CENWS-OD-TS-DM

MEMORANDUM FOR RECORD 8 December 2005

SUBJECT: DETERMINATION OF THE SUITABILITY OF SEDIMENT PROPOSED TO BE MAINTENANCED DREDGED FROM POINT ROBERTS MARINA, POINT ROBERTS, WASHINGTON FOR OPEN-WATER DISPOSAL AT THE WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES (DNR) ROSARIO STRAIT PSDDA OPEN WATER DISPOSAL SITE, AS EVALUATED UNDER SECTION 404 OF THE CLEAN WATER ACT.

1. The following summary reflects the consensus determination of the agencies that comprise the regional Dredged Material Management Program (DMMP) for the State of Washington. The agencies include the Corps of Engineers, Department of Ecology, Department of Natural Resources, and the Environmental Protection Agency. The agencies are charged with determining the suitability of proposed dredged material for in-water disposal and have evaluated the proposed maintenance dredging of 164,900 cubic yards from the Point Roberts Marina Resort, Point Roberts, Whatcom County, Washington.

2. The project was ranked moderate for testing purposes. The sampling and analysis plan was approved on June 13, 2005 by the DMMP agencies for an estimated total dredged material footprint volume of 164,900 cubic yards.

The sampling design called for analyzing representative samples of the proposed maintenance material down to – 15.9 feet MLLW. Sampling of the proposed maintenance dredging footprint (see figure 2) was conducted on July 11 through 17, 2005, and consisted of collecting samples from 35 core stations representing 11 DMMUs.

Samples were collected for both chemistry and potential biological testing. A tiered testing approach was used, and all samples for potential biological testing were archived at 4◦C pending completion of the chemical analysis.

3. Relevant dates for regulatory tracking purposed are included in Table 1.

Table 1. Regulatory Tracking Information and Dates

SAP SUBMITTAL DATE:	MAY 23, 2005
SAP Approval letter date:	June 13, 2005
Sampling date(s):	July11-17, 2005
Sediment data characterization report submittal date:	November 7, 2005
DAIS Tracking Number	PRMSD-1-B-F-222
Recency Determination Date: Moderate (5 years)	November 2010

4. The Sampling and Analysis Plan approved by the agencies for testing for the eleven DMMUs was followed, and quality assurance/quality control guidelines specified by the PSDDA Users Manual were generally complied with. The data gathered were deemed sufficient and acceptable for decision-making by the DMMP agencies based on best professional judgment and current program guidelines.

5. The project was ranked moderate and required a maximum DMMU volume of 16,000 cy, for an estimated dredging volume of 173,145 cy (164,900 cy+5% uncertainty factor). One field sample for every 4,000 cy and one laboratory sample analysis for each 16,000 cy was also required. Subsurface sediments were not separated out as the volume was limited to primarily the edges of the moorage basin and at a few isolated locations. As each of the areas with subsurface sediments will be dredged in one pass, it was determined not to be practical to separate surface and subsurface material. DMMUs are labeled as C1-C11 as presented in attached tables 2A and 2B.

A total of 35 samples were collected from 35 core stations (S-1 through S-35) within the Marina and composited into eleven samples representing eleven DMMUs. Core depth is presented in Table 4. Samples from DMMUs 1, 3, 4, 5, and 9 were sampled utilizing gravity coring techniques from a floating platform. Attempts to core the remaining samples in DMMUs 2, 6, 7, 8, 10, and 11 with the gravity corer were not successful; therefore a vibro-corer mounted on a floating platform was utilized to complete the remaining cores. However, neither coring technique recovered significant sample volume once native material was encountered, primarily in the northern portion of the Marina. As a result, cores were advanced just into the native material based upon guidance provided by Section 3.3.4 of the 2000 Dredged Material Evaluation and Disposal Procedures User Manual.

6. Of the eleven DMMUs, only DMMU 4 had any chemical criteria exceedances. 2-Methylphenol was detected above both the screening level and maximum level and 2-4-Dimethylphenol was detected above the screening level in DMMU 4. Chemical analysis of the DMMU indicated that there were no detected or detection limit exceedences of screening level for any chemicals of concern in the remaining DMMU composites. Tables 2A and 2B provide a complete dry weight chemical analysis inventory and an analysis summary of the results of the conventional parameters analyzed for the eleven DMMUs.

Based on analytical results, sediment from DMMU 4 was selected for sediment toxicity to evaluate the following:

1. 10 day survival of amphipod *Eohastorius etuarius*
2. 20 day survival and growth of the polychaete *Neathes arenaceodentata*
3. 48 hour larval survival and development of the bivalve *Mytilus edulis*

The sample did not exhibit significant adverse effects in the *E. estuarius* or *N. arenaceodentata* tests compared with either the control or reference sediment. No adverse effect was observed on survival in the bivalve larval development tests; however, a statistically significant reduction of percent normal larvae and normal surviving larvae (combined endpoint) was observed in both the reference sediment and DMMU 4 compared with the control. Percent normal development and normal survival was not reduced in DMMU 4 relative to the reference sediment. Although percent normal and normal surviving larvae for DMMU 4 sediment was statistically significantly reduced, the adverse effect was less than 20% relative to the seawater control and is not considered an adverse effect according to the Interim Revised Performance Standards for the Sediment Larval Bioassay Clarification Paper prepared by the Seattle Army Corps of Engineers (1994). Results of the bioassays are presented in Tables 5 through 7.

A sample identified as West Beach was evaluated concurrently as a reference sample. The West Beach sample was collected from Whidbey Island on August 15, 2005.

As interstitial ammonia concentrations were relatively high, reference ammonia toxicity tests were evaluated concurrently using *E. estuarius* and *N. arenaceodentata*. Porewater was extracted from C-4 to be used for analysis of interstitial ammonia. Results indicated that the ammonia levels observed in the sediment tests were lower than the ammonium LC50s for these two organisms.

