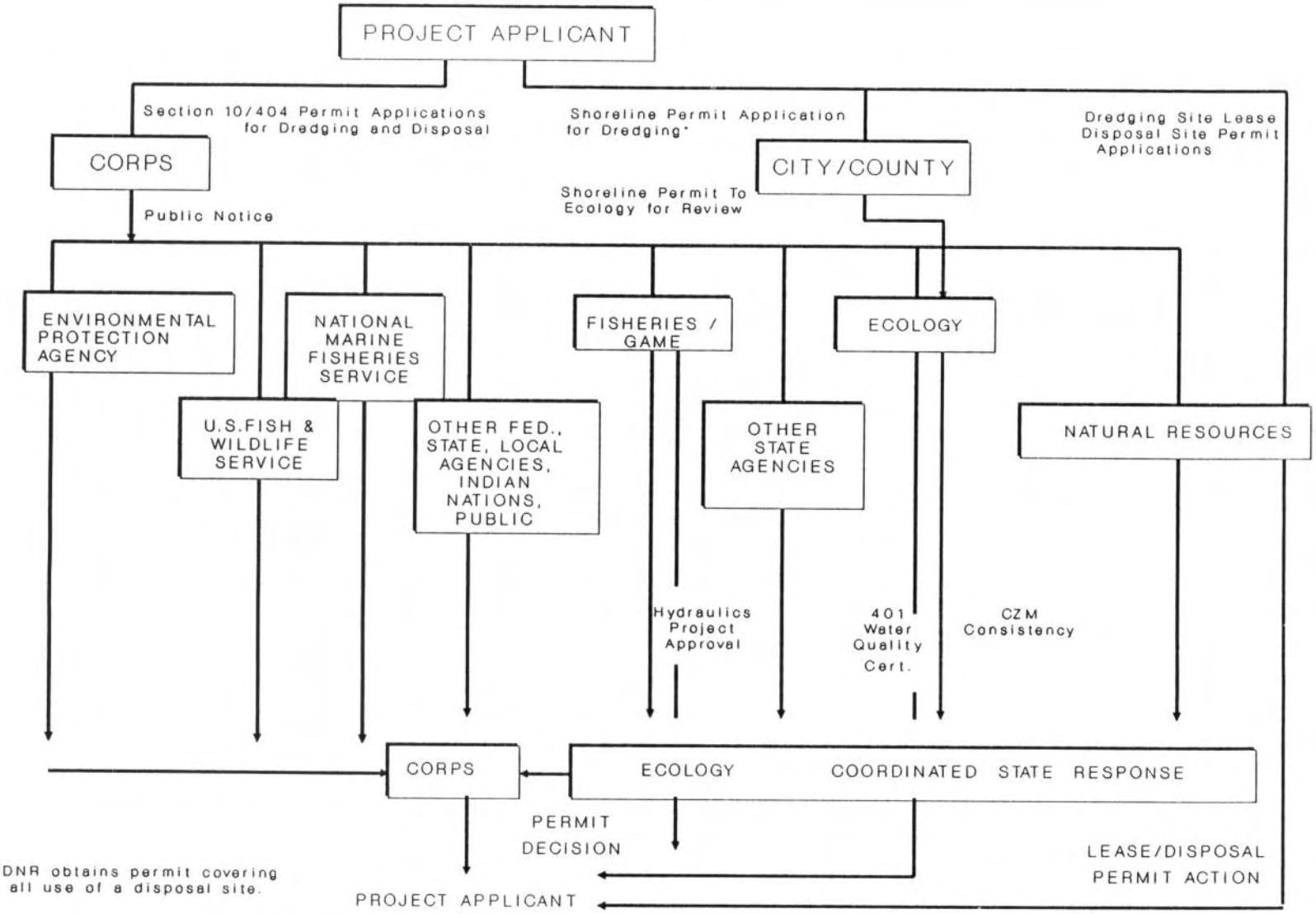


FIGURE 3a. PERMITTING PROCESS FOR NON-CORPS PROJECTS.

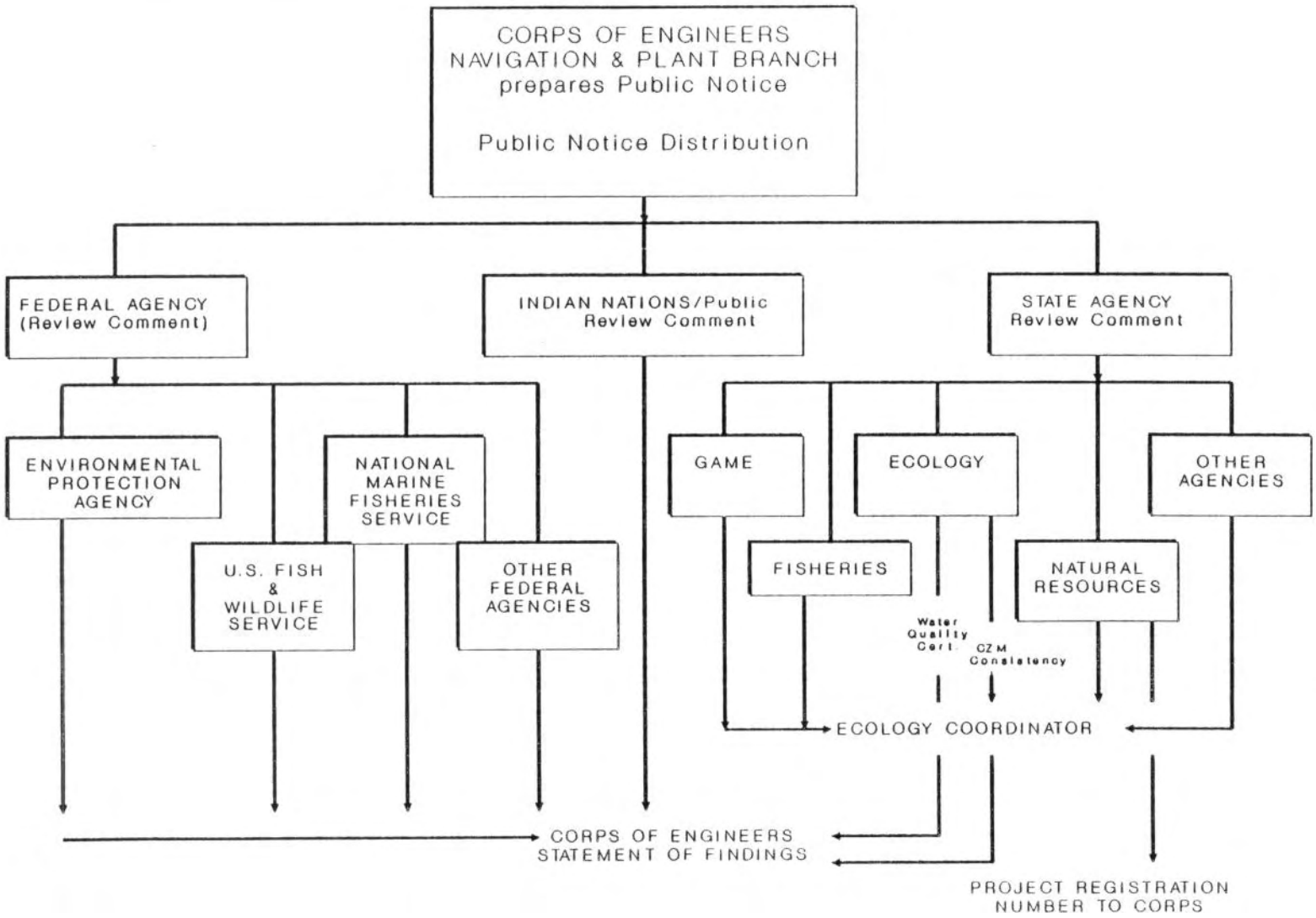


FIGURE 3b. PERMITTING PROCESS FOR CORPS PROJECTS.

