CENWS-OD-TS-NR

MEMORANDUM FOR: RECORD January 5, 2017

SUBJECT: DETERMINATION REGARDING THE SUITABILITY OF PROPOSED DREDGED MATERIAL FROM THE PORT OF GRAYS HARBOR, WESTPORT MARINA, WESTPORT, WASHINGTON, FOR PLACEMENT AT THE PT. CHEHALIS OR SOUTH JETTY DISPERSIVE OPEN-WATER DISPOSAL SITES, OR AT AN APPROVED UPLAND SITE.

1. INTRODUCTION. This memorandum reflects the consensus determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Environmental Protection Agency, and Washington Departments of Ecology and Natural Resources) regarding the suitability of up to a total of 245,000 cubic yards (cy) of dredged material from the Port of Grays Harbor Westport Marina for open-water disposal. Proposed in-water dredged material placement is at the South Jetty or Point Chehalis DNR dispersive sites. Proposed upland disposal is on Port-owned property adjacent to the marina.

2. PROJECT SUMMARY. The Port of Grays Harbor proposes to dredge portions of Westport Marina to restore safe navigable depths (Figure 1). Proposed dredging is planned for winter 2018. The proposed dredge prism will range in thickness from less than 1 ft. to 8 ft. below mudline (including overdredge allowance). The proposed dredging volume within the marina basin is approximately 245,000 cubic yards.

   Subsequent to the testing described in this memo, the Port of Grays Harbor requested that the final suitability be postponed while project planners considered additional dredging and disposal options. Among the options was further testing for alternative dredge prisms, in which case those results would be considered alongside the 2015 results in a composite suitability determination. On December 7, 2016, the Port submitted a letter detailing updated disposal plans and requesting that this decision document be finalized based on existing information.

Table 1. Westport Marina Project Tracking

SAP received	September 9, 2014
SAP approved	September 24, 2014
Sampling dates	October 6-10, 2014
Data report received	April 13, 2015
SD Postponement requested	July 1, 2015
SD Finalization requested	December 7, 2016
DMMP Tracking number	PGHWM-1-B-F-353
EIM Project number	PGHWM14
USACE Permit Number	TBD
Recency Expiration Date (Mod Rank--5 years)	October 2019

3. PROJECT RANKING AND SAMPLING REQUIREMENTS. Westport Marina was ranked “moderate” for this characterization, per the general ranking for marinas in Grays Harbor in the DMMP User

Manual (DMMP 2016). For a moderate-ranked project with heterogeneous sediment, the number of samples and analyses are calculated using the following guidelines:

- Maximum volume of sediment represented by each field sample = 4,000 cubic yards.
- Maximum volume of sediment represented by each analysis in the upper 4-feet of the dredging prism (surface sediment) = 16,000 cubic yards.
- Maximum volume of sediment represented by each analysis in the subsurface portion of the dredging prism = 24,000 cubic yards.

The sampling approach for this project was based on the proposed dredge volume, dredge prism configuration, and sampling frequency, and also based on typical cross sections and conditions within the project area (Table 3). The dredge prism for the sampling design included the following assumptions:

- Existing top of mudline ranges from approximately elevation 0 to -18 feet MLLW.
- Design dredging depth will be elevation –16 feet MLLW and -18 feet MLLW depending upon the location in the marina. These depths include 1 ft. of allowable overdredge depth.
- All proposed dredged material was considered to be "surface" material.

4. SAMPLING. Sampling took place on October 6 - 10, 2014, using a vibracore sampler. Thirty-nine cores were obtained per the approved SAP. Some sample locations were revised in the field due to blocked access, or because the elevation of the proposed location was below the design dredge depth (Table 4).

5. CONVENTIONAL AND CHEMICAL ANALYSIS. The approved sampling and analysis plan was followed and quality control guidelines specified by the PSEP and DMMP programs were met, with only minor quality control deviations (BergerABAM 2015). After results of the initial composite analyses were received, some follow-up analyses were done, per details below. The final data were considered sufficient and acceptable for regulatory decision-making under the DMMP program.

   Sediment conventional results (Table 5) showed that the proposed dredged material is predominantly sandy silt and silty sand. Total fine fractions (silt + clay) ranged from 27% in DMMU-16 to 87% in DMMU-3. Total organic carbon ranged from under 1% to almost 4%.

   Chemical results indicated several detected exceedances of DMMP standard chemicals of concern screening levels (Table 6). In initial results, bis(2-ethylhexyl) phthalate (DEHP) was detected above the SL in DMMUs 3, 7, 9 and 16, and above the ML in DMMUs 12 and 14. Chrysene exceeded the SL in DMMU-5, and guidelines for Grays Harbor dioxin/furan TEQs were exceeded in DMMU-12. There were undetected exceedances of heptachlor in DMMU-7, and of total chlordane in DMMU-14. Since both these DMMUs underwent additional testing, the undetected exceedances alone did not drive any further testing.

   Follow-up analyses. Five DMMUs (3, 5, 7, 9 and 16) were submitted to Northwest Aquatic Sciences for bioassay toxicity testing after DMMP Screening Levels were exceeded. Two other DMMUs had exceedances that were not submitted for bioassay testing: DMMU-12 had an exceedance of GH dioxin guidelines, and DMMU-14 had an exceedance of the DMMP Maximum Level for DEHP. Separate sample cores associated with these DMMU composites were submitted for follow-up chemical analysis of DEHP and/or dioxin in order to see whether contamination was isolated within the given DMMU. After separate cores did not reflect the high levels of DEHP in the original composites, the archived sediment from the composite samples for all DMMUs with exceedances of DEHP were re-extracted and re-analyzed for that chemical only. Z-samples associated with DMMUs 7, 9, 12 and 14 were also

submitted for analysis of DEHP. Z-samples associated with DMMU-12 were submitted for dioxin analysis due to the overlying exceedance.

Dioxins. Dioxins/furans were detected in all 17 DMMU composite samples, with toxicity equivalents (TEQ, with U = ½ estimated detection limit) ranging from 3.4 to 24.1 ng/kg dry wt. (Table 7). Sixteen DMMU had TEQs below the 15 ng/kg TEQ suitability level set for Grays Harbor; only DMMU-12 exceeded the dioxin TEQ regulatory guidelines. Levels of 2,3,7,8 TCDD were below the 5 ng/kg suitability level set for this dioxin congener in all DMMUs, with levels ranging from non-detect to 1.42 ng/kg dry wt.

Bis(2-ethylhexyl) phthalate (DEHP). Initial results indicated very high levels of bis(2-ethylhexyl) phthalate, also known as DEHP. Four DMMU (3, 7, 9 and 16) were submitted for bioassay analysis based on this SL exceedance alone; no other chemical exceedances were detected. Two DMMUs (12 and 14) had exceedances of the DMMP ML of DEHP. DMMU-12 was considered unsuitable due to dioxin exceedances, which cannot be overridden with bioassays. The DEHP ML exceedance in DMMU-14 was a single exceedance, but the project proponent chose not to pursue bioassay testing on this DMMU. ML exceedances are set at a level where biological impacts are routinely seen, so conducting bioassay tests on DMMU-14 was not considered practicable.