7. The results of the chemical analysis for the composite DMMU sample representing a total of 164,900 CY of potential dredged material is determined to be suitable for unconfined open-water disposal at the Rosario Strait PSSDA disposal site.

8. This memorandum documents the suitability of sediment to be dredged from the Point Roberts Marina dredging project for disposal at a DNR approved dispersive open-water disposal site. However, this suitability determination does not constitute final agency approval of the project. A dredging plan for this project must be completed as part of the final project approval process. A final decision will be made after full consideration of agency input, and after alternatives analysis is done under Section 404(b)(1) of the Clean Water Act.

Concur:

1/5/06
Date

Gwyn Puckett, Seattle District Corps of Engineers

1/5/06
Date

Jonathan Freedman, Environmental Protection Agency

1/5/06
Date

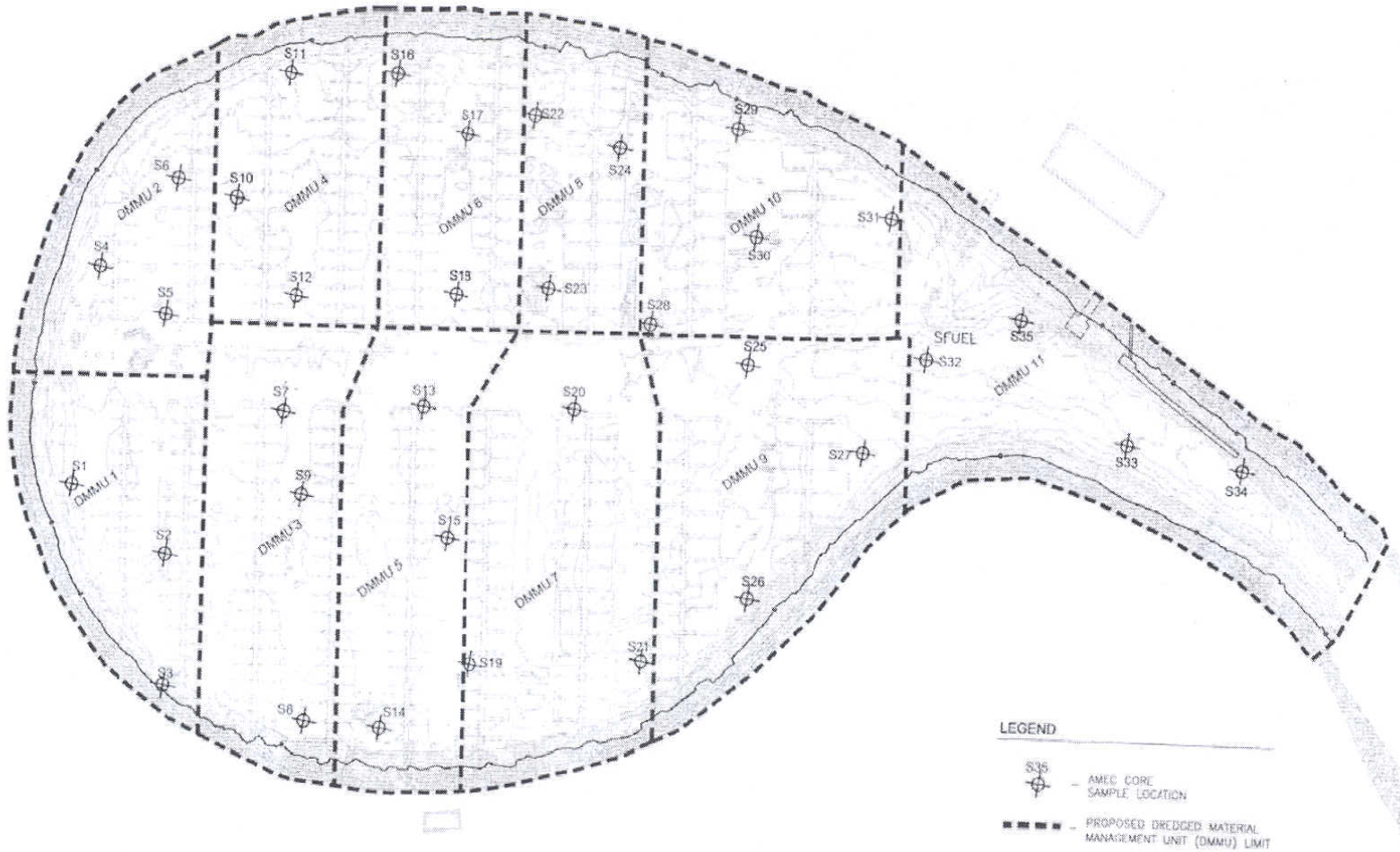
Cinde Donoghue, Washington Department of Ecology

Jan. 5, 2006
Date

Peter Leon, Washington Department of Natural Resources

Copies Furnished:

Randall Perry, Regulatory Branch Project Manager
Jonathan Freedman, EPA
Erika Hoffman, EPA
Cinde Donoghue, Ecology
Tom Gries, Ecology
Helen Pressley, Ecology
Peter Leon, DNR
DMMO File



amec

AMEC EARTH & ENVIRONMENTAL, INC
11335 N.E. 122nd Way, Suite 100
Kirkland, WA U.S.A. 98034-6918

SITE AND EXPLORATION PLAN

POINT ROBERTS MARINA

POINT ROBERTS, WASHINGTON

FIGURE 2

TABLE 2A. CHEMICAL PARAMETERS FOR SEDIMENT SAMPLES DMMUC1THROUGH DMMUC6
POINT ROBERTS MARINA RESORT
Sediment Samples Compared to PSSDA Numerical Criteria
Date Collected: July 11 through 17, 2005