Invoking the NEPA/SEPA EIS process would increase schedule and agency attention, which would delay the permit decision. In the two permits issued above, no significant NEPA/SEPA issues were present.

IV. CONCLUSIONS AND RECOMMENDATIONS.

A. PSDDA Guideline Applications. Projects tested during the 1989 dredging year covered by this report generally complied with PSDDA sampling and testing guidelines, which allow for best professional judgement in interpreting test data (EPTA, page II-106; Phase I MPR, pages A-17 and A-25).

B. Protocol Issues/Clarifications. Protocol clarifications which were implemented during the course of the 1989 dredging year are completely discussed in Chapter 5 of the Phase II MPR and summarized below. Issues surfacing during the dredging year, which need to be discussed and resolved at the PSDDA Annual Review Meeting are discussed separately below.

1. Sampling. Several sampling issues required protocol clarifications in the Phase II MPR, and these are discussed below:

(a) Requirement to archive samples below dredging depth (Clarification). Perceived problems in sampling and archiving sediment samples below project dredging depth in "high concern" areas and PSEP/PSDDA mandated holding times as outlined in EPTA (1988, page I-14) and the Phase I MPR (page A-12) required a clarification in the Phase II MPR. Briefly summarized, the PSSDA clarification requires archiving samples of post-dredging surfaces in "high concern" areas (such as those where groundwater contamination is suspected), or where there is "reason to believe" that subsurface sediments newly exposed may be contaminated. A decision to analyze or not analyze the archived samples will be made after reviewing sediment characterization data by the PSDDA agencies. Relatively short holding time requirements for volatile organics (14 days), mercury (28 days), and sediment conventional parameters such as ammonia (7 days) and total sulfides (7 days), may otherwise constrain the dredger to do the above chemical analyses on the archived samples before the results are known for the other tests. Therefore, if archived sample analysis is required, PSDDA will only require analyses of metals and semivolatile organics. In the case of mercury the 28 day holding time would be waived. Bioassays will not be required of the archived material, since results of archived samples if analyzed would be compared directly with predredging chemical levels, hence the need for ammonia and sulfide data is moot. This clarification may not apply however, in designated Superfund or RCRA (Resource Conservation Reclamation Act) areas, where the Department of Ecology and EPA may impose special sampling and analyses requirements outside those described above.

(b) Reference Area Sampling. The 1988 PSDDA guidelines specified an allowable mortality of 20% (absolute) in the reference sediment relative to the control sediment mortality in the amphipod, sediment larvae, juvenile infaunal (i.e., Geoduck Bioassay replaced by the Neanthes 10 day acute test with Phase II implementation), and microtox bioassay tests. Recent problems with reference sediment performance relative to the PSDDA mandated bioassays, has necessitated taking another look at reference sediments in general. PSDDA normally has required that bioassay tests be repeated if reference performance standards are not met. This can result in significant expense and potential unreasonable delays to dredgers. Problems outlined above with echinoderm embryo bioassay performance relative to sediment controls and reference sediment, necessitated this requirement being re-examined. Additionally, new information regarding grain size effects on amphipod survival have been documented for the amphipod bioassay (see Phase II MPR, pages 5-32 to 5-33). Examination of reference areas in Puget Sound and their performance relative to the amphipod bioassay suggests that higher mortalities observed from a number of reference areas (i.e., Dabob Bay, Port Susan, Samish Bay, Sequim Bay) were influenced by some other factor than chemical toxicity (PTI, 1989). A paper by Dewitt, Ditsworth and Schwartz (1988) found a high correlation between decreasing grain size and increasing mortality for the amphipod Rhepoxynius abronius, which was attributed to fine-grained particle interference with respiration and feeding mechanisms. This was postulated as an explanation for the poor survival of amphipods observed in the Port Susan reference sediment during PSDDA baseline monitoring sediment characterization (PTI, 1988c). Of the two projects tested during the 1989 dredging year, where reference sediments were used, both performed satisfactorily during the amphipod test. However, as discussed earlier, problems were experienced with the echinoderm embryo tests (possibly due to ammonia and/or sulfide, although these tests were not done; see discussion on page 17). In the Phase II MPR, PSDDA has retained the 20 percent absolute over control performance limit for reference sediments. If exceeded in the amphipod test, the test may or may not have to be re-run, depending on PSDDA Agency review and examination of all relevant data including percent fines (clays and silts) relative to published reference sediment performances (PTI, 1989).

2. Testing Issues.

a. Chemical Testing Issues. Clarifications on a number of chemical testing issues were required during the first year following PSDDA implementation and are summarized completely in the Phase II MPR (pages 5-27 to 5-31).

(1) Limits of Detection. Limits of Detection (LOD) required by PSDDA were clarified for both organic chemicals and metals. Experience during the 1989 dredging year showed that achieving PSDDA limits of detection was generally not a problem for metals, but was for semivolatile organic compounds analyzed using the "Modified CLP" methods recommended and approved by the 1986 PSEP protocols and adopted by PSDDA (see discussion above, and Tables 3 and 4). PSDDA agencies have concluded that laboratory required LOD's for organic compounds must be quantitated or detected below the SL for each compound.

(2) QA/QC Clarification to Sonication Method. A particular concern was raised for the "Sonication" extraction method (e.g., EPA method 3550) described in the 1986 PSEP protocol document. This concern surfaced during interagency (non-PSDDA) QA/QC review of the U.S. Navy Homeport test data outside the 1989 dredging year cut off period (June 15, 1989). The concern focused on the lack of adequate QA/QC during the critical drying step when more volatile extractables may be lost. With the implementation of the Phase II MPR, PSDDA now recommends adding matrix spikes and surrogate standards at the beginning of the drying step, before the addition of the extracting solvent. Failure to do this can result in a quality control failure under PSDDA.

b. Bioassays. A number of bioassay protocol changes were necessary to correct problems observed during the early PSDDA implementation process. These changes are discussed below:

(1) Sediment Larval Bioassay.