Results for DEHP in the separate cores of DMMUs 12 and 14 were two orders of magnitude lower than those seen in the original composites. DEHP is an environmental contaminant, but it is also a known laboratory contaminant. The Port requested that DMMU-14—which had no exceedances other than DEHP, but which hadn't undergone bioassay testing before bioassay holding time expired—be considered suitable for open-water disposal based on the re-tests. The DMMP agreed that the original levels of DEHP may have been erroneous, and could not be considered conclusive. But two of the DMMUs with DEHP SL exceedances did not pass bioassay testing, even with no other chemical exceedances. The DMMP agreed that DMMP-14 could be reconsidered for suitability IF archived sediment of all DMMUs with DEHP exceedances were analyzed. If the result for DMMU-14 was below the result for any DMMU that failed bioassays, then DMMU-14 could be considered for open-water disposal. Results of all samples tested, including proposed dredged material as well as Z-samples, showed levels of DEHP well below the DMMP SL. Results for DMMU-14 were also lower than in DMMU-5, which passed bioassays. DMMU-14 was thus considered suitable for open-water disposal.

6. BIOASSAY TESTS. Composite samples from DMMUs 3, 5, 7, 9 and 16 were submitted to Northwest Aquatic Sciences for bioassay toxicity testing after DMMP Screening Levels were exceeded. Reference sediment samples were collected November 20, 2014 near the Grays Harbor reference site GHS7. Collection included both a "high-fines" (76%) reference sediment and a "low-fines" (25%) sediment, so that an appropriate reference would be available for all test samples (Figure 3). Fines content of reference sediments was estimated in the field via wet-sieve analysis (BergerABAM 2015). Field analysis showed that DMMU-7 had total fines of 48%, intermediate between the reference samples. DMMU-7 was thus compared with both reference sediments; the most conservative comparison was used for interpretation (Tables 9-12).

   Tests were conducted at Northwest Aquatic Sciences, Newport, Oregon, based on PSEP 1995. Quality control guidelines were generally met, though slightly high levels of ammonia were detected in some samples. Results were considered sufficient and acceptable for regulatory decision-making under the DMMP program.

   Amphipod (*Eohaustorius estuarius*) acute survival test: Control sediment was collected from the *E. estuarius* collection site in Yaquina Bay, Oregon. Test control and reference sediment criteria were

met and the positive control performance was within the laboratory acceptance criteria (Table 10). Only DMMU-9 failed this bioassay, under the single hit dispersive rule.

Polychaete worm *(Neanthes arenaceodentata)* chronic survival and growth test: Control sediment was collected from Yaquina Bay, Oregon. All control and reference sediments met performance guidelines, and no test sediments failed under dispersive site guidelines (Table 11).

Larval *(Mytilus galloprovincialis)* sediment toxicity test: Control and test seawater were collected from Yaquina Bay, Oregon. All control and reference sediments met performance guidelines. For data interpretation, the number of normal larvae was used instead of the normalized combined mortality and abnormality (NCMA) due to the NCMA resulting in negative numbers in some replicates. DMMU-7 and DMMU-9 test sediments both failed under dispersive site 1-hit guidelines (Table 12).

7. POST-DREDGE SEDIMENT QUALITY. The sediment to be exposed by dredging must either meet the State of Washington Sediment Quality Standards (SQS) or the State's Antidegradation standard (Ecology 2013) as outlined by DMMP guidance (DMMP 2008). For this project, most sediment exposed by dredging—as represented by the Z-samples for DMMUs that had SL exceedances—had all results below DMMP SLs. This included all Z-samples tested except for DMMU-12, which failed due to dioxin (Z-28 and Z-29). Dioxin results in those Z-samples was 7.44 TEQ and 10.92 TEQ, respectively—both lower than dioxin standards for Grays Harbor. However, the laboratory duplicate for Z-29 had a TEQ of 16.1—slightly over the 15 TEQ set for disposal in Grays Harbor. Since all values are below the dredged material TEQ of 24.1 in DMMU-12, the sediment to be exposed by dredging is not considered to be degraded relative to the currently exposed sediment surface. Thus the DMMP agencies concluded that this project is in compliance with the State of Washington anti-degradation policy.

8. PROJECT RE-RANK. For this characterization, the DMMP ranked this project "moderate" per guidelines in the DMMP User Manual (DMMP 2016). Project rankings "represent a best professional judgment of concern or potential risk by the agencies, typically based on a scale of potential for adverse biological effects or elevated concentrations of chemicals of concern" as outlined in Table 2.

Table 2. Dredged Material Ranking Guidelines (Table 5-1 in 2016 User Manual)

RANK	GUIDELINES
Very Low	Project is sufficiently removed from potential sources of sediment contamination either geospatially or vertically (in the case of native sediment). Bioaccumulative compounds are not likely present at levels of concern based on review of historical data and comparison to DMMP bioaccumulation triggers. The site is subject to strong current and/or tidal energy and contains coarse-grained sediment with at least 80 percent sand retained in a No. 230 sieve and total organic carbon (TOC) content of less than 0.5 percent.
Low	Few or no sources of chemicals of concern. Data are available to verify low chemical concentrations (below DMMP screening levels and bioaccumulation triggers) and no significant response in biological tests.
Low-Moderate	Available information indicates a "low" rank, but there are insufficient data to confirm the ranking.
Moderate	Sources exist in the vicinity of the project, or there are present or historical uses of the project site, with the potential for producing chemical concentrations within a range associated historically with some potential for causing adverse biological impacts.
High	Many known chemical sources, high concentrations of chemicals of concern, and/or biological testing failures in one or both of the two most recent cycles of testing. Projects located within or adjacent to a MTCA/CERCLA cleanup site may be subject to project-specific ranking guidelines with higher sampling and testing requirements.

Per Table 2, one of the criteria for a "high" rank is biological testing failures in one or both of the two most recent cycles of testing. Since two project DMMUs failed bioassay testing, this project will be ranked "high" for the next round of testing.

9. SUITABILITY DETERMINATION. This memorandum documents the evaluation of the suitability of sediment proposed for dredging from the Port of Grays Harbor Westport Marina for open-water disposal at a DMMP dispersive disposal site. The approved sampling and analysis plan was generally followed and the data gathered were deemed sufficient and acceptable for regulatory decision-making under the DMMP program. Based on the results of the previously described testing, the DMMP agencies concluded that 204,200 cy are suitable for open-water disposal at a DMMP dispersive site. A total of 40,800 cy are NOT suitable for in-water disposal, as detailed below:

   - Suitable for in-water disposal: DMMUs 1, 2, 3, 4, 5, 6, 8, 10, 11, 13, 14, 15, 16, 17
   - Unsuitable for in-water disposal: DMMUs 7, 9, 12

   DMMUs suitable for open-water disposal are also potentially suitable for in-water beneficial use. However, any proposed beneficial use site must be separately permitted and may have additional guidelines or requirements for use of this material.

   Debris Management. The DMMP agencies implemented a debris screening requirement in 2015 to prevent the disposal of solid waste and large debris at open-water disposal sites (DMMP 2015). It states that "all projects must use a screen to remove debris unless it can be demonstrated that debris is unlikely to be present or that the debris present is large woody debris that can be easily observed and removed by other means during dredging." For this project, a 12"x12" debris screen must be used for all DMMUs, unless information is provided to the DMMP that meet the "reason to believe" criteria laid out in DMMP 2015.