Chemical Parameter	Analysis Method	Group	Units	PSSDA		C1		C2		C3		C4		C5		C6	
				SL	ML												
MISCELLANEOUS																	
Total Solids	EPA 160.3, SM 2540 B	Miscellaneous	percent			51.3		61		43.6		61.3		45.3		71.2	
Preserved Total Solids	EPA 160.3, SM 2540 B	Miscellaneous	percent			43		50.4		46		53.6		42.7		63.1	
Total Volatile Solids	EPA 160.3, SM 2540 B	Miscellaneous	percent			4.95		3.95		10.24		2.97		7.31		3.23	
Total Organic Carbon	Plumb, 1981	Miscellaneous	percent			1.55		1.11		2.51		0.946		2		0.977	
N-Amonia	EPA 350.1, 4500 NH3 H	Miscellaneous	mg-N/kg			39.2		14.5		50.9		15.4		19.2		18.5	
Sulfide	EPA 376.2, SM4500S2-D	Miscellaneous	mg/kg			830		520		51		520		490		320	
NWTPH-Gasoline	WDOE methods	Miscellaneous	mg/kg			< 18	U	< 18	U	< 17	U	< 19	U	< 23	U	< 12	U
NWTPH-Diesel	WDOE methods	Miscellaneous	mg/kg			< 9.4	U	< 8.1	U	< 10	U	< 8.4	U	< 11	U	< 7.0	U
NWTPH-Motor Oil	WDOE methods	Miscellaneous	mg/kg			< 19	U	< 16	U	< 21	U	< 17	U	< 22	U	< 14	U
METALS (mg/kg dry weight, ppm)																	
Tributyl Tin (ion)	Selected for Monitoring GC/MS	Metals (porewater)	µg/l	0.15	--	0.074		0.024		0.1		0.12		0.13		< 0.019	U
Antimony	6010B	Metals	mg/kg-dry	150	200	10	U	8	U	10	U	8	U	10	U	7	U
Arsenic	6010B	Metals	mg/kg-dry	57	700	10		8		10		8	U	10		7	U
Cadmium	6010B	Metals	mg/kg-dry	5.1	14	0.6		0.4		0.7		0.4		0.6		0.3	U
Chromium	6010B	Metals	mg/kg-dry	--	--	46		33.3		47		31.5		46		24.6	
Copper	6010B	Metals	mg/kg-dry	390	1300	43.1		32		44.9		34.1		46.6		18.9	
Lead	6010B	Metals	mg/kg-dry	450	1200	10		7		10		7		10		4	
Mercury	747*AA	Metals	mg/kg-dry	0.41	2.3	0.09	U	0.08	U	0.08	U	0.07	U	0.1	U	0.06	U
Nickel	6010B	Metals	mg/kg-dry	140	370	40		29		40		26		40		20	
Silver	6010B	Metals	mg/kg-dry	6.1	8.4	0.5	U	0.5	U	0.6	U	0.5	U	0.7	U	0.4	U
Zinc	6010B	Metals	mg/kg-dry	410	3,800	80		62.9		79		62		88		40.4	
IONIZABLE ORGANIC COMPOUNDS (mg/kg dry weight, ppm)																	
Phenol	8270-GC/MS	Ionizable Organic Compounds	µg/kg	420	1,200	< 59	U	< 58	U	< 20	U	320		< 20	U	< 19	U

TABLE 2A. CHEMICAL PARAMETERS FOR SEDIMENT SAMPLES DMMUC1THROUGH DMMUC6
POINT ROBERTS MARINA RESORT
Sediment Samples Compared to PSSDA Numerical Criteria
Date Collected: July 11 through 17, 2005

Chemical Parameter	Analysis Method	Group	Units	PSSDA		C1		C2		C3		C4		C5		C6	
				SL	ML												
Benzyl alcohol	8270-GC/MS	Ionizable Organic Compounds	µg/kg	57	870												
2-Methylphenol	8270-GC/MS	Ionizable Organic Compounds	µg/kg	63	77	< 58	U	< 58	U	< 20	U	78		< 20	U	< 19	U
4-Methylphenol	8270-GC/MS	Ionizable Organic Compounds	µg/kg	670	3,600	< 58	U	< 58	U	< 20	U	110		< 20	U	< 19	U
2,4-Dimethylphenol	8270-GC/MS	Ionizable Organic Compounds	µg/kg	29	210	< 58	U	< 58	U	< 20	U	65		< 20	U	< 19	U
Benzoic acid	8270-GC/MS	Ionizable Organic Compounds	µg/kg	650	760												
Pentachlorophenol	8270-GC/MS	Ionizable Organic Compounds	µg/kg	400	690	< 290	U	< 290	U	< 98	U	< 000	U	< 99	U	< 290	U
NONIONIZABLE ORGANIC COMPOUNDS (ug/kg dry weight, ppb)																	
Chlorinated Benzenes																	
1,3-Dichlorbenzene	8270-GC/MS	Chlorinated Benzenes	µg/kg	170	--	< 58	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U
1,4-Dichlorobenzene	8270-GC/MS	Chlorinated Benzenes	µg/kg	110	120	< 58	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U
1,2,-Dichlorobenzene	8270-GC/MS	Chlorinated Benzenes	µg/kg	35	110	< 58	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U
1,2,4-Trichlorobenzene	8270-GC/MS	Chlorinated Benzenes	µg/kg	31	64	< 58	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U
Hexachlorobenzene	8270-GC/MS	Chlorinated Benzenes	µg/kg	22	230	< 58	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U
CHLORINATED PESTICIDES																	
Alpha BHC	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	--	--	< 0.97	U	< 0.98	U	< 0.98	U	< 0.98	U	< 0.99	U	< 0.96	U
gamma-BHC (Lindane)	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	10	--	< 0.97	U	< 0.98	U	< 0.98	U	< 0.98	U	< 0.99	U	< 0.96	U
Heptachlor	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	10	--	< 0.97	U	< 0.98	U	< 0.98	U	< 0.98	U	< 0.99	U	< 0.96	U
Aldrin	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	10	--	< 0.97	U	< 0.98	U	< 0.98	U	< 0.98	U	< 0.99	U	< 0.96	U
Dieldrin	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	10	--	< 1.9	U	< 2.0	U	< 2.0	U	< 2.0	U	< 2.0	U	< 1.9	U
Total 4,4' – DDT	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	6.9	69	< 1.9	U	< 2.0	U	< 2.0	U	< 2.0	U	<2.0	U	< 1.9	U

