CENWS-OD-ME-DMMO

MEMORANDUM FOR: RECORD October 1, 2013

SUBJECT: DETERMINATION REGARDING THE SUITABILITY OF PROPOSED MAINTENANCE DREDGED MATERIAL FROM THE PORT OF SEATTLE TERMINAL 5 (CORPS PERMIT: NWS-2009-1559-WRD), EVALUATED UNDER SECTION 404 OF THE CLEAN WATER ACT, FOR OPEN-WATER DISPOSAL AT THE ELLIOTT BAY NONDISPERSIVE SITE.

1. The following summary reflects the consensus determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington Departments of Ecology and Natural Resources, and the Environmental Protection Agency) regarding the suitability of an estimated 7,490 cy of maintenance material from Terminal 5 for disposal at the Elliott Bay nondispersive open-water site.

Table 1. Project Summary

JARPA application number	NWS-2009-1559-WRD
Project rank	High
Proposed dredging volume	7,490 cy
Proposed dredging depth (including 1 foot of advanced maintenance and 1 foot of overdepth)	-47 feet (south end) -52 feet (north end)
SAP received	April 24, 2013
SAP approved	May 9, 2013
Sampling date	May 31, 2013
Draft characterization report	August 27, 2013
Final characterization report	September 25, 2013
Recency determination (high rank = 2 years)	May 2015
DAIS reference number	POST5-1-A-F-342

2. Background . This project is located within the CERCLA Harbor Island Operational Unit. Portions of this project were previously characterized under DMMP guidelines. In 1992 and 1997 all tested material was found suitable for open-water disposal at the Elliott Bay disposal site. Testing in 2008 – supplemented with additional testing in 2009 – resulted in 6,390 cy of maintenance material from Berth 3 being found unsuitable and 4,320 cy from Berths 1 and 2 being found suitable for Elliott Bay disposal (DMMP, 2010). Chemicals with elevated concentrations in the unsuitable DMMUs were TBT, PCBs and fluoranthene. Z-samples also had elevated concentrations of these chemicals and were not in compliance with the antidegradation standard, requiring placement of a clean sand cover over the area of concern.

3. Sampling. The sampling and analysis plan was submitted on April 24, 2013, and approved on May 9, 2013 with revisions. Sampling was initiated and completed on May 31, 2013 (Windward, 2013a). Vibracore samples were taken at the eight stations listed in Table 2 and shown in Figure 1. Three cores (mudline to -52 feet MLLW) were composited for DMMU-S3 and two were composited for DMMU-S4. Because so little dredged material existed at stations S1-01, S1-02 and S2-01, the DMMP agencies agreed to use the results from DMMUs S3 and S4 to determine the suitability of material at these three stations. Z-samples were collected from all eight stations. Table 3 shows the compositing scheme and z-sample IDs. Composites representing the two DMMUs and the eight individual z-samples were submitted for physical and chemical analysis.

4. Analytical Results. Testing included evaluation of grain size, sediment conventionals, standard DMMP chemicals of concern, TBT and dioxins/furans. The characterization report was submitted on August 27, 2013 for review, and a revised report was submitted on September 25, 2013 (Windward 2013b). The DMMP agencies

concluded that the quality assurance/quality control guidelines specified by DMMP were complied with, and the data were deemed suitable for decision-making.

Grain-size and sediment conventional results for the DMMUs and z-samples can be found in Table 4. The chemistry results for the two DMMUs are compared to the DMMP evaluation guidelines in Table 5, and z-sample results are compared to the Sediment Management Standards in Table 6.

The grain-size results indicated that the proposed dredged material was predominantly sand. This was true for the z-samples as well, with the exception of S2-Z1, which had a large silt component. Total organic carbon content ranged from 1.33 to 1.39% for the DMMUs and from 0.51 to 1.85% for the z-samples. Ammonia concentrations were low, but total sulfides concentrations were elevated at some stations, ranging as high as 1,370 mg/kg for S1-Z1.

The chemistry results indicated that the SL for PCBs (130 ug/kg) was exceeded in both DMMUs, with S3 and S4 having concentrations of 169 and 203 ug/kg respectively. The concentration of TBT in the porewater from S3 (0.5 ug/l) exceeded the bioaccumulation trigger of 0.15 ug/l. Bulk sediment concentrations of TBT were also determined, with both S3 and S4 exceeding the bioaccumulation trigger of 73 ug/kg. The dioxin TEQ concentrations for S3 and S4 were 4.08 J and 6.15 J ng/kg respectively. The reporting limits for dieldrin, total chlordane and heptachlor exceeded the SL for both DMMUs.

Analysis of the z-samples indicated that mercury exceeded the CSL of 0.59 mg/kg in S4-Z2 (0.64 J mg/kg). The SQS for total PCBs (12 mg/kg oc) was exceeded by four of the z-samples (S1-Z1, S-Z2, S4-Z1 and S4-Z2) and the SQS for butylbenzylphthalate (4.9 mg/kg oc) was exceeded by S1-Z2 (5.7 ug/kg). The carbon-normalized reporting limits for several chemicals also exceeded SQS or CSL. There are no numeric SQSs or CSLs for TBT and dioxins, so concentrations of these chemicals of concern were compared to the DMMP guidelines. Adequate porewater for TBT analysis could only be collected from one of the z-samples, S1-Z1, which had a concentration of 0.22 ug/L and exceeded the porewater BT. Bulk sediment concentrations of TBT for the z-samples ranged from 5.5 to 490 ug/kg, with six of the eight z-samples exceeding the BT of 73 ug/kg. Dioxin concentrations in the z-samples ranged from 1.04 J to 12.3 J ng/kg TEC.