   Permitting. This suitability determination does *not* constitute final agency approval of this project. During the comment period that follows a public notice, resource agencies will provide input on the overall project. A final decision will be made after full consideration of agency input, and after an alternatives analysis is done under section 404(b)(1) of the Clean Water Act. A DNR site use authorization must also be acquired for disposal at a DMMP disposal site.

   Pre-Dredge Quality Control Plan and Meeting. A pre-dredge meeting with DNR, Ecology, EPA and the Corps of Engineers is required at least 7 days prior to dredging. A dredging quality control plan (QCP) must be developed and submitted to the Regulatory Branch of the Seattle District Corps of Engineers at least 7 days prior to the pre-dredge meeting. The dredging quality control plan must clearly show how the unsuitable material will be dredged and handled separately from suitable material. Dredging, positioning, de-watering, transloading and disposal will all need to be addressed with enough detail to provide assurance to the agencies that the dredge plan will be properly implemented. The QCP must include a debris management plan, including the use of a 12"x12" debris screen as required.

10. REFERENCES

BergerABAM 2015. *Dredged Material Characterization Report, Port of Grays Harbor, Westport Marina, Westport, Washington*. Prepared by BergerABAM for US Army Corps of Engineers, Seattle District. 6 April 2015.

DMMP 1997. *DMMP Clarification Paper: Beneficial Use of Dredged Material.* Prepared by Justine Barton (EPA Region 10) for the Dredged Material Management Program, May 1997.

DMMP 2008. *DMMP Clarification Paper: Quality of Post-Dredge Sediment Surfaces (Updated).* Prepared by David Fox (USACE), Erika Hoffman (EPA) and Tom Gries (Ecology) for the Dredged Material Management Program, June 2008.

DMMP 2013. *DMMP Clarification Paper: Bioassay Endpoint Refinements: Bivalve Larval and Neanthes Growth Bioassays.* Prepared by David Kendall, (U.S. Army Corps of Engineers) and Russ McMillan (Washington State Department of Ecology) for the DMMP agencies and SMS Program, and Bill Gardiner, Brian Hester, and Jack D Word (NewFields, LLC). June 2013.

DMMP 2016. *Dredged Material Evaluation and Disposal Procedures (User Manual)*. Dredged Material Management Program, updated August 2016.

Ecology 2013. *Sediment Management Standards – Chapter 173-204 WAC*. Washington State Department of Ecology, February 2013.

PSDDA 1988. *Evaluation Procedures Technical Appendix – Phase I – Central Puget Sound*. U.S. Army Corps of Engineers Seattle District, U.S. Environmental Protection Agency Region 10, Washington State Department of Ecology, Washington State of Natural Resources. June 1988.

PSEP 1995. *Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments, with modifications as specified by the Dredged Material Management Program. Dredged Material Evaluation and Disposal Procedures User Manual, December 2014*.

Table 3. Westport Marina Samples and DMMUs

DMMU ID	DMMU volume (cy)	Sample ID	Sample volume (cy)
DMMU-1	15,100	WMar1	3,900
		WMar2	3,900
		WMar3	3,700
		WMar4	3,600
DMMU-2	13,900	WMar5	2,800
		WMar5b	2,800
		WMar6	2,100
		WMar6b	3,700
		WMar7	2,500
DMMU-3	15,300	WMar8	3,800
		WMar9	3,200
		WMar9b	3,600
		WMar10	2,000
		WMar10b	2,700
DMMU-4	15,800	WMar11	2,300
		WMar11b	2,700
		WMar12	3,600
		WMar12b	2,800
		WMar13	4,400
DMMU-5	14,200	WMar14	4,000
		WMar15	4,000
		WMar16	3,500
		WMar16b	2,700
DMMU-6	16,100	WMar17	4,000
		WMar17b	4,000
		WMar18	4,200
		WMar18b	3,900
DMMU-7	16,000	WMar19	4,000
		WMar19b	4,100
		WMar20	4,200
		WMar20b	3,700
DMMU-8	10,200	WMar21	3,900
		WMar22	3,700
		WMar22b	2,600
DMMU-9	8,700	WMar23	4,200
		WMar23b	4,500
DMMU-10	10,900	WMar24	4,300
		WMar24b	4,400
		WMar25	2,200
DMMU-11	15,300	WMar26	4,100
		WMar26b	4,300
		WMar27	2,400
		WMar27b	4,500
DMMU-12	16,100	WMar28	3,700
		WMar28b	4,200
		WMar29	4,100
		WMar29b	4,100
DMMU-13	15,800	WMar30	3,500
		WMar30b	3,900
		WMar31	4,400
		WMar31b	4,000
DMMU-14	14,800	WMar32	3,500
		WMar32b	3,800
		WMar33	3,700
		WMar33b	3,800
DMMU-15	15,600	WMar34	4,100
		WMar34b	4,000
		WMar35	3,900
		WMar35b	3,600
DMMU-16	15,600	WMar36	4,100
		WMar36b	3,500
		WMar37	3,700
		WMar37b	4,300
DMMU-17	15,600	WMar38	3,500
		WMar38b	4,000
		WMar39	3,700
		WMar39b	4,400

Table 4. Westport Marina – Sampling locations and core recovery (adapted from BergerAbam 2015)

DMMU ID (design depth in ft. MLLW)	Core ID	Northing	Easting	Adjusted Tide Mudline Elevation (ft. MLLW)	Core Penetration (ft.)	Core Recovered (ft.)	Core Recovery
DMMU 1 (-15)	WMar1	595781.56	737396.73	-10.54	7.9	5.5	70%
	WMar2	595929.71	737258.91	-11.44	6.9	5.8	83%
	WMar3	596156.00	737141.72	-10.81	7.2	6.2	86%
	WMar4	595728.37	737632.30	-12.73	7.3	5.3	72%
DMMU 2 (-15 to -17)	WMar5	595932.53	737569.57	-15.27	5.17	4.0	77%
	WMar6	596014.84	737742.51	-15.75	5.47	3.9	72%
	WMar7	596096.65	737919.57	-14.44	4.07	3.1	76%
DMMU 3 (-15 to -17)	WMar8	595531.97	737767.24	-11.51	7.07	6.1	86%
	WMar9	595937.03	737860.67	-13.43	7.07	6.6	93%
	WMar10	595942.65	738064.41	-13.24	7.07	5.5	78%
DMMU 4 (-15 to -17)	WMar11	595363.75	737860.27	-10.22	7.17	6.23	87%
	WMar12	595615.92	738071.12	-13	7.17	5.16	72%
	WMar13	595274.88	738163.69	-14.82	7.17	5.88	82%
DMMU 5 (-15 to -17)	WMar14	596069.79	738116.11	-13.94	5.37	4.62	86%
	WMar15	595880.38	738522.25	-11.89	7.07	5.1	72%
	WMar16	595944.81	738316.56	-13.57	7.27	5.1	70%
DMMU 6 (-17)	WMar17	595355.23	738423.86	-14.13	6.17	5.04	82%
	WMar18	595068.69	738201.24	-11.62	8.17	6.35	78%
DMMU 7 (-15 to -17)	WMar19	595322.77	738625.52	-16	4.07	3.42	84%
	WMar20	594899.01	738327.85	-11.42	7.07	6.06	86%
DMMU 8 (-17)	WMar21	595168.88	738720.63	-15.5	4.73	3.83	81%
	WMar22	594770.53	738480.58	-11.22	9	6	67%
DMMU 9 (-15)	WMar23A/B	594783.56	738759.46	-14.51	4.07	3.52	86%
		594786.65	738761.63	-14.28	5.1	4.44	87%
DMMU 10 (-15 to -17)	WMar24	594554.74	738753.23	-12.25	5.87	4.58	78%
	WMar25	594795.04	738963.13	-15.47	5.07	4.58	90%
DMMU 11 (-15)	WMar26	594374.72	738842.05	-14.37	4.27	2.81	66%
	WMar27	594478.29	738901.43	-15.29	3.07	2.92	95%
DMMU 12 (-15)	WMar28	594072.37	739048.24	-11.52	7.3	5.45	75%
	WMar29	594003.04	739151.48	-13.14	4.57	4	88%
DMMU 13 (-15)	WMar30	594231.57	739375.10	-12.15	6.07	5.125	84%
	WMar31	593796.58	739281.82	-13.51	6	2.33	39%
DMMU 14 (-15)	WMar32	593944.59	739599.60	-13.19	5.07	3.9	77%
	WMar33	593714.92	739392.40	-14.19	4.07	2.67	66%
DMMU 15 (-15)	WMar34	593616.26	739522.02	-13.17	5	4.29	86%
	WMar35	593551.84	739691.90	-12.7	5.67	4.7	83%
DMMU 16 (-15 to -17)	WMar36	593475.28	739800.02	-10.33	7.97	5.95	75%
	WMar37	593610.20	739949.26	-13.58	5.87	4	68%
DMMU 17 (-17)	WMar38	593669.65	740177.91	-13.99	6.07	5.04	83%
	WMar39	593874.30	740359.80	-11.32	6.57	4.96	75%