TABLE 2A. CHEMICAL PARAMETERS FOR SEDIMENT SAMPLES DMMUC1THROUGH DMMUC6
POINT ROBERTS MARINA RESORT
Sediment Samples Compared to PSSDA Numerical Criteria
Date Collected: July 11 through 17, 2005

Chemical Parameter	Analysis Method	Group	Units	PSSDA		C1		C2		C3		C4		C5		C6	
				SL	ML												
gamma Chlordane	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	10	--	< 0.97	U	< 0.98	U	< 0.98	U	< 0.98	U	< 0.99	U	< 0.96	U
alpha Chlordane	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	10	--	< 0.97	U	< 0.98	U	< 0.98	U	< 0.98	U	< 0.99	U	< 0.96	U
MISCELLANEOUS																	
Hexachloroethane	8270-GC/MS	Miscellaneous	µg/kg	1,400	14,000	< 58	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U
Hexachlorobutadiene	8270-GC/MS	Miscellaneous	µg/kg	29	270	< 58	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U
Dibenzofuran	8270-GC/MS	Miscellaneous	µg/kg	540	1700	< 58	U	< 58	U	45		< 59	U	< 20	U	< 19	U
N-nitrosodiphenylamine	8270 GC/MS	Miscellaneous	µg/kg	28	130	< 58	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U
PCBs																	
Aroclor 1016	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U
Aroclor 1242	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U
Aroclor 1248	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U
Aroclor 1254	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U
Aroclor 1260	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U
Aroclor 1221	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U
Aroclor 1232	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U
Total PCBs		PCB	µg/kg	130	3100	< 3.9		< 3.9		< 3.9		< 3.9		< 3.9		< 3.9	
Phthalate Esters																	
Dimethyl phthalate	8270-GC/MS	Phthalate Esters	µg/kg	1400	--	< 58	U	< 58	U	< 20	U	< 60	U	< 20	U	< 19	U
Diethyl phthalate	8270-GC/MS	Phthalate Esters	µg/kg	1200	--	< 58	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U
Di-n-butyl phthalate	8270-GC/MS	Phthalate Esters	µg/kg	6,100		24	B	24	B	23	B	2,600	ss	23	B	21	B
Butyl benzyl phthalate	8270-GC/MS	Phthalate Esters	µg/kg	970	--	< 58	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U
Bis(2-ethylhexyl)phthalate	8270-GC/MS	Phthalate Esters	µg/kg	8,300	--	40		29		39		46		50		< 19	U
Di-n-octyl phthalate	8270-GC/MS	Phthalate Esters	µg/kg	6,200	--	< 58	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U
Aromatic Hydrocarbons																	
Fluoranthene	8270-GC/MS	HPAH	µg/kg	1,700	30,000	230		90		320		160		210		53	

TABLE 2A. CHEMICAL PARAMETERS FOR SEDIMENT SAMPLES DMMUC1THROUGH DMMUC6																			
POINT ROBERTS MARINA RESORT																			
Sediment Samples Compared to PSSDA Numerical Criteria																			
Date Collected: July 11 through 17, 2005																			
Chemical Parameter	Analysis Method	Group	Units	PSSDA		C1		C2		C3		C4		C5		C6			
				SL	ML														
Pyrene	8270-GC/MS	HPAH	µg/kg	2,600	16,000	220		140		300		260		280		53			
Benzo[a]anthracene	8270-GC/MS	HPAH	µg/kg	1,300	5,100	51		30		58		44		50		34			
Chrysene	8270-GC/MS	HPAH	µg/kg	1,400	21,000	100		52		110		120		100		76			
Benzo(b)fluoranthene	8270-GC/MS	HPAH	µg/kg	3,200	9,900	120		80		120		120		130		51			
Benzo(k)fluoranthene	8270-GC/MS	HPAH	µg/kg	3,200	9,900	86		59		73		120		110		62			
Total Benzofluoranthene			µg/kg	3,200	9,900	186		139		193		240		240		113			
Benzo[a]pyrene	8270-GC/MS	HPAH	µg/kg	1,600	3,600	40		30		53		52		53		26			
Indeno[1,2,3-cd]pyrene	8270-GC/MS	HPAH	µg/kg	600	4,400	< 56	U	< 58	U	20		< 59	U	20		< 19	U		
Dibenz[a,h]anthracene	8270-GC/MS	HPAH	µg/kg	230	1,900	< 56	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U		
Benzo[ghi]perylene	8270-GC/MS	HPAH	µg/kg	670	3,200	< 56	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U		
Total HPAH			µg/kg	12,000	55,000	827		481		1054		876		953		367			
Naphthalene	8270-GC/MS	LPAH	µg/kg	2,100	2,400	< 56	U	< 58	U	36		< 59	U	< 20	U	37			
2-Methylnaphthalene	8270-GC/MS	LPAH	µg/kg	670	1,900	< 56	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U		
Acenaphthylene	8270-GC/MS	LPAH	µg/kg	560	1,300	< 56	U	< 58	U	< 20	U	< 59	U	< 20	U	< 19	U		
Acenaphthene	8270-GC/MS	LPAH	µg/kg	500	2,000	< 56	U	< 58	U	95		< 59	U	< 20	U	< 19	U		
Fluorene	8270-GC/MS	LPAH	µg/kg	540	3,600	< 56	U	< 58	U	76		< 59	U	< 20	U	< 19	U		
Phenanthrene	8270-GC/MS	LPAH	µg/kg	1,500	21,000	36		< 58	U	160		61		64		24			
Anthracene	8270-GC/MS	LPAH	µg/kg	960	13,000	24		23		40		< 59	U	22		< 19	U		
Total LPAH			µg/kg	5,200	29,000	60		23		407		61		86		61			
VOLATILE ORGANIC COMPOUNDS																			
Ethylbenzene	Purge & Trap GC/MS	Volatile Organic Compounds	µg/kg	10	50	< 1.9	U	< 1.8	U	< 1.8	U	< 2.0	U	< 2.2	U	< 1.4	U		
Tetrachloroethene	Purge & Trap GC/MS	Volatile Organic Compounds	µg/kg	57	210	< 1.9	U	< 1.8	U	< 1.8	U	<2.0	U	< 2.2	U	< 1.4	U		
Total Xylene	Purge & Trap GC/MS	Volatile Organic Compounds	µg/kg	40	160	< 3.8	U	< 3.6	U	< 3.7	U	<3.9	U	< 4.3	U	< 2.9	U		
Trichloroethene	Purge & Trap GC/MS	Volatile Organic Compounds	µg/kg	160	1,600	< 1.9	U	< 1.8	U	< 1.8	U	<2.0	U	<2.2	U	< 1.4	U		