5. Suitability Determination. The PCB SL exceedance for DMMUs S3 and S4 triggered the requirement to conduct standard DMMP toxicity testing to further assess the suitability of the dredged material for open-water disposal. Similarly, the porewater TBT BT exceedance for DMMU S3 triggered the requirement to conduct bioaccumulation testing of this DMMU. Also, both DMMUs exceeded the site management objective of 4 pptr TEQ for dioxins and cannot be considered for open-water disposal at the Elliott Bay site without bioaccumulation testing. The Port of Seattle elected not to conduct toxicity testing or bioaccumulation testing. Therefore, in the absence of this additional testing, DMMUs S3 and S4 are unsuitable for open-water disposal. As indicated previously, the Port and DMMP agencies agreed to use the results from S3 and S4 to determine the suitability of dredged material at stations S1-01, S1-02 and S2-01. Therefore, the dredged material at these stations is also unsuitable for open-water disposal. All 7,490 cubic yards of dredged material are unsuitable for open-water disposal.

6. Antidegradation Evaluation. The DMMP agencies evaluated data from the z-samples with respect to the antidegradation guidelines provided in DMMP, 2008 and came to the following conclusions:

   DMMU 1: The Z-samples from locations S1-Z1 and S1-Z2 fail antidegradation. Sample S1-Z1 had a dioxin concentration (12.3 pptr TEQ) greater than that found in the dredged material prism (represented by DMMUs 3 and 4) and exceeding the dioxin BT of 10 pptr. The TBT concentration at S1-Z1 (490 ppb dry wt) was also greater than that in the dredged material prism and more than six times the dry-weight BT (73 ppb). TBT in S1-Z2 (140 ppb), although less than that in S1-Z1, still exceeded the dry-weight BT by nearly two-fold. PCBs in

both z-samples (15.6 and 17.2 ppm oc for S1-Z1 and S1-Z2 respectively) were greater than that in the dredge prism and above the SQS (12 ppm oc).

DMMU 2: The S2-Z1 z-sample representing this DMMU passes antidegradation. The dioxin and TBT concentrations were very low and PCBs were undetected. The dredging depth of DMMU 2 is different from DMMU 1, making these two DMMUs physically distinct.

DMMU 3: The z-samples from locations S3-Z1 and S3-Z2 pass antidegradation. The dioxin concentration measured in S3-Z1 (5.34 pptr TEQ) was slightly higher than that in the dredge prism (4.08 pptr TEQ) but this difference falls within the range of analytical uncertainty typically seen in dioxin analysis. Although there was a TBT BT exceedance in the S3-Z1 sample, this concentration (140 ppb) was lower than that observed in the overlying prism (390 ppb). Since this sample location is not contiguous with the other areas of TBT exceedances, and since bioaccumulation is an area-weighted concern, the DMMP agencies used BPJ to allow the TBT BT exceedance associated with S3-Z1 to remain uncovered. As for S3-Z2, the dioxin and TBT concentrations were very low and PCBs were undetected.

The z-sample from location S3-Z3 fails antidegradation. This sample had a TBT concentration (420 ppb) at over five times the dry-weight BT and in excess of that measured in the prism (390 ppb), a phthalate SQS exceedance, and dioxin (9.03 pptr TEQ) exceeding that of the overlying prism (4.08 pptr TEQ).

DMMU 4: The z-samples from locations S4-Z1 and S4-Z2 fail antidegradation. The mercury concentration at S4-Z2 (0.64 ppm) was above the CSL (0.59 ppm) and total PCBs (17 ppm oc) were above the SQS. PCBs in sample S4-Z1 (12.3 ppm oc) slightly exceeded the PCB SQS. Although TBT concentrations in both S4-Z1 and S4-Z2 (140 and 130 ppb, respectively) were lower than that measured in the prism (160 ppb), they were both more than two times the BT. In consideration of the combination of exceedances and the fact that S4-Z1 is situated between two areas that clearly failed antidegradation (S3-Z3 and S4-Z2), the DMMP agencies determined that the entire z-surface for DMMU 4 must be covered with sand to address antidegradation.

In summary, to address antidegradation, a minimum 6" sand cover must be placed from 1+50 to 9+00 (DMMU 1) and from 23+40 to the northern extent of dredging (approximately 150 feet north of 29+00), representing a total of approximately 1,460 lineal feet. Note that the southern extent of cover associated with failed z-sample S3-Z3 coincides with the northern end of the sheet pile wall which lies adjacent to DMMU 2 and the southern portion of DMMU 3. Based on the results of dredge prism and z-sample testing, the area adjacent to the sheet pile wall was less contaminated, possibly