Notes:

[1]Northing and easting are based on the North American Datum of 1983 (NAD83) State Plane Coordinate System, Washington South.

[2]Lead line was used to measure water depth.

[3]Tidal stage was obtained from the TideTrac mobile application which collects data from the tidal station at Westport Marina.

[4]Adjusted Mudline Elevation = Water Depth + Tidal Stage

Shaded samples were those that deviated from proposed locations due to sediment depth or obstructions

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Table 5. Westport Marina – Conventional Results

DMMU ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
DMMU Volume	15,100	13,900	15,300	15,800	14,200	16,100	16,000	10,200	8,700	10,900	15,300	16,100	15,800	14,800	15,600	15,600	15,600
Gravel	0.8%	2.0%	1.2%	2.3%	2.5%	1.8%	1.2%	1.0%	2.1%	2.3%	7.1%	11.0%	1.0%	0.7%	2.3%	17.1%	1.2%
Sand	51.5%	14.1%	12.0%	23.6%	23.8%	38.3%	50.7%	24.9%	17.7%	18.0%	43.6%	47.9%	27.9%	47.1%	62.4%	56.1%	28.1%
Silt	33.4%	59.6%	60.0%	54.0%	53.6%	42.5%	34.9%	53.7%	61.2%	58.3%	35.8%	28.9%	51.3%	37.0%	25.5%	18.4%	49.2%
Clay	14.4%	24.3%	26.9%	20.1%	20.2%	17.4%	13.1%	20.6%	19.2%	21.4%	13.5%	12.4%	19.6%	15.1%	9.5%	8.3%	21.4%
Total Fines (silt+clay)	47.8%	83.9%	86.9%	74.1%	73.8%	59.9%	48.0%	74.3%	80.4%	79.7%	49.3%	41.3%	70.9%	52.1%	35.0%	26.7%	70.6%
Ammonia (mg/kg dry wt.)	31.7	34.2	49.9	40.2	33.8	37.2	55.1	82.7	45.1	88.2	42.1	135	73.5	97	28.7	40.8	28.3
Total Sulfides (mg/kg dry wt.)	3,050	1,420	1,240	1,500	2,530	1,840	3,930	3,360	3,720	4,010	3,820	2,290	3,930	3,510	1,780	2,590	1,530
Total Solids (%)	66.9	52.5	51.3	52.2	54.97	57.8	58.7	53.6	55	52.4	65.1	53.8	57.5	55.5	66.2	66.4	54.3
Total volatile solids (%)	3.5	7.2	6.97	7.04	7.32	6.0	4.5	6.2	6.3	6.4	3.9	5.5	5.3	6.0	3.3	3.6	5.5
Total organic carbon (%)	0.796	2.3	1.7	2.18	1.64	3.9	1.71	1.88	2.27	1.96	2.2	2	1.6	2.65	0.906	1.37	1.68

Note: shaded DMMUs underwent bioassays

Notes:

- sediment larval test used % normal for test interpretation, with 100% used for seawater control normalization
- all reported *Neanthes* results are ash-free dry weight (AFDW)
- DMMU 7 was compared to both ref sediments; only more conservative comparison is shown

Table 6. Westport Marina Chemical Analysis Results compared with DMMP Guidelines.