TABLE 2B. CHEMICAL PARAMETERS FOR SEDIMENT SAMPLES DMMU7 THROUGH DMMU11
POINT ROBERTS MARINA RESORT
Sediment Samples Compared to PSSDA Numerical Criteria
Date Collected: July 11 through 17, 2005

Chemical Parameter	Analysis Method	Group	Units	PSSDA		C7		C8		C9		C10		C11	
				SL	ML										
MISCELLANEOUS															
Total Solids	EPA 160.3, SM 2540 B	Miscellaneous	percent			48.3		56.7		47.1		55.6		60.1	
Preserved Total Solids	EPA 160.3, SM 2540 B	Miscellaneous	percent			43.9		54.9		45.7		53		63.6	
Total Volatile Solids	EPA 160.3, SM 2540 B	Miscellaneous	percent			5.31		5.51		5.37		4.92		4.32	
Total Organic Carbon	Plumb, 1981	Miscellaneous	percent			1.76		1.73		1.71		1.54		1.25	
N-Amorsa	EPA 350.1, 4500 NH3 H	Miscellaneous	mg-N/kg			13.9		14.6		14.2		34.9		33.1	
Sulfide	EPA 376.2, SM4500S2-D	Miscellaneous	mg/kg			420		260		53		610		160	
NWTPH-Gasoline	WDOE methods	Miscellaneous	mg/kg			< 21	U	< 16	U	< 20	U	< 17	U	< 16	U
NWTPH-Diesel	WDOE methods	Miscellaneous	mg/kg			< 11	U	< 8.2	U	< 10	U	< 9.1	U	< 8.5	U
NWTPH-Diesel	WDOE methods	Miscellaneous	mg/kg			< 21	U	< 16	U	< 20	U	< 18	U	< 17	U
METALS (mg/kg dry weight, ppm)															
Tributyl Tin (ion)	Selected Ion Monitoring GC/MS	Metals (porewater)	ug/l	0.15	--	0.032		0.071		0.11		0.13		0.094	
Antimony	6010B	Metals	mg/kg-dry	150	200	10	U	8	U	10	U	9	U	8	U
Arsenic	6010B	Metals	mg/kg-dry	57	700	10		8		10		9		9	
Cadmium	6010B	Metals	mg/kg-dry	5.1	14	0.6		0.3		0.6		0.6		0.4	
Chromium	6010B	Metals	mg/kg-dry	--	--	45		33.7		41		40.2		35.5	
Copper	6010B	Metals	mg/kg-dry	390	1300	42		31.9		39.8		39.9		29	
Lead	6010B	Metals	mg/kg-dry	450	1200	9		6		8		9		7	
Mercury	7471AA	Metals	mg/kg-dry	0.41	2.3	0.07	U	0.06	U	0.07	U	0.06	U	0.06	U
Nickel	6010B	Metals	mg/kg-dry	140	370	39		28		34		34		30	
Silver	6010B	Metals	mg/kg-dry	6.1	8.4	0.6	U	0.6	U	0.6	U	0.5	U	0.5	U
Zinc	6010B	Metals	mg/kg-dry	410	3,800	81		61.2		85		73		58	

TABLE 2B. CHEMICAL PARAMETERS FOR SEDIMENT SAMPLES DMMU7 THROUGH DMMU11
POINT ROBERTS MARINA RESORT
Sediment Samples Compared to PSSDA Numerical Criteria
Date Collected: July 11 through 17, 2005