(a) Species substitution. PSDDA allows the substitution of either the mussel larvae or echinoderm embryo bioassay for the oyster larvae bioassay. Species selection for the sediment larvae test relative to the timing of the test has been found to be critical to survival of larvae spawned in the laboratory. This may have been a major factor influencing the test run failures for the Duwamish Yacht Club and Olympia Harbor Feasibility Study. Artificial spawning of test species outside their normal spawning period, has generally been found to result in lower viability of larvae spawned with resulting higher mortalities close to or higher than the 30 percent allowable under the PSDDA guidelines. A sediment larvae workshop held on June 15, 1989 (EPA Bioassay Workshop handouts and notes) recommended that species selected for use in a particular test run be in their normal spawning cycle to reduce the stress on the animals, and thereby increase the viability (i.e., survival) of larvae spawned. This recommendation was endorsed by PSDDA and has been incorporated into evaluation procedures changes in the Phase II MPR (pages 5-(16-24)).

(b) Inoculation Time. Additionally, PSDDA subsequently recommended that the PSEP protocol's 10 second inoculation time (i.e., after sediments are suspended within each test beaker) be extended from one to four hours to allow settling of fine material in suspension prior to inoculating the test beakers with larvae (see Phase II MPR, page 5-21). This recommendation was presented at the PSEP bioassay workshop on October 4, 1989, and a four hour inoculation time was subsequently adopted for the sediment larvae bioassay.

As a result of the adjustments to the protocol discussed above, it now appears that many of the early problems have been generally worked out for this test. Recent test results for the Echinoderm embryo bioassay have been very encouraging (i.e., all control and reference performance limits within guidelines).

(2) Ammonia/total Sulfide Monitoring. High sediment ammonia and total sulfides have also been observed to potentially induce problems with the sediment larvae test, thereby contributing to mortalities observed in test sediments (see Phase II MPR, page 5-21). The four hour inoculation time discussed above may also help to alleviate problems with these parameters, which are generally transitory and short lived in dredged material as observed in actual disposal site monitoring (Burkes and Engler, 1978). In order to better evaluate sediment quality factors other than COC, which also may contribute to mortalities in test sediments tested, PSDDA now recommends that total sulfide and ammonia be measured as optional water quality parameters at the beginning and end of the sediment larvae test and amphipod bioassay for each tested sediment. Recent test results have underscored the need to collect these data to enable better interpretation of the test results by PSDDA regulatory agencies.

(3) Saline Microtox. Changes to the saline Microtox bioassay protocol were necessary to enable direct comparison of test sediments and reference sediments for interpretation purposes as required under the PSDDA guidelines. Experience with the test to date has shown that reference sediments generally fail to show a significant dose response in the dilution series. This is not unexpected in a nontoxic sediment with low background levels of chemicals. Test sediments exhibiting a significant dose response via the dilution series must be compared with the reference sediment to complete the PSDDA evaluation. Therefore, to allow a direct comparison of dose responsive test sediments (via the dilution series) with the reference sediment, the following protocol adjustments were made (see Phase II MPR, page 5-24): Five replicates at the highest dilution are analyzed for the reference sediment and all test sediments. A t-Test comparison is then made for all test sediments and reference sediment responses at the highest dilution for the five replicates. Those sediments found to be

dose responsive, where the test sediment response indicates a reduction in luminosity of 20 percent or more compared with the reference sediment, and exhibits a statistically significant response relative to the reference sediment ($p < 0.05$) are considered to be a "hit", thereby failing PSDDA interpretation criteria for this test. Those test sediments found to be dose responsive, and exhibiting a decrease in luminosity relative to reference sediments of less than 20 percent are considered "non hits" for this test, passing PSDDA guidelines for UCOWD whether or not they exhibit a statistically significant response relative to reference. Sediments not found to be dose responsive but exhibiting a decrease in luminosity at the highest dilution greater than 20 percent, and demonstrating a statistically significant difference relative to the reference sediment response also are considered a "non hit" for this test, but will be flagged as questionable. To be considered a "hit" a test sediment must exhibit both (1) a response greater than or equal to 20 percent absolute over reference sediment; and (2) statistically significant response relative to reference sediment (t-Test; $p < 0.05$). The definitive endpoint as defined in the Phase II MPR is the absolute percent difference and statistical significance in the test sediment and reference sediment response at the highest dilution.

C. PSDDA Annual Review Meeting Issues: Several issues that need to be clarified and resolved at the next annual review meeting are discussed below.

1. Data Submission Requirements. PSDDA outlines general test data submission requirements in EPTA and in the Phase I and II MPR's. However, with the development of the PSDDA data base management system (see Appendix IV for overview) it has become increasingly apparent that a standardized format for the laboratory reporting of data was needed. Moreover, due to increasing manpower constraints, the time required to conduct initial Quality Assurance (QA1) review of the PSDDA test data was impacting the ability to render timely regulatory decisions on the suitability of the dredged material for unconfined open-water disposal given the nonstandardized laboratory reporting formats. Accordingly, the Corps after consulting with the PSDDA agencies has standardized the laboratory reporting format using electronic media (i.e., Lotus spreadsheets, 5.25 inch floppy diskettes), which will enable a timely computerized check of the major QA guidelines. When this QA flagging program becomes operational, it will greatly facilitate the data review and validation process leading to more timely decisions on dredged material suitability. PSDDA agencies with the Corps as the lead agency are now recommending that all data be submitted using the Corps recommended formats and media. Whether or not to make this a formal PSDDA requirement needs to be clarified at the next Annual Review Meeting.

2. Sediment Conventional Analysis of Reference Sediments. In general, because of concerns about reference sediment performance relative to bioassays, PSDDA now recommends on an interim basis that sediment conventional parameters be analyzed for all reference sediments. Whether or not to make this a PSDDA requirement when bioassays are conducted needs to be clarified. These data are vital in matching test sediment physical characteristics with appropriate reference sediment stations, and in tracking reference site performance during bioassays. Sediment conventional and chemistry data (where available), along with the locations of each reference station will be input into the PSDDA data base to enable tracking of reference station performances relative to bioassays, and to assist in the interpretation of results. These data will also be used to match test sediments for dredging projects requiring biological testing with an appropriately matched reference sediment by station location.

3. Ammonia/Sulfide Monitoring during Bioassays. As discussed above, ammonia and sulfide monitoring are currently recommended during the beginning and end of the amphipod and sediment larvae bioassays. Whether or not to make it a PSDDA requirement to conduct ammonia and sulfide monitoring of the amphipod and sediment larvae bioassays needs to be clarified.

4. Saline Microtox. Test sediments found not to be dose responsive that exhibit a decrease in luminosity at the highest dilution greater than 20 percent relative to the reference sediment response, which is also statistically different are considered a "non hit", but are flagged as questionable (Phase II MPR, page 5-24, first bullet). Further clarification on the interpretation of this latter response relative to PSDDA disposal guidelines needs to be clarified at the next annual review meeting.

V. REFERENCES

Burkes, S.A., and R.M. Engler. 1978. Water Quality Impacts of Aquatic Dredged Material Disposal (Laboratory Investigations). Technical Report DS-78-4. U.S. Army Corps of Engineers; Waterways Experiment Station, Vicksburg, Mississippi.

Dewitt, T. H., G.R. Ditsworth, and R.C. Schwartz. 1988. Effects of natural sediment features on survival of the phoxocepalid amphipod, Rhepoxynius abronius. Mar. Env. Res. 25: 99-124.