CHEMICAL	DMMP Guidelines			DMMU-1	DMMU-2	DMMU-3		DMMU-4	DMMU-5	DMMU-6	DMMU-7		DMMU-8	DMMU-9		DMMU-10	DMMU-11	DMMU-12		DMMU-13	DMMU-14		DMMU-15	DMMU-16		DMMU-17
	SL	BT	ML			initial	DEHP retest				initial	DEHP retest		initial	DEHP retest			initial	DEHP retest		initial	DEHP retest		initial	DEHP retest	
METALS (mg/kg dry weight)																										
Antimony	150	---	200	7 U	9 U	9 U		9 U	9 U	8 U	8 U		8 U	9 U		10 U	7 U	8 U		10 U	9 U		8 U	7 U		10 U
Arsenic	57	507.1	700	3.83 J	5.59 J	6.51 J		5.99 J	5.36 J	5.77 J	4.13 J		4.93 J	5.5 J		8 J	6.39 J	6.19 J		5.2 J	6.73 J		5.38 J	3.56 J		5.1 J
Cadmium	5.1	11.3	14	0.4	0.6	0.5		0.5	0.4	0.309 J	0.4		0.5	0.6		0.4 U	0.3 U	0.3 U		0.5	0.319 J		0.176 J	0.19 J		0.367 J
Chromium	260	260	---	26	37	38		47.3	35.1	34	30.8		31.1	37.6		35	25.8	28.8		40	34.8		25.5	21.9		35
Copper	390	1,027	1,300	29.8	51.1	47.8		50.9	44	40.1	34.2		35.9	50		42.8	29.8	34.3		47.9	78.4		28.4	20.1		41.6
Lead	450	975	1,200	7	10	13		9	9	8	7		7	9		8	6	7		9	9		11	5		9
Mercury	0.41	1.5	2.3	0.04	0.13	0.23		0.07	0.08	0.07	0.04		0.08	0.06		0.06	0.04	0.06		0.07	0.06		0.032 J	0.0183 J		0.06
Nickel	---	---	---	19	25	26		26	24	25	22		22	27		24	19	21		27	24		17	16		24
Selenium	---	3	---	0.264 J	0.489 J	0.517 UJ		0.486 J	0.54 J	0.307 J	0.268 J		0.233 J	0.578 J		0.49 J	0.241 J	0.278 J		0.4 J	0.49 J		0.343 J	0.233 J		0.423 J
Silver	6.1	6.1	8.4	0.4 U	0.6 U	0.5 U		0.6 U	0.6 U	0.5 U	0.5 U		0.5 U	0.5 U		0.6 U	0.4 U	0.5 U		0.6 U	0.6 U		0.5 U	0.4 U		0.6 U
Zinc	410	2,783	3,800	70	97	103		99	90	85	83		86	104		96	72	86		97	89		64	51		84
PAHs (µg/kg dry weight)																										
Naphthalene	2,100	---	2,400	8.9	33	12		47	40	43	26		37	31		43	11	66		38	39		8.1	19		24
Acenaphthylene	560	---	1,300	5.5	6.8	3.9 J		8.7	100	4.8	4 J		6.8	3.7 J		6.4	4.0 J	4.4 J		5.9	7.0		4.1 J	10		6.5
Acenaphthene	500	---	2,000	6.8	2.9 J	1.5 J		5.5	19 U	3.5 J	4.4 J		8.3	2.9 J		7.1	5	130		8.5	5.1		3.8 J	17 J		3.3 J
Fluorene	540	---	3,600	16	9.0	7.9 J		10	28	6.3	8.4		11.0	6.2		23	11	130		8.0	11		7.1	22		7.3
Phenanthrene	1,500	---	21,000	57	140	56		58	110	56	43		62	60		120	52	220		70	100		31	180		36
Anthracene	960	---	13,000	22	25	8		23	390	20	29		36	25		43	27	63		35	80		21	21		14
2-Methylnaphthalene[1]	670	---	1,900	8.3	43	8		57	20	13	18		20	10		37 M	10	15		15	21		7.8	8.0		29
Total LPAH	5,200	---	29,000	116	217	89		152	668	134	115		161	129		243	110	613		165	242		75	269		91
Fluoranthene	1,700	4,600	30,000	240	150	37		110	530	130	160		130	130		260	130	620		150	290		120	980		68
Pyrene	2,600	11,980	16,000	340	180	130		230	2,600	230	160		290	240		560	210	500		390	450		240	760		160
Benzo(a)anthracene	1,300	---	5,100	68	45	26		45	1,200	38	37		50	46		76	42	94		65	150		42	76		26
Chrysene	1,400	---	21,000	140	110	38		68	2,400	81	52		130	75		160	82	170		150	350		83	360		46
Benzofluoranthenes (b, j ,k)	3,200	---	9,900	140	140	77		120	3,200	120	75		150	100		190	93	180		180	300		180	320		69
Benzo(a)pyrene	1,600	---	3,600	58	55	33		38	1,000	35	28		44	32		49	29	56		53	97		63	70		22
Indeno(1,2,3-c,d)pyrene	600	---	4,400	26	32	21		25	340	20	5		25	7.1		29	12	26		28	42		21	36		12
Dibenz(a,h)anthracene	230	---	1,900	14 J	15 J	8.4		12	200	9	4.3 J		10	7.5		13	6	12		11	18		10	17		6.1
Benzo(g,h,i)perylene	670	---	3,200	30	36	25		30	280	22	7.0		25	8.9		27	15	25		23	38		18 J	36		15
Total HPAH	12,000	---	69,000	1,056	763	395		678	11,750	685	528		854	647		1,364	619	1,683		1,050	1,735		777	2,655		424
CHLORINATED HYDROCARBONS (µg/kg dry weight)																										
1,4-Dichlorobenzene	110	---	120	4.8 U	4.8 U	4.9 U		4.9 U	4.8 U	4.8 U	4.8 U		4.9 U	4.8 U		5 U	4.8 U	4.8 U		5 U	5 U		4.8 U	4.7 U		5 U
1,2-Dichlorobenzene	35	---	110	4.8 U	4.8 U	4.9 U		4.9 U	4.8 U	4.8 U	4.8 U		4.9 U	4.8 U		5 U	4.8 U	4.8 U		5 U	5 U		4.8 U	4.7 U		5 U
1,2,4-Trichlorobenzene	31	---	64	4.8 U	4.8 U	4.9 U		4.9 U	4.8 U	4.8 U	4.8 U		4.9 U	4.8 U		5 U	4.8 U	4.8 U		5 U	5 U		4.8 U	4.7 U		5 U
Hexachlorobenzene (HCB)	22	168	230	0.97 U	5 YL	0.98 U		4 YLP	1 U	4.4 YLP	11 YLP		0.96 U	7.1 YLP		9.2 YLP	5.4 YLP	15 YLP		6.9 YLP	8.9 YLP		0.99 U	0.99 U		0.98 U
PHTHALATES (µg/kg dry weight)																										
Dimethyl phthalate	71	---	1,400	34	7.1	8.6		9.1	3.8 J	4.8 U	6.8		22	7.8		21	4.9	32		7.1	4.8 J		3.5 J	4.7		2.8 J
Diethyl phthalate	200	---	1,200	32 B	19 U	20 U		23 B	19 U	19 U	19 U		21 B	19 U		38 B	19 U	19 U		25 B	27 B		19 U	23 B		20 U
Di-n-butyl phthalate	1,400	---	5,100	19 U	19 U	20 U		20 U	19 U	19 U	6.7 J		20 U	7.8 J		20 U	19 U	13 J		20 U	15 J		19 U	19 U		20 U
Butyl benzyl phthalate	63	---	970	6.8	5.4	6.9		27	4.8 U	4.8 U	8.1		4.9 U	12		5.5	4.8 U	12		3.1 J	16		4.8 U	6.8		2.9 J
Bis(2-ethylhexyl) phthalate	1,300	---	8,300	91	48 U	4,600	31 J	61	42 J	48 U	5,200	30 J	41 J	6,100	49	100	120	9,500	*69*	70	9,800	32 J	28 J	6,600	48 U	50 U
Di-n-octyl phthalate	6,200	---	6,200	19 U	19 U	20 U		20 U	19 U	19 U	19 U		20 U	19 U		20 U	19 U	19 U		20 U	20 U		19 U	19 U		20 U
PHENOLS (µg/kg dry weight)																										
Phenol	420	---	1,200	12 J	38	16 J		130	37	34	25		26	50		20 U	12 J	25		46	42		10 J	13 J		30
2-Methylphenol	63	---	77	4.8 U	3.4 J	4.9 U		6.7	19 U	4.8 U	4.8 U		4.9 U	3.5 J		8	4.8 U	4.8 U		5 U	2.6 J		4.8 U	4.7 U		5 U
4-Methylphenol	670	---	3,600	21	51	32		84	44	38	41		56	42		61	28	41		46	61		19 U	19		39
2,4-Dimethylphenol	29	---	210	24 U	24 U	25 U		25 U	24 U	24 U	24 U		24 U	24 U		25 U	24 U	24 U		25 U	25 U		24 U	23 U		25 U
Pentachlorophenol	400	504	690	19 U	19 U	20 U		20 U	52 J	19 U	19 U		20 U	19 U		20 U	19 U	19 U		20 U	20 U		19 U	19 U		20 U
MISCELLANEOUS EXTRACTABLES (µg/kg dry weight)																										
Benzyl alcohol	57	---	870	19 U	19 U	20 U		20 U	19 U	19 U	19 U		20 U	19 U		20 U	19 U	19 U		20 U	20 U		19 U	19 U		20 U
Benzoic acid	650	---	760	190 U	180 J	84		460	160 J	130 J	120 J		140 J	220		300	68	130 J		170 J	150 J		190 U	68 J		170 J
Dibenzofuran	540	---	1,700	6.6	6.9	3.4 J		9.3	5.3	5.2	7		8.6	18 J		25	8.4	31		21	20		5.5	5.4		6.4
Hexachlorobutadiene	11	---	270	0.97 U	0.96 U	0.98 U		0.97 U	1 U	0.98 U	1 U		0.96 U	0.96 U		0.99 U	0.96 U	0.97 U		0.97 U	0.98 U		0.99 U	0.99 U		0.98 U
N-Nitrosodiphenylamine	28	---	130	4.8 U	4.8 U	4.9 U		4.9 U	4.8 U	4.8 U	4.8 U		4.9 U	4.8 U		5 U	4.8 U	4.8 U		5 U	5 U		4.8 U	4.7 U		5 U
PESTICIDES & PCBs (µg/kg dry weight)																										
4,4'-DDD	16	---	---	0.97 U	0.96 U	0.97 U		0.97 U	1 U	0.98 U	1 U		0.96 U	0.96 U		0.99 U	0.96 U	0.97 U		0.97 U	0.98 U		0.99 U	0.99 U		0.98 U