Chemical Parameter	Analysis Method	Group	Units	PSSDA		C7		C8		C9		C10		C11	
				SL	ML										
IONIZABLE ORGANIC COMPOUNDS (mg/kg dry weight, ppm)															
Phenol	8270-GC/MS	Ionizable Organic Compounds	µg/kg	420	1,200	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Benzyl alcohol	8270-GC/MS	Ionizable Organic Compounds	µg/kg	57	870										
2-Methylphenol	8270-GC/MS	Ionizable Organic Compounds	µg/kg	63	77	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
4-Methylphenol	8270-GC/MS	Ionizable Organic Compounds	µg/kg	670	3,600	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
2,4-Dimethylphenol	8270-GC/MS	Ionizable Organic Compounds	µg/kg	29	210	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Benzoic acid	8270-GC/MS	Ionizable Organic Compounds	µg/kg	650	760										
Pentachlorophenol	8270-GC/MS	Ionizable Organic Compounds	µg/kg	400	690	< 97	U	< 290	U	< 98	U	< 250	U	< 300	U
NONIONIZABLE ORGANIC COMPOUNDS (µg/kg dry weight, ppb)															
Chlorinated Benzenes															
1,3-Dichlorbenzene	8270-GC/MS	Chlorinated Benzenes	µg/kg	170	--	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
1,4-Dichlorobenzene	8270-GC/MS	Chlorinated Benzenes	µg/kg	110	120	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
1,2- Dichlorobenzene	8270-GC/MS	Chlorinated Benzenes	µg/kg	35	110	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
1,2,4-Trichlorobenzene	8270-GC/MS	Chlorinated Benzenes	µg/kg	31	64	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Hexachlorobenzene	8270-GC/MS	Chlorinated Benzenes	µg/kg	22	230	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
CHLORINATED PESTICIDES															
Alpha-BHC	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	--	--	< 0.96	U	< 0.96	U	< 0.98	U	< 0.98	U	< 0.99	U
gamma-BHC (Lindane)	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	10	--	< 0.96	U	< 0.96	U	< 0.98	U	< 0.98	U	< 0.99	U

TABLE 2B. CHEMICAL PARAMETERS FOR SEDIMENT SAMPLES DMMU7 THROUGH DMMU11
POINT ROBERTS MARINA RESORT
Sediment Samples Compared to PSSDA Numerical Criteria
Date Collected: July 11 through 17, 2005

Chemical Parameter	Analysis Method	Group	Units	PSSDA		C7		C8		C9		C10		C11	
				SL	ML										
Heptachlor	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	10	--	< 0.98	U	< 0.96	U	< 0.98	U	< 0.98	U	< 0.99	U
Aldrin	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	10	--	< 0.98	U	< 0.96	U	< 0.98	U	< 0.98	U	< 0.99	U
Dieldrin	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	10	--	< 2.0	U	< 1.9	U	< 2.0	U	< 2.0	U	< 2.0	U
Total 4,4' – DDT	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	6.9	69	< 2.0	U	< 1.9	U	< 2.0	U	< 2.0	U	< 2.0	U
gamma Chlordane	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	10	--	< 0.98	U	< 0.96	U	< 0.98	U	< 0.98	U	< 0.99	U
alpha Chlordane	Pesticides/PCBs by GC/ECD	Chlorinated Pesticides	µg/kg	10	--	< 0.98	U	< 0.96	U	< 0.98	U	< 0.98	U	< 0.99	U
MISCELLANEOUS															
Hexachloroethane	8270-GC/MS	Miscellaneous	µg/kg	1,400	14,000	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Hexachlorobutadiene	8270-GC/MS	Miscellaneous	µg/kg	29	270	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Dibenzofuran	8270-GC/MS	Miscellaneous	µg/kg	540	1700	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
N-nitrosodiphenylamine	8270-GC/MS	Miscellaneous	µg/kg	28	130	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
PCBs															
Aroclor 1016	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 4.0	U
Aroclor 1242	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 4.0	U
Aroclor 1248	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 4.0	U
Aroclor 1254	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 4.0	U
Aroclor 1260	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 4.0	U
Aroclor 1221	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 4.0	U
Aroclor 1232	Pesticides/PCBs by GC/ECD	PCB	µg/kg			< 3.9	U	< 3.9	U	< 3.9	U	< 3.9	U	< 4.0	U
Total PCBs		PCB	µg/kg	130	3100	0		0		0		0		0	
Phthalate Esters															
Dimethyl phthalate	8270-GC/MS	Phthalate Esters	µg/kg	1400	--	< 20	U	19		< 20	U	< 59	U	< 59	U

TABLE 2B. CHEMICAL PARAMETERS FOR SEDIMENT SAMPLES DMMU7 THROUGH DMMU11
POINT ROBERTS MARINA RESORT
Sediment Samples Compared to PSSDA Numerical Criteria
Date Collected: July 11 through 17, 2005