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

MPR, 1988. Puget Sound Dredged Disposal Analysis (PSDDA) Phase I (Central Puget Sound) Management Plan Report. Prepared by the Corps of Engineers in cooperation with the Environmental Protection Agency, Region X, and the Washington State Departments of Ecology and Natural Resources.

MPR, 1989. Puget Sound Dredged Disposal Analysis (PSDDA) Phase II (North and South Puget Sound) Management Plan Report. Prepared by the Corps of Engineers in cooperation with the Environmental Protection Agency, Region X, and the Washington State Departments of Ecology and Natural Resources.

PTI, 1988a. Pastorok, R.A., and D.S. Becker. Comparison of Bioassays for Assessing Sediment Toxicity in Puget Sound. Prepared for U.S. Environmental Protection Agency by PTI Environmental Services, Inc. (December).

PTI, 1988b. Barrick, R. L. Brown, and S. Becker. Sediment Quality Values Refinement: Volume II - Evaluation of PSDDA Sediment Quality Values. Report prepared for the Environmental Protection Agency by PTI Environmental Services, Inc.(December).

PTI, 1988c. Puget Sound Dredged Disposal Analysis: Baseline Survey of Phase I Disposal Sites. Prepared for Washington Department of Ecology by PTI Environmental Services, Inc.

PTI, 1989. Pastorok, R.A., R. Sonnerup, J.J. Greene, M.A. Jacobson, L.B. Read, and R.C. Barrick. Performance Area Standards for Puget Sound Reference Areas. Draft report submitted by PTI Environmental Services to Ecology (June).

Tetra Tech, 1986. Recommended Protocols for Sampling and Testing in Puget Sound. Prepared for Environmental Protection Agency, Region X, Office of Puget Sound.

VI. APPENDICES

APPENDIX I. PROJECT CHEMISTRY TESTING SUMMARY

CHEMICAL	PROJECT HIGHEST	1988 PSDDA GUIDELINES SL	BT	ML	ANALYSES FAILING DISPOSAL GUIDELINES POE STA. 5	DYC STA. 1	DYC STA. 5	OHN STA. Z
METALS (ppm - dry wgt)								
Antimony	4.55	2.6	19	26			4.55	
Arsenic	22.7	70	511	700				
Copper	364	81		810		112	364	103
Nickel	155	28	43	120	56	104	155	39.9
Cadmium	2.6	0.96		9.60		1.14		2.58
Lead	194	66		660		88	194	
Mercury	0.37	0.21	1.5	2.1		0.29		0.37
Silver	1	1.2	4	5.2				
Zinc	707	160		1,600		340	707	
ORGANIC CHEMICALS (ppb - dry wgt)								
Phenol	330	120	876	1,200				
2-Methyphenol	34	10		72		29u	18u	
4-Methylphenol	1,400	120		1,200	140			
2-4-Dimethylphenol	60u	10		50		60u	37u	
Pentachlorophenal	220u	140	1,022		190u	140u		
Naphthalene	230	210		2,100				
Acenaphthylene	43	64		640				
Anthracene	240	130		1,300				
Acenaphthene	210	63		630				
Fluorene	190	64		640		320		
Phenanthrene	1,500	320		3,200				
2-Methylnaphthalene	32	67		670				
TOTAL LPAH	2,215	610		6,100		597	2215	
Chrysene	1,100	670		6,700				
Benzofluoranthenes	1,300	800		8,000		890	1300	
Ideno(1,2,3-c,d)pyrene	520	69		5,200		290	520	
Benzo(a)anthracene	910	450		4,500		650	910	
Dibenzo(a,h)anthracene	910	120		1,200		150	130	
Fluoranthene	1,900	630	4,600	6,300		1500	1700	
Benzo(a)pyrene	540	680	4,964	6,800				
Pyrene	2,300	430		7,300		1500	2300	
Benzo(g,h,i)perylene	360	540		5,400				
TOTAL HPAH	8,860	1,800		51,000		6080	8860	
MISCELLANEOUS								
Benzyl Alcohol	27	10		73	18u	140u	91u	
Benzoic Acid	1,100	216		690	460u	290u	1100	
Dibenzofuran	75	54		540			75	
Hexachloroethane	2.9u	1,400	10,220					
Hexaclorobutadiene	60u	29	212	290		60u	37u	
N-Nitrosodiphenylamine	29u	22	161	220		29u		
PHTHALATES								
Dimethyl Phthalate	510	160	1,168			320	510	
Diethyl Phthalate	100	97						
Di-n-butyl phthalate	33	1,400	10,220					
Butyl benzyl phthalate	220	470						
Bis(2-ethylhexyl) phthalate	1,600	3,100	13,870					
Di-n-octyl phthalate	129	69,000						
CHLORINATED HYDROCARBONS								
1,3-Dichlorobenzene	29u	170	1,241					
1,4-Dichlorobenzene	29u	26	190	260		29u		
1,2-Dichlorobenzene	29u	19	37	350		29u		
1,2,4-Trichlorbenzene	29u	6.4		64	18u	29u	18u	
Hexachlorobenzene	2	23	168	230	36u	29u		
VOLATILES								
Trichloroethene	2.9u	160	1,168	1,600				
Tetrachloroethene	4u	14	102	210				
Ethylbenzene	6u	10	27	50				
Total Xylene	10	12		160				
PESTICIDES								
Total DDT	2	6.9	50	69				
Aldrin	3u	5	37					
Dieldrin	4.3u	5	37					
Heptachlor	2.2u	5	37					
Chlordane	1	5	37		18u			
Lindane	2.2u	5	37					
Total PCB's	247	130	1,789	2,500		247	209	
# > SL (1988):					2	17	17	4
# Undetected > SL (1988):					6	11	5	0
# > BT (1988):					1	1	1	0
# > ML (1988):					0	0	2	0

Legend: SL = Screening Level; BT = Bioaccumulation Trigger; ML = Maximum Level; u = Undetected