Table 6, continued.

CHEMICAL	DMMP Guidelines			DMMU-1	DMMU-2	DMMU-3		DMMU-4	DMMU-5	DMMU-6	DMMU-7		DMMU-8	DMMU-9		DMMU-10	DMMU-11	DMMU-12		DMMU-13	DMMU-14		DMMU-15	DMMU-16		DMMU-17
	SL	BT	ML			initial	DEHP retest				initial	DEHP retest		initial	DEHP retest			initial	DEHP retest		initial	DEHP retest		initial	DEHP retest	
4,4'-DDE	9	---	---	0.97 U	0.96 U	0.97 U		0.97 U	1 U	0.98 U	1 U		0.96 U	0.96 U		0.99 U	0.96 U	0.97 U		0.97 U	0.98 U		0.99 U	0.99 U		0.98 U
4,4'-DDT	12	---	---	0.97 U	0.96 U	0.97 U		0.97 U	1 U	0.98 U	1 U		0.96 U	0.96 U		0.99 U	0.96 U	0.97 U		0.97 U	0.98 U		0.99 U	0.99 U		0.98 U
sum of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT	---	50	69	0.97 U	0.96 U	0.97 U		0.97 U	1 U	0.98 U	1 U		0.96 U	0.96 U		0.99 U	0.96 U	0.97 U		0.97 U	0.98 U		0.99 U	0.99 U		0.98 U
Aldrin	9.5	---	---	0.49 U	0.48 U	0.49 U		0.49 U	0.5 U	0.49 U	0.5 U		0.48 U	0.48 U		0.49 U	0.48 U	2.9 YLP		1.4 YLP	1.1 YLP		0.49 U	0.49 U		0.49 U
Total Chlordane	2.8	37	---	1.2 Y	1 YL	0.98 U		1.4 YLP	1 U	2.4 Y	0.5 U		0.96 U	0.96 U		2 YLP	0.96 U	2 YL		0.97 U	4.4 Y		0.99 U	0.67		0.98 U
cis-chlordane	---	---	---	0.49 U	0.48 U	0.98 U		0.49 U	0.5 U	0.49 U	0.5 U		0.48 U	0.48 U		0.49 U	0.48 U	0.49 U		0.49 U	0.49 U		0.49 U	0.49 U		0.49 U
trans-chlordane	---	---	---	1.2 Y	1 YL	0.49 U		1.4 YLP	0.5 U	2.4 Y	0.5 U		0.48 U	0.48 U		2 YLP	0.48 U	1.6 YLP		0.49 U	4.4 Y		0.49 U	0.67		0.49 U
cis-nonachlor	---	---	---	0.97 U	0.96 U	0.49 U		0.97 U	1 U	0.98 U	1 U		0.96 U	0.96 U		0.99 U	0.96 U	0.97 U		0.97 U	0.98 U		0.99 U	0.99 U		0.98 U
trans-nonachlor	---	---	---	0.97 U	0.96 U	0.98 U		0.97 U	1 U	2.8 Y	1 U		0.96 U	0.96 U		0.99 U	0.96 U	2 U		0.97 U	2.8 Y		0.99 U	0.99 U		0.98 U
oxychlordane	---	---	---	0.97 U	0.96 U	0.98 U		0.97 U	1 U	0.98 U	1 U		0.96 U	0.96 U		0.99 U	0.96 U	0.97 U		0.97 U	0.98 U		0.99 U	0.99 U		0.98 U
Dieldrin	1.9	---	1,700	0.97 U	0.96 U	0.98 U		0.97 U	1 U	0.98 U	1 U		0.96 U	0.96 U		0.99 U	0.96 U	0.97 U		0.97 U	0.98 U		0.99 U	0.99 U		0.98 U
Heptachlor	1.5	---	270	1.5 Y	1.5 Y	0.49 U		1.3 U	1.5 Y	1.2 Y	2.4 YLP		1.5 Y	1.5 Y		1.5 Y	1.5 Y	1.5 Y		1.5 Y	1.5 Y		0.49 U	0.49 U		1.5 Y
Total PCBs Aroclors (Sum of:	130	--	3,100	11	20.3	36		7.5 J	16.4	8.4 JP	32 Y		8.5 J	6.1 J		24 Y	9.5 U	25.7		8.1 J	6.6 J		7.2 J	19 Y		19 Y
Total PCBs (mg/kg OC)	--	38[(2)]	--	1.4	0.9	2.1		0.3 J	1	0.6 JP	1.9 Y		0.5 J	0.27 J		1.2 Y	0.4 U	1.3 U		0.5 J	0.2 J		0.8 J	1.4 Y		1.1 Y
ORGANOMETALLIC COMPOUNDS																										
Tributyltin ion (interstitial water; ug/L)	0.15	0.15	---	0.005 U	0.005 U	0.005 U		0.005 U	0.005 U	0.006 U	0.005 U		0.005 U	0.005 U		0.005 U	0.005 U	0.009 U		0.005 U	0.005 U		0.005 U	0.005 U		0.005 U

Notes:

D > SL

D > ML

U > SL

italics = value is average of separate cores

DMMUs in red font failed DMMU guidelines and are not suitable for open-water disposal or beneficial use.

DMMUs in orange font failed BU guidelines and are not suitable for in-water beneficial use.