Chemical Parameter	Analysis Method	Group	Units	PSSDA		C7		C8		C9		C10		C11	
				SL	ML										
Diethyl phthalate	8270-GC/MS	Phthalate Esters	µg/kg	1200	--	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Di-n-butyl phthalate	8270-GC/MS	Phthalate Esters	µg/kg	5,100	--	20	B	24	B	< 20	U	36	B	21	B
Butyl benzyl phthalate	8270-GC/MS	Phthalate Esters	µg/kg	970	--	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Bis[2-ethylhexyl]phthalate	8270-GC/MS	Phthalate Esters	µg/kg	8,300	--	22		27		33		20		< 59	U
Di-n-octyl phthalate	8270-GC/MS	Phthalate Esters	µg/kg	6,200	--	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Aromatic Hydrocarbons															
Fluoranthene	8270-GC/MS	HPAH	µg/kg	1,700	30,000	88		320		170		140		180	
Pyrene	8270-GC/MS	HPAH	µg/kg	2,600	16,000	130		280		220		250		220	
Benzo[a]anthracene	8270-GC/MS	HPAH	µg/kg	1,300	5,100	28		40		41		51		76	
Chrysene	8270-GC/MS	HPAH	µg/kg	1,400	21,000	66		110		91		100		100	
Benzo(b)fluoranthene	8270-GC/MS	HPAH	µg/kg	3,200	9,900	73		110		100		100		110	
Benzo(k)fluoranthene	8270-GC/MS	HPAH	µg/kg	3,200	9,900	59		100		84		130		79	
Total Benzofluoranthene			µg/kg	3,200	9,900	132		210		184		230		189	
Benzo[a]pyrene	8270-GC/MS	HPAH	µg/kg	1,600	3,600	27		100		45		61		81	
Indeno[1,2,3-cd]pyrene	8270-GC/MS	HPAH	µg/kg	600	4,400	< 20	U	< 58	U	< 20	U	< 59	U	22	
Dibenz[a,h]anthracene	8270-GC/MS	HPAH	µg/kg	230	1,900	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Benzo[ghi]perylene	8270-GC/MS	HPAH	µg/kg	670	3,200	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Total HPAH			µg/kg	12,000	69,000	471		1060		751		832		868	
Naphthalene	8270-GC/MS	LPAH	µg/kg	2,100	2,400	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
2-Methylnaphthalene	8270-GC/MS	LPAH	µg/kg	670	1,900	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Acenaphthylene	8270-GC/MS	LPAH	µg/kg	560	1,300	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Acenaphthene	8270-GC/MS	LPAH	µg/kg	500	2,000	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Fluorene	8270-GC/MS	LPAH	µg/kg	540	3,600	< 20	U	< 58	U	< 20	U	< 59	U	< 59	U
Phenanthrene	8270-GC/MS	LPAH	µg/kg	1,500	21,000	41		48		74		32		71	
Anthracene	8270-GC/MS	LPAH	µg/kg	960	13,000	< 20	U	< 58	U	< 20	U	27		25	
Total LPAH			µg/kg	5,200	2,900	41		48		74		59		96	

TABLE 2B. CHEMICAL PARAMETERS FOR SEDIMENT SAMPLES DMMU7 THROUGH DMMU11															
POINT ROBERTS MARINA RESORT															
Sediment Samples Compared to PSSDA Numerical Criteria															
Date Collected: July 11 through 17, 2005															
Chemical Parameter	Analysis Method	Group	Units	PSSDA		C7		C8		C9		C10		C11	
				SL	ML										
VOLATILE ORGANIC COMPOUNDS															
Ethylbenzene	Purge & Trap GC/MS	Volatile Organic Compounds	µg/kg	10	50	< 2.1	U	< 1.8	U	< 2.0	U	< 1.8	U	< 1.7	U
Tetrachloroethene	Purge & Trap GC/MS	Volatile Organic Compounds	µg/kg	57	210	< 2.1	U	< 1.8	U	< 2.0	U	< 1.8	U	< 1.7	U
Total Xylene	Purge & Trap GC/MS	Volatile Organic Compounds	µg/kg	40	160	< 4.2	U	< 3.5	U	< 3.9	U	< 3.6	U	< 3.4	U
Trichloroethene	Purge & Trap GC/MS	Volatile Organic Compounds	µg/kg	160	1,600	< 2.1	U	< 1.8	U	< 2.0	U	< 1.8	U	< 1.7	U

Notes for Tables 2A and 2B:

-- = no numerical criterion of this type for the chemical

J - estimated

U - undetected

SL - screening level

ML - maximum level

PCB - polychlorinated biphenyl

HPAH - high molecular weight polycyclic aromatic hydrocarbon

LPAH - low molecular weight polycyclic aromatic hydrocarbon

* As per PSDDA guidance the highest recorded value is reported.

- Bolded values indicate positive detections

Shaded box indicates an exceedance of SL or ML value

Table 3. Grain Size Distribution Point Roberts Marina Resort

Sample	Clay	Silt	Sand	Gravel	Total Fines	Total
DMMUC1	32.4	42.3	24.1	1.0	74.7	99.8
DMMUC2	25.3	42.3	31.7	0.6	67.6	99.9
DMMUC3	31.8	48.5	19.1	0.5	80.3	99.9
DMMUC4	19.9	36.5	38.4	5.2	56.4	100.0
DMMUC5	34.1	46.1	19.7	0.2	80.2	100.1
DMMUC6	14.1	29.8	54.1	2.0	43.9	100.0
DMMUC7	35.8	40.8	20.8	2.6	76.6	100.0
DMMUC8	22.6	50.8	26.2	0.3	73.4	99.9
DMMUC9	29.7	46.8	22.8	0.7	76.5	100.0
DMMUC10	29.4	50.2	19.5	0.9	79.6	100.0
DMMUC11	19.6	38.5	38.8	3.3	58.1	100.2

Table 4. Sampling Station Boring Depths and Elevations

Station Name	*Location*	*Core (feet MLLW)*
Sample 1	S of T Pier near Slip 6	-8.0 to-12.0
Sample 2	S of I Pier near Slip 31	-9.7 to -15.4
Sample 3	N of J Pier near Slip 12	-8.4 to -13.1
Sample 4	N of T Pier near Slip 34	-7.5 to -11.6
Sample 5	N of A Pier near Slip 8	-9.8 to -12.4
Sample 6	N of A Pier near Slip 36	-8.6 to -11.9
Sample 7	N between B Pier and K Pier	-10.8 to -13.4
		-10.8 to -15.4
		-10.8 to -14.1
Sample 8	S of K Pier near Slip 13	-9.8 to -12.7
		-9.8 to-14.2
		-9.8 to -14.4
Sample 9	N of L Pier Slip 64	-10.7 to -15.3
		-10.7 to -15.3
		-10.7 to -13.2
Sample 10	N of B Pier near Slip 32	-9.9 to -11.9
		-9.9 to14.1
Sample 11	S of B Pier near Slip 1	-8.9 to -13.2
Sample 12	S of B Pier near Slip 51	-10.1 to -12.6
		-10.1 to -13.1
Sample 13	Between Piers D and M	-10.6 to -13.5
		-10.6 to -13.1
		-10.6 to -14.3
		-10.6 to -14.1
Sample 14	N of M Pier near Slip 9	-10.0 to -13.3
		-10.0 to -14.4
		-10.0 to -12.8
		-10.0 to -13.2
		-10.0 to -13.9
Sample 15	S of M Pier near Slip 53	-10.1 to -13.3
		-10.1 to -13.9
		-10.1 to -13.9
		-10.1 to -14.1
		-10.1 to -13.5
Sample 16	N of D Pier near Slip 8	-6.3 to -8.46
Sample 17	N of E Pier Slip 18	-8.9 to -12.6
Sample 18	N of E Pier near Slip 54	-9.8 to -12.6
Sample 19	N Pier Slip 22	-10.6 to -14.6
Sample 20	Between F and O Piers	-10.7 to -14.5
Sample 21	S of O Pier near Slip 17	-11.4 to -15.2
Sample 22	S of E Pier near Slip 7	-8.0 to -11.0
Sample 23	S of E Pier near Slip 43	-6.5 to -9.0
Sample 24	F Pier Slip 7	-8.8 to -10.3
Sample 25	Between G and P Piers	-11.3 to -13.7
		-11.5 to -13.8
		-11.3 to -14.0