APPENDIX II. CHEMICAL ANALYSIS SUMMARY RELATIVE TO 1988 PSDDA GUIDELINES

CHEMICAL	PROJECT HIGHEST	1988 SL	1988 BT	1988 ML	1988 % SL	1988 % ML	1988 % BT	1988 (SL+ML)/2	PERCENT (SL+ML)/2
METALS (ppm (dry wgt)):									
Antimony	4.55	2.6	19	26	175.0%	17.5%	23.9%	14.3	31.8%
Arsenic	22.7	70	511	700	32.4%	3.2%	4.4%	385	5.9%
Copper	364	81		810	449.4%	44.9%		445.5	81.7%
Nickel	155	28	43	120	553.6%	129.2%	360.5%	74.0	209.5%
Cadmium	2.6	0.96		9.6	270.8%	27.1%		5.3	49.2%
Lead	194	66		660	293.9%	29.4%		363	53.4%
Mercury	0.37	0.21	1.5	2.1	176.2%	17.6%	24.7%	1.2	32.0%
Silver	1	1.2	4	5.2	83.3%	19.2%	25.0%	3.2	31.3%
Zinc	707	160		1,600	441.9%	44.2%		880	80.3%
ORGANIC CHEMICALS (ppb (dry wgt)):									
Phenol	330	120	876	1,200	275.0%	27.5%	37.7%	660	50.0%
2-Methyphenol	34	10		72	340.0%	47.2%		41	82.9%
4-Methylphenol	1400	120		1,200	1166.7%	116.7%		660	212.1%
2-4-Dimethylphenol	60u	10		50				30	
Pentachlorophenal	220u	140	1,022						
Naphthalene	230	210		2,100	109.5%	11.0%		1,155	19.9%
Acenaphthylene	43	64		640	67.2%	6.7%		352	12.2%
Anthracene	240	130		1,300	184.6%	18.5%		715	33.6%
Acenaphthene	210	63		630	333.3%	33.3%		346.5	60.6%
Fluorene	190	64		640	296.9%	29.7%		352	54.0%
Phenanthrene	1500	320		3,200	468.8%	46.9%		1,760	85.2%
2-Methylnaphthalene	32	67		670	47.8%	4.8%		368.5	8.7%
TOTAL LPAH	2215	610		6,100	363.1%	36.3%		3,355	66.0%
Chrysene	1100	670		6,700	164.2%	16.4%		3,685	29.9%
Benzofluoranthenes	1300	800		8,000	162.5%	16.3%		4,400	29.5%
Ideno(1,2,3-c,d)pyrene	520	69		5,200	753.6%	10.0%		2634.5	19.7%
Benzo(a)anthracene	910	450		4,500	202.2%	20.2%		2,475	36.8%
Dibenzo(a,h)anthracene	910	120		1,200	758.3%	75.8%		660	137.9%
Fluoranthene	1900	630	4,600	6,300	301.6%	30.2%	41.3%	3,465	54.8%
Benzo(a)pyrene	540	680	4,964	6,800	79.4%	7.9%	10.9%	3,740	14.4%
Pyrene	2300	430		7,300	534.9%	31.5%		3,865	59.5%
Benzo(g,h,i)perylene	360	540		5,400	66.7%	6.7%		2,970	12.1%
TOTAL HPAH	8860	1,800		51,000	492.2%	17.4%		26,400	33.6%
MISCELLANEOUS									
Benzyl Alcohol	27	10		73	270.0%	37.0%		41.5	65.1%
Benzoic Acid	1100	216		690	509.3%	159.4%		453	242.8%
Dibenzofuran	75	54		540	138.9%	13.9%		297	25.3%
Hexachloroethane	2.9u	1,400	10,220						
Hexaclorobutadiene	60u	29	212	290				159.5	
N-Nitrosodiphenylamine	29u	22	161	220				121	
PHTHALATES									
Dimethyl Phthalate	510	160	1,168		318.8%		43.7%		
Diethyl Phthalate	100	97			103.1%				
Di-n-butyl phthalate	33	1,400	10,220		2.4%		0.3%		
Butyl benzyl phthalate	220	470			46.8%				
Bis(2-ethylhexyl) phthalate	1600	3,100	13,870		51.6%		11.5%		
Di-n-octyl phthalate	129	69,000			0.2%			34,500	0.4%
CHLORINATED HYDROCARBONS									
1,3-Dichlorobenzene	29u	170	1,241						
1,4-Dichlorobenzene	29u	26	190	260				143	
1,2-Dichlorobenzene	29u	19	37	350				184.5	
1,2,4-Trichlorbenzene	29u	6.4		64				35.2	
Hexachlorobenzene	2	23	168	230	8.7%	0.9%	1.2%	126.5	1.6%
VOLATILES									
Trichloroethene	2.9u	160	1,168	1,600				880	
Tetrachloroethene	4u	14	102	210				112	
Ethylbenzene	6u	10	27	50				30	
Total Xylene	10	12		160	83.3%	6.3%		86	11.6%
PESTICIDES									
Total DDT	2	6.9	50	69	29.0%	2.9%	4.0%	38	5.3%
Aldrin	3u	5	37						
Dieldrin	4.3u	5	37						
Heptachlor	2.2u	5	37						
Chlordane	1	5	37		20.0%		2.7%		
Lindane	2.2u	5	37						
Total PCB's	247	130	1,789	2,500	190.0%	9.9%	13.8%	1,315	18.8%