Bold - Analyte detected

U - Analyte not detected

J - Estimated value

T - Concentration between the MDL and PQL

P - Greater than 40 percent difference between the primary and secondary GC columns

K - Analyte identification criteria not met

Total PCB Aroclors = Sum of 1016, 1221, 1242, 1248, 1254, 1260, 1268

Total chlordane = sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane

Total LPAHs = sum of naphthalene, acenaphthene, acenaphthylene, fluorene, phenanthrene, anthracene

Total HPAHs = fluoranthene, pyrene, benzo(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene

Table 7. Dioxin TEQs for Westport Marina

	TEF	ND=1/2 RL TEQ																		
	WHO 2005	DMMU 1	DMMU 2	DMMU 3	DMMU 4	DMMU 5	DMMU 6	DMMU 7	DMMU 8	DMMU 9	DMMU 10	DMMU 11	DMMU 12	DMMU 13	DMMU 14	DMMU 15	DMMU 16	DMMU 17	Z28	Z29
2,3,7,8-TCDF	0.1	0.116	0.157	0.114	0.109	0.180	0.175	0.105	0.381	0.095	0.156	0.080	0.103	0.216	0.130	0.065	0.030	0.300	0.132	0.240
2,3,7,8-TCDD	1	0.451	0.745	0.805	1.190	1.340	0.635	1.250	0.695	0.620	1.420	0.654	0.491	1.380	1.260	0.299	0.397	1.100	0.991	0.550
1,2,3,7,8-PeCDF	0.03	0.014	0.015	0.019	0.014	0.026	0.014	0.011	0.021	0.013	0.017	0.004	0.011	0.015	0.007	0.003	0.003	0.013	0.018	0.018
2,3,4,7,8-PeCDF	0.3	0.157	0.172	0.263	0.162	0.271	0.151	0.114	0.215	0.132	0.092	0.041	0.118	0.082	0.145	0.077	0.038	0.125	0.220	0.192
1,2,3,7,8-PeCDD	1	2.160	2.770	2.850	1.960	3.060	2.210	1.740	3.120	2.070	1.295	1.110	2.280	2.740	2.210	0.948	1.100	2.130	1.780	2.430
1,2,3,4,7,8-HxCDF	0.1	0.249	0.199	0.242	0.173	0.229	0.057	0.099	0.181	0.109	0.084	0.084	0.363	0.149	0.130	0.063	0.027	0.053	0.233	0.193
1,2,3,6,7,8-HxCDF	0.1	0.055	0.113	0.129	0.043	0.141	0.079	0.031	0.120	0.073	0.097	0.046	0.199	0.105	0.081	0.034	0.044	0.040	0.149	0.139
2,3,4,6,7,8-HxCDF	0.1	0.169	0.156	0.048	0.126	0.223	0.114	0.047	0.186	0.103	0.140	0.067	0.498	0.181	0.132	0.031	0.066	0.051	0.097	0.214
1,2,3,7,8,9-HxCDF	0.1	0.072	0.069	0.075	0.053	0.088	0.047	0.019	0.073	0.046	0.038	0.041	0.205	0.071	0.026	0.029	0.029	0.046	0.063	0.080
1,2,3,4,7,8-HxCDD	0.1	0.237	0.205	0.162	0.151	0.313	0.171	0.066	0.260	0.129	0.095	0.088	0.388	0.251	0.200	0.067	0.067	0.145	0.157	0.319
1,2,3,6,7,8-HxCDD	0.1	1.120	0.888	0.752	0.689	1.690	0.710	0.541	1.320	0.692	0.966	0.470	3.580	1.090	0.880	0.338	0.313	0.604	0.546	1.280
1,2,3,7,8,9-HxCDD	0.1	0.748	0.814	0.670	0.592	1.070	0.663	0.493	0.945	0.595	0.675	0.325	0.969	0.810	0.673	0.268	0.278	0.518	0.498	0.817
1,2,3,4,6,7,8-HpCDF	0.01	0.265	0.248	0.224	0.177	0.303	0.164	0.122	0.241	0.144	0.175	0.104	0.813	0.232	0.185	0.082	0.086	0.127	0.388	0.301
1,2,3,4,7,8,9-HpCDF	0.01	0.017	0.014	0.015	0.011	0.014	0.008	0.007	0.006	0.004	0.004	0.007	0.032	0.010	0.004	0.005	0.004	0.007	0.020	0.016
1,2,3,4,6,7,8-HpCDD	0.01	2.850	1.910	1.160	1.500	3.910	1.200	1.030	2.240	1.250	1.670	1.150	10.800	2.200	1.770	0.919	0.732	1.030	1.650	3.330
OCDF	0.0003	0.019	0.015	0.011	0.010	0.017	0.008	0.006	0.012	0.007	0.008	0.007	0.074	0.009	0.007	0.006	0.004	0.006	0.034	0.016
OCDD	0.0003	0.783	0.471	0.212	0.372	0.864	0.227	0.221	0.441	0.272	0.354	0.292	3.180	0.525	0.456	0.297	0.209	0.220	0.462	0.786
Totals		9.48	8.96	7.75	7.33	13.74	6.63	5.90	10.46	6.35	7.28	4.57	24.10	10.07	8.30	3.53	3.43	6.51	7.44	10.92

Table 8. DMMP Bioassay Interpretation Guidelines

Bioassay	Negative Control Performance Standard	Reference Sediment Performance Standard	Dispersive Disposal Site Interpretation Guidelines		Nondispersive Disposal Site Interpretation Guidelines	
			1-hit rule	2-hit rule	1-hit rule	2-hit rule
Amphipod Mortality	$M_C \leq 10\%$	$M_R - M_C \leq 20\%$	$M_T - M_C > 20\%$ and M_T vs. M_R SS (p=.05) AND			
			$M_T - M_R > 10\%$	NOCN	$M_T - M_R > 30\%$	NOCN
Larval Development	$N_C \div I \geq 0.70$	$N_R \div N_C \geq 0.65$	$N_T \div N_C < 0.80$ and N_T/N_C vs. N_R/N_C SS (p=.10) AND			
			$N_R/N_C - N_T/N_C > 0.15$	NOCN	$N_R/N_C - N_T/N_C > 0.30$	NOCN
Neanthes Growth	$M_C \leq 10\%$ and $MIG_C \geq 0.38$	$M_R \leq 20\%$ and $MIG_R \div MIG_C \geq 0.80$	$MIG_T \div MIG_C < 0.80$ and MIG_T vs. MIG_R SS (p=.05) AND			
			$MIG_T/MIG_R < 0.70$	NOCN	$MIG_T/MIG_R < 0.50$	$MIG_T/MIG_R < 0.70$

M = mortality
N = normal larvae
I = initial count
MIG = mean individual growth rate (mg/individual/day) SS = statistically significant
NOCN = no other conditions necessary
Subscripts:
R = reference sediment
C = negative control
T = test sediment

Table 9. Westport Marina Bioassay Summary

Sample			Amphipod (*E. estuarius*) Mortality (%)		Sediment Larval (*M. galloprovincialis*) normal (%)		20-day *Neanthes* Growth					Pass/Fail (dispersive guidelines)
	% fines	% clay					Mortality (%)	MIG (mg/ind/day)		MIG % of control	MIG % of reference	
			mean	sd	mean	sd		mean	sd			
Control			1.0	2.2	254	25	0	0.58	0.07	--	--	
Reference GH-25	25.0		2.0	4.5	243	22	0	0.54	0.07	93%	--	
Reference GH-76	76.0		4.0	5.5	235	23	0	0.57	0.07	98%	--	
DMMU-3	86.8	26.9	8.0	2.7	218	18	0	0.60	0.04	103%	105%	pass
DMMU-5	73.7	20.2	7.0	5.7	231	20	0	0.61	0.08	105%	107%	pass
DMMU-7 vs GH25	48.0	13.1	9.0	6.5	195	41	0	0.53	0.08	91%	98%	fail
DMMU-7 vs GH76	48.0	13.1	9.0	6.5	195	41	0	0.53	0.08	91%	93%	fail
DMMU-9	80.2	19.2	27.0	15.2	185	22	0	0.54	0.07	93%	95%	fail
DMMU-16	26.8	8.3	4.0	4.2	212	23	0	0.61	0.06	105%	113%	pass
Reference toxicant			96-hr LC50: 250 mg/L		EC50: 10.9 µ/L Cu		Ammonium chloride, 96-hr LC50: 248 mg/L NH_3-N					
Lab Control limits			76.4 - 397 mg/L NH_3-N		6.28 - 14.6 µ/L Cu		174 - 323 mg/L NH_3-N					