Table 4. Sampling Station Boring Depths and Elevations

Station Name	*Location*	*Core (feet MLLW)*
Sample 1	S of T Pier near Slip 6	-8.0 to-12.0
Sample 2	S of I Pier near Slip 31	-9.7 to -15.4
Sample 3	N of J Pier near Slip 12	-8.4 to -13.1
Sample 4	N of T Pier near Slip 34	-7.5 to -11.6
Sample 5	N of A Pier near Slip 8	-9.8 to -12.4
Sample 6	N of A Pier near Slip 36	-8.6 to -11.9
Sample 7	N between B Pier and K Pier	-10.8 to -13.4
		-10.8 to -15.4
		-10.8 to -14.1
Sample 8	S of K Pier near Slip 13	-9.8 to -12.7
		-9.8 to-14.2
		-9.8 to -14.4
Sample 9	N of L Pier Slip 64	-10.7 to -15.3
		-10.7 to -15.3
		-10.7 to -13.2
Sample 10	N of B Pier near Slip 32	-9.9 to -11.9
		-9.9 to14.1
Sample 11	S of B Pier near Slip 1	-8.9 to -13.2
Sample 12	S of B Pier near Slip 51	-10.1 to -12.6
		-10.1 to -13.1
Sample 13	Between Piers D and M	-10.6 to -13.5
		-10.6 to -13.1
		-10.6 to -14.3
		-10.6 to -14.1
Sample 14	N of M Pier near Slip 9	-10.0 to -13.3
		-10.0 to -14.4
		-10.0 to -12.8
		-10.0 to -13.2
		-10.0 to -13.9
Sample 15	S of M Pier near Slip 53	-10.1 to -13.3
		-10.1 to -13.9
		-10.1 to -13.9
		-10.1 to -14.1
		-10.1 to -13.5
Sample 16	N of D Pier near Slip 8	-6.3 to -8.46
Sample 17	N of E Pier Slip 18	-8.9 to -12.6
Sample 18	N of E Pier near Slip 54	-9.8 to -12.6
Sample 19	N Pier Slip 22	-10.6 to -14.6
Sample 20	Between F and O Piers	-10.7 to -14.5
Sample 21	S of O Pier near Slip 17	-11.4 to -15.2
Sample 22	S of E Pier near Slip 7	-8.0 to -11.0
Sample 23	S of E Pier near Slip 43	-6.5 to -9.0
Sample 24	F Pier Slip 7	-8.8 to -10.3
Sample 25	Between G and P Piers	-11.3 to -13.7
		-11.5 to -13.8
		-11.3 to -14.0

Sample 26	S of P Pier near Slip 11	-11.5 to -14.5 -11.5 to -14.8 -11.5 to -15.0
Sample 27	S of Q Pier near Slip 13	-10.8 to -12.8
Sample 28	N of G Pier near Slip 34	-6.9 to -10.1
Sample 29	S of G Pier near Slip 3	-9.5 to -13.2
Sample 30	E of the Fuel Dock	-10.9 to -15.9
Sample 31	E of the Guest Dock	-9.9 to -13.9
Sample 32	S of the Guest Dock	-10.7 to -14.6
Sample 33	E of the Guest Dock	-9.8 to -11.4
Sample 34	S of the Guest Dock	-8.8 to -11.6
Sample 35	Between the Fuel and the Guest Docks	-8.6 to -11.1

Table 5. Results (means ± standard deviations) for *E. estuarius* survival

Station ID	Survival (%)
Control	91.0 ± 4.2
West Beach (reference)	91.0 ± 5.5
C-4	84.0 ± 7.4

Table 6. Results (means ± standard deviations) for *N. arenaceodentata* survival and growth

Station ID	Survival (%)	Total weight (mg)	Individual dry weight (mg)	Individual growth (mg/day)
Control	96.0±8.9	69.0±12.8	14.3±1.7	0.69±0.09
West Beach (reference)	100.0±0.0	83.3±25.3	16.7±5.1	0.81±0.25
C-4	96.0±8.9	74.6±17.7	15.4±2.7	0.74±0.13

Table 7. Results (means ± standard deviations) for *M. edulis* survival and normal development

Station ID	Surviving larvae (%)	Normal larvae (%)	Normal surviving larvae (%)
Control	95.1 ± 5.6	91.1 ± 1.2	87.2 ± 5.3
West Beach (reference)	87.1 ± 11.7	81.1 ± 7.6	71.2 ± 15.0*
C-4	91.0 ± 7.5	81.1 ± 3.8	74.1 ± 7.0*

* Indicated significant difference to the control.