APPENDIX III. CHEMICAL ANALYSIS SUMMARY RELATIVE TO 1989 PSDDA GUIDELINES

CHEMICAL	PROJECT HIGHEST	1989 SL	1989 BT	1989 ML	1989 % SL	1989 % ML	1989 % BT	1989 (SL+ML)/2	PERCENT (SL+ML)/2
METALS (ppm (dry wgt)):									
Antimony	4.55	20	126	200	22.8%	2.3%	3.6%	110	4.1%
Arsenic	22.7	57	393.1	700	39.8%	3.2%	5.8%	378.5	6.0%
Copper	364	81		810	449.4%	44.9%		445.5	81.7%
Nickel	155	140	504		110.7%		30.8%		
Cadmium	2.6	0.96		9.6	270.8%	27.1%		5.3	49.2%
Lead	194	66		660	293.9%	29.4%		363	53.4%
Mercury	0.37	0.21	1.5	2.1	176.2%	17.6%	24.7%	1.2	32.0%
Silver	1	1.2	4.6	6.1	83.3%	16.4%	21.7%	3.7	27.4%
Zinc	707	160		1,600	441.9%	44.2%		880	80.3%
ORGANIC CHEMICALS (ppb (dry wgt)):									
Phenol	330	120	876	1,200	275.0%	27.5%	37.7%	660	50.0%
2-Methyphenol	34	10		72	340.0%	47.2%		41	82.9%
4-Methylphenol	1400	120		1,200	1166.7%	116.7%		660	212.1%
2-4-Dimethylphenol	60u	10		50	0.0%	0.0%		30	0.0%
Pentachlorophenal	220u	69	504	690	0.0%	0.0%	0.0%	379.5	0.0%
Naphthalene	230	210		2,100	109.5%	11.0%		1,155	19.9%
Acenaphthylene	43	64		640	67.2%	6.7%		352	12.2%
Anthracene	240	130		1,300	184.6%	18.5%		715	33.6%
Acenaphthene	210	63		630	333.3%	33.3%		346.5	60.6%
Fluorene	190	64		640	296.9%	29.7%		352	54.0%
Phenanthrene	1500	320		3,200	468.8%	46.9%		1,760	85.2%
2-Methylnaphthalene	32	67		670	47.8%	4.8%		368.5	8.7%
TOTAL LPAH	2215	610		6,100	363.1%	36.3%		3,355	66.0%
Chrysene	1100	670		6,700	164.2%	16.4%		3,685	29.9%
Benzofluoranthenes	1300	800		8,000	162.5%	16.3%		4,400	29.5%
Ideno(1,2,3-c,d)pyrene	520	69		5,200	753.6%	10.0%		2,634.5	19.7%
Benzo(a)anthracene	910	450		4,500	202.2%	20.2%		2,475	36.8%
Dibenzo(a,h)anthracene	910	120		1,200	758.3%	75.8%		660	137.9%
Fluoranthene	1900	630	4,600	6,300	301.6%	30.2%	41.3%	3,465	54.8%
Benzo(a)pyrene	540	680	4,964	6,800	79.4%	7.9%	10.9%	3,740	14.4%
Pyrene	2300	430		7,300	534.9%	31.5%		3,865	59.5%
Benzo(g,h,i)perylene	360	540		5,400	66.7%	6.7%		2,970	12.1%
TOTAL HPAH	8860	1,800		51,000	492.2%	17.4%		26,400	33.6%
MISCELLANEOUS									
Benzyl Alcohol	27	10		73	270.0%	37.0%		41.5	65.1%
Benzoic Acid	1100	216		690	509.3%	159.4%		453	242.8%
Dibenzofuran	75	54		540	138.9%	13.9%		297	25.3%
Hexachloroethane	2.9u	1,400	10,220		0.0%		0.0%		
Hexaclorobutadiene	60u	29	212	290	0.0%	0.0%	0.0%	159.5	0.0%
N-Nitrosodiphenylamine	29u	22	161	220	0.0%	0.0%	0.0%	121	0.0%
PHTHALATES									
Dimethyl Phthalate	510	160	1,168		318.8%		43.7%		
Diethyl Phthalate	100	97			103.1%				
Di-n-butyl phthalate	33	1,400	10,220		2.4%		0.3%		
Butyl benzyl phthalate	220	470			46.8%				
Bis(2-ethylhexyl) phthalate	1600	3,100	13,870		51.6%		11.5%		
Di-n-octyl phthalate	129	6,200			2.1%				
CHLORINATED HYDROCARBONS									
1,3-Dichlorobenzene	29u	170	1,241		0.0%		0.0%		
1,4-Dichlorobenzene	29u	26	190	260	0.0%	0.0%	0.0%	143	0.0%
1,2-Dichlorobenzene	29u	19	37	350	0.0%	0.0%	0.0%	184.5	0.0%
1,2,4-Trichlorbenzene	29u	6.4		64	0.0%	0.0%		35.2	0.0%
Hexachlorobenzene	2	23	168	230	8.7%	0.9%	1.2%	126.5	1.6%
VOLATILES									
Trichloroethene	2.9u	160	1,168	1,600	0.0%	0.0%	0.0%	880	0.0%
Tetrachloroethene	4u	14	102	210	0.0%	0.0%	0.0%	112	0.0%
Ethylbenzene	6u	10	27	50	0.0%	0.0%	0.0%	30	0.0%
Total Xylene	10	12		160	83.3%	6.3%		86	11.6%
PESTICIDES									
Total DDT	2	6.9	50	69	29.0%	2.9%	4.0%	38	5.3%
Aldrin	3u	10	37		0.0%		0.0%		
Dieldrin	4.3u	10	37		0.0%		0.0%		
Heptachlor	2.2u	10	37		0.0%		0.0%		
Chlordane	1	10	37		10.0%		2.7%		
Lindane	2.2u	10	37		0.0%		0.0%		
Total PCB's	247	130	38 *	2,500	190.0%	9.9%	27.4%**	1,315	ERR

* Value normalized to Total Organic Carbon
(TOC normalized: 247.2*.463 (solids)*.091(TOC) = 10.41)
** Based on TOC normalized data

APPENDIX IV. PSDDA DATA MANAGEMENT SYSTEM OVERVIEW.

A. Present/Future System Design. Development of the PSDDA Data Base Management System, known as the "Dredged Analysis Information System" (DAIS) is well underway, with various portions of the system already operational. The generalized types of environmental and administrative data are depicted in Figure IV-1. DAIS is being maintained by the U.S. Army Corps of Engineers, Seattle District. The generalized flow of data to and from DAIS to the State of Washington, Department of Ecology sediment data system, other PSDDA agencies, and the Puget Sound Water Quality Authority is depicted in Figure IV-2. Data submitted by permit applicants and PSDDA baseline and monitoring data will be entered into DAIS after first undergoing an appropriate QA/QC review. Only environmental data passing QA/QC review, and/or with appropriate data qualifier codes will be entered into DAIS. PSDDA environmental and administrative data and/or appropriate non-computerized data maintained in hard copy files (e.g., QA/QC data) will be stored and maintained by the Corps and will be transferred or made available for review to the Ecology sediment data system or to other PSDDA agencies upon request. Lab data will generally be electronically transmitted on 5-1/4 inch floppy diskettes to the PSDDA data manager in Lotus spreadsheets using standardized formats. The generalized DAIS data flow is depicted in Figure IV-3. Data not transmitted on diskettes will be input manually into DAIS by the Corps. The data input into DAIS will first go through a QA1 flagging program which will output a summary report and a QA1 flagging report. The QA1 report will highlight all data flagged not conforming with PSDDA Quality Assurance/Quality Control (QA/QC) requirements including exceedences of screening level (SL), bioaccumulation trigger (BT), and/or maximum level (ML) values. Data failing QA1 will be returned to the Applicant/Lab for corrective action. The data summary report will be available to all PSDDA agencies and other interested groups/persons through either an electronic bulletin board or hard copy for independent review. As part of QA1 review, this report will be checked and validated against the laboratory hard copy report and abbreviated QA1 checklist summary report filled out by the lab/dredger for each dredging project. Data passing QA1 review and/or data annotated with appropriate qualifier codes will be entered into DAIS.

The interim DAIS system will rely on the use of SEDQUAL (modified version 2.0) to store most of the environmental data. All data not stored in SEDQUAL will be stored in an accessory DAIS module (i.e., Administrative data, environmental data not stored in SEDQUAL), which will ultimately be part of the long-range DAIS system. The long range DAIS system will be a stand alone data management system able to input/store/output all PSDDA