Notes:

- sediment larval test used % normal for test interpretation, with 100% used for seawater control normalization
- all reported *Neanthes* results are ash-free dry weight (AFDW)
- DMMU 7 was compared to both ref sediments

Table 10. Amphipod *(E. estuarius)* Mortality (%)

Sample			% mortality				2-hit >20%?	1-hit >10%?	Dispersive	
	% fines	% clay	mean	sd	sig. diff. from GH-25?	sig. diff. from GH-76?	% diff. over control	% diff. over ref.	1-hit failure?	2-hit failure?
Control			1.0	2.2	---	---	---	---	---	---
Reference GH-25	25.0		2.0	4.5	---	---	---	---	---	---
Reference GH-76	76.0		4.0	5.5	---	---	---	---	---	---
DMMU-3	86.8	26.9	8.0	2.7	---	no	8.0	8.0	no	no
DMMU-5	73.7	20.2	7.0	5.7	---	no	7.0	7.0	no	no
DMMU-7	48.0	13.1	9.0	6.5	yes	no	9.0	5.0, 7.0	no	no
DMMU-9	80.2	19.2	27.0	15.2	---	yes	27.0	27.0	yes	yes
DMMU-16	26.8	8.3	4.0	4.2	no	---	4.0	4.0	no	no

Table 11. 20-day ***Neanthes*** Growth

Sample			% mortality				2-hit MIG_T/MIG_C <0.80	1-hit MIG_T/MIG_R <0.70	Dispersive	
	% fines	% clay	mean	sd	sig. diff. from GH-25?	sig. diff. from GH-76?	MIG % of control	MIG % of reference	1-hit failure?	2-hit faiure?
Control			0.0	0.0	---	---	---	---	---	---
Reference GH-25	25.0		0.0	0.0	---	---	93%	---	---	---
Reference GH-76	76.0		0.0	0.0	---	---	98%	---	---	---
DMMU-3	86.8	26.9	0.0	0.0	---	no	103%	105%	no	no
DMMU-5	73.7	20.2	0.0	0.0	---	no	105%	107%	no	no
DMMU-7	48.0	13.1	0.0	0.0	no	no	91%	93%, 98%	no	no
DMMU-9	80.2	19.2	0.0	0.0	---	no	93%	95%	no	no
DMMU-16	26.8	8.3	0.0	0.0	no	---	105%	113%	no	no

Table 12. Sediment Larval (***M. galloprovincialis***) normal (%)

Sample			% Normal		Comparisons			Dispersive		
								2-hit failure?		1-hit failure?
	% fines	% clay	mean	sd	N_T/N_C	N_R/N_C	N_R/N_C - N_T/N_C	N_T/N_C vs. N_R/N_C SS (p=.10)?	N_T/N_C < 0.80?	N_R/N_C - N_T/N_C > 0.15?
Control	---	---	254	25				---	---	---
Reference GH-25	25.0	---	243	22		0.96		---	---	---
Reference GH-76	76.0	---	235	23		0.93		---	---	---
DMMU-3	86.8	26.9	218	18	0.86		0.07	no	no	no
DMMU-5	73.7	20.2	231	20	0.91		0.02	no	no	no
DMMU-7 vs GH25	48.0	13.1	195	41	0.77		0.19	yes	yes	yes
DMMU-7 vs GH76	48.0	13.1	195	41	0.77		0.16	yes	yes	yes
DMMU-9	80.2	19.2	185	22	0.73		0.20	yes	yes	yes
DMMU-16	26.8	8.3	212	23	0.83		0.12	no	no	no

Table 13. Bioassay Performance for Westport Marina

Bioassay		Negative Control Performance	Ref. Sed. (25% fines) Performance	Ref. Sed. (76% fines) Performance	
Amphipod (*E. estuarius*) Mortality	Standard	$M_C \leq 10\%$	$M_R - M_C \leq 20\%$	$M_R - M_C \leq 20\%$	
	Actual	$M_C = 1\%$	$M_R - M_C = 1\%$	$M_R - M_C = 3\%$	all acceptable
Larval (*M. galloprovincialis*) Development	Standard	$N_C/I \geq 0.70$	$N_R/N_C \geq 0.65$	$N_R/N_C \geq 0.65$	
	Actual	$N_C/I = 1.009$	$N_R/N_C = 0.95$	$N_R/N_C = 0.92$	all acceptable
Juvenile Polychaete *(N. arenaceodentata)* growth	Standard	$M_C \leq 10\%$ and $MIG_C \geq 0.38$	$M_R \leq 20\%$ and $MIG_R/MIG_C \geq 0.80$	$M_R \leq 20\%$ and $MIG_R/MIG_C \geq 0.80$	
	Actual	$M_C = 0\%$ and $MIG_C = 0.58$	$M_R = 0\%$ and $MIG_R/MIG_C = 0.93$	$M_R = 0\%$ and $MIG_R/MIG_C = 0.98$	all acceptable

Notes:

M = mortality; N = normal defelopment; Nc =

all reported Neanthes results are ash-free dry weight, per DMMP 2013

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Figure 1 - Vicinity Map

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Figure 2 - Site Plan - DMMUs

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LEGEND

Reference sample location

NOTES:
1. The location of the features shown are approximate.
2. This figure is for information purposes and is intended to assist in showing features discussed in the attached document.
3. Reference samples were collected by Research Support Services on November 20, 2014.

Figure 3 - Reference Sample Locations

Port of Grays Harbor - Westport Marina Sediment Characterization Report

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SCALE IN MILES

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10. AGENCY SIGNATURES

SUBJECT: DETERMINATION REGARDING THE SUITABILITY OF PROPOSED DREDGED MATERIAL FROM THE PORT OF GRAYS HARBOR, WESTPORT MARINA, WESTPORT, WASHINGTON, FOR PLACEMENT AT THE PT. CHEHALIS OR SOUTH JETTY DISPERSIVE OPEN-WATER DISPOSAL SITES, OR AT AN APPROVED UPLAND SITE.

Concur:

_____ _____
Date Lauran Cole Warner - Seattle District Corps of Engineers

_____ _____
Date Justine Barton - Environmental Protection Agency

_____ _____
Date Laura Inouye, Ph.D. - Washington Department of Ecology

_____ _____
Date Celia Barton - Washington Department of Natural Resources

Signed copy on file in Dredged Material Management Office, Seattle District, USACE

Copies furnished:

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Marc Horton, Washington Project Consultants
Joe Schumacker, Quinault Tribe