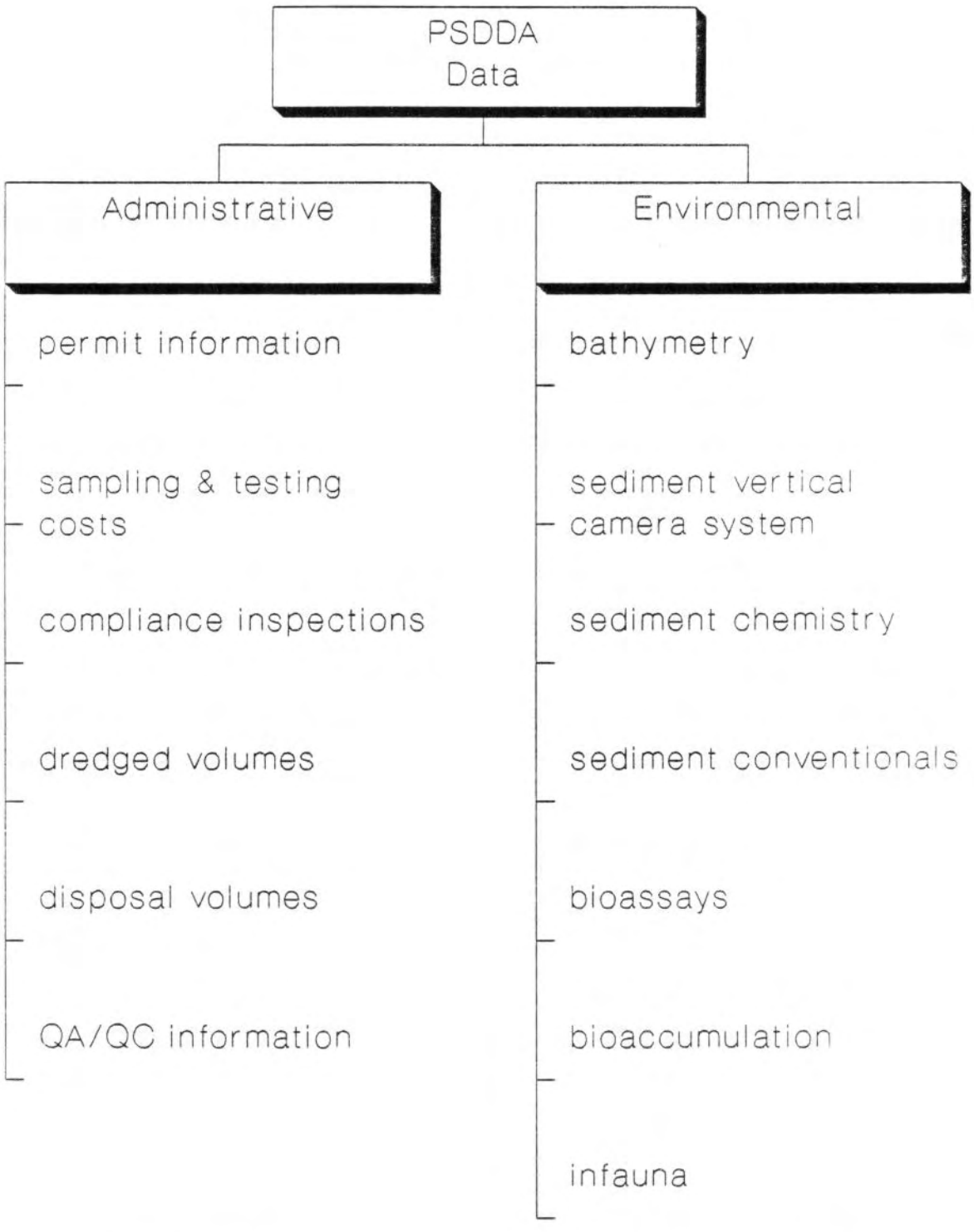


FIGURE IV-1. PSDDA DATA TYPES.

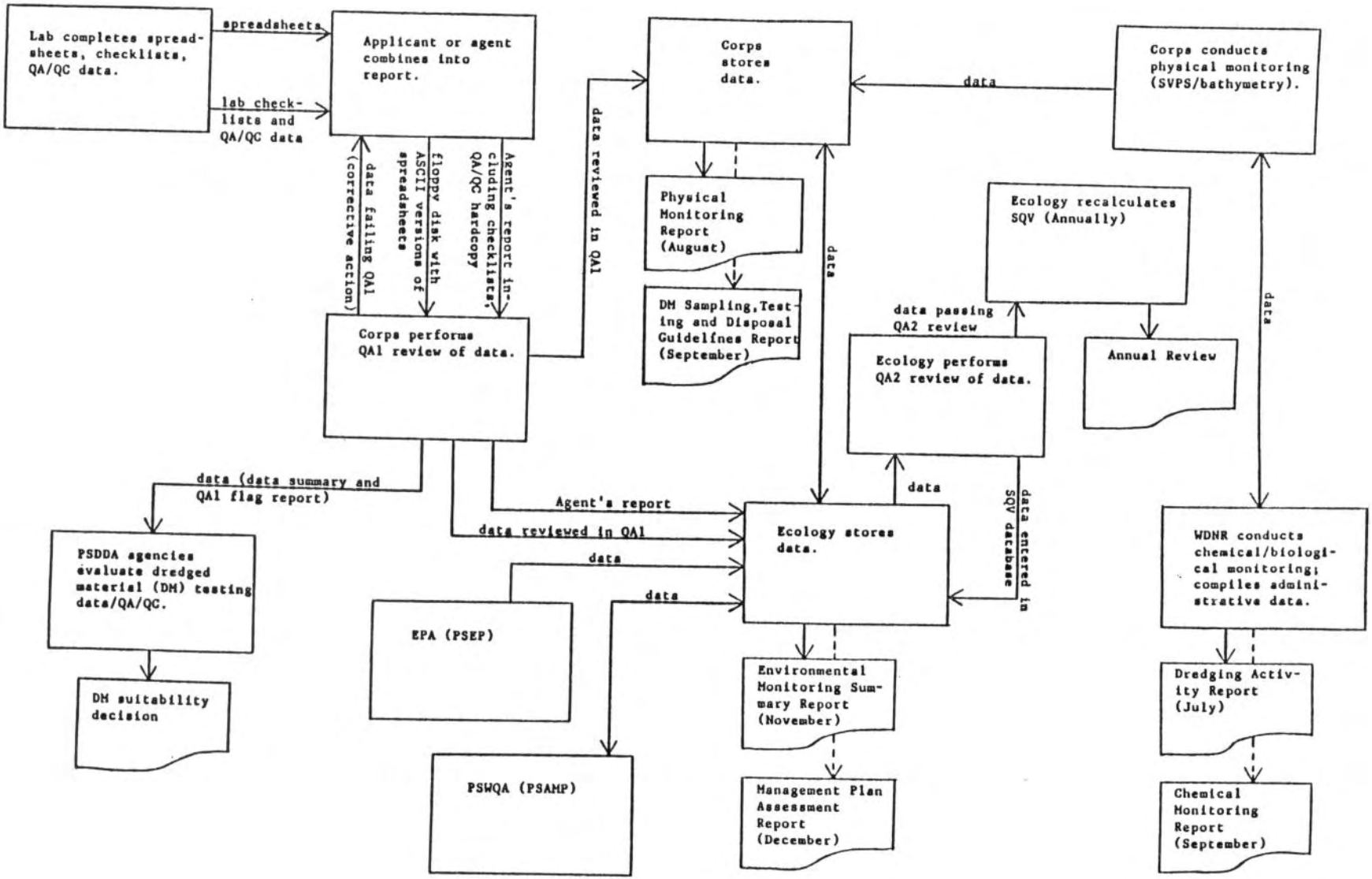


FIGURE IV-2. PSDDA DATA FLOW.

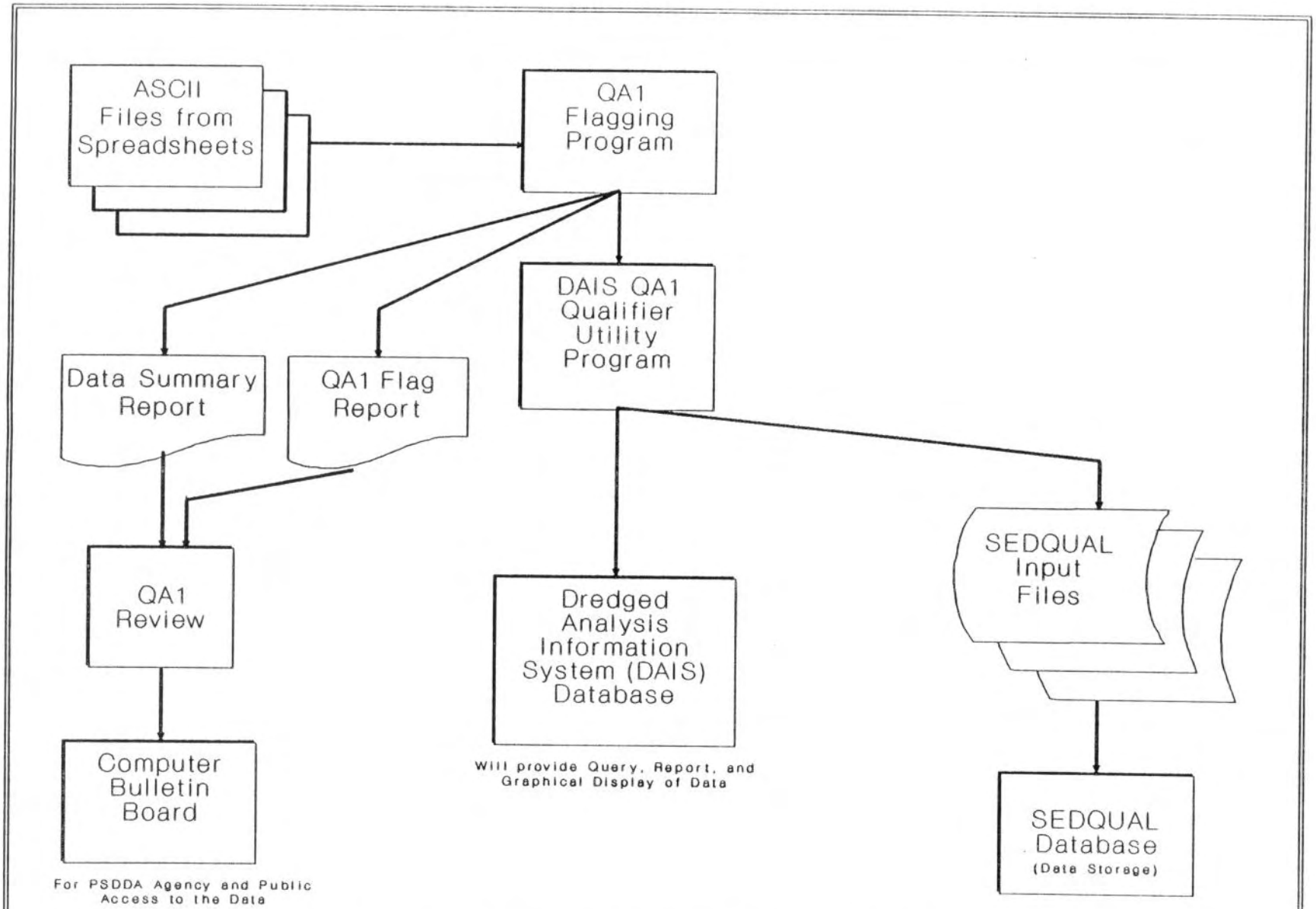


FIGURE IV-3. DREDGED ANALYSIS INFORMATION SYTEM DATA FLOW.

data (i.e., administrative, environmental, and physical). DAIS will be compatible with SEDQUAL input/output formats, such that data may be imported and exported from DAIS to the Ecology sediment data base system, and vice versa. The long range DAIS system will have a Geographical Locator System (GLS), enabling a graphic view of PSDDA sampling stations (e.g., dredging test data, disposal site monitoring data, etc.) including corresponding environmental data (e.g., chemistry, bioassay, benthic abundance etc.) and administrative data within a prescribed area. Data of interest identified through the GLS could then be tagged and output to a data/text file for analysis and/or report writing.

B. PSDDA Data Submission Guidelines. All relevant environmental and administrative data will be input onto Lotus 1-2-3 Spreadsheets (Version 2.0). The current Data submission guide explains how all data is to be entered into the spreadsheets. Standardizing the data input and format requirements will insure consistency in lab reporting performance relative to the PSDDA guidelines, and will result in substantial time savings in subsequent data interpretation and analysis, including QA review necessary to validate data prior to making decision on dredged material suitability for UCOWD, and entry into DAIS. The three types of data to be submitted to the Corps are (1) a hard copy of laboratory results including QA/QC, (2) completed spreadsheets, and (3) completed dredger/laboratory checklists.

The five spreadsheets are broken down into a (1) Station and Lab Sample Identification template, (2) Sediment Conventional Parameters template, (3) Sediment Chemistry template, (4) Bioassay template, and (5) Bioaccumulation template. Each spreadsheet will collect all the relevant QA/QC data necessary to validate the data before making the suitability decision.

A. Data Quality Assurance. Quality assurance for PSDDA data will rely heavily on the QA1 Flagging Program in DAIS to perform QA checks of data. All data necessary to conduct QA1 review is to be input into the five spreadsheets described above. Abbreviated dredger and laboratory checklists filled out by the dredgers/laboratories will also provide a general summary of the QC data. The abbreviated checklists will be put onto floppy disks (5-1/4 inch) in a wordprocessing format (i.e., Wordperfect 5.0) to facilitate completion by the lab/dredger, although they may choose to fill out the checklists by hand and transmit hard copies to the District. The raw data collected on the spreadsheets including ancillary QC (holding times, method blanks, matrix spikes, surrogate standards, certified reference materials (CRM's), replicates, qualifier codes, etc.) and administrative data will be transmitted to the Corps on an electronic medium (5-1/4 inch floppy disks) and will be run

through a QA1 flagging and analysis program prior to entering data into DAIS. Data will be quality assured by checking QA1 flagging report and checklist summary reports for QC violations. Data with major QA1 failures will be sent back to dredger/applicant for corrective action. Data with minor QA1 failures will be annotated with appropriate qualifier codes before entering into DAIS. A data summary/QA1 flagging report and checklist summary (if inputed on electronic media) will then be placed on the PSDDA/DAIS electronic bulletin board to make them readily available for review by the other PSDDA agencies. QA/QC Checklist Summaries on hard copy media will be mailed to PSDDA agencies for review. The other PSDDA agencies will assist the Corps in this review and advise the Corps as to the adequacy of the data to make a determination of suitability of the dredged material for unconfined open-water disposal at a PSDDA disposal site. The final determination on the adequacy of data for entry into DAIS, shall be the Corps' responsibility. Prior to entry into DAIS, all data will be run through a Utility Program, which will assign Qualifier Codes if needed to data that has not complied with all the PSDDA QA guidelines. This will enable all data including qualified data to be entered into DAIS, while still maintaining the integrity of the data for discrete retrieval and analysis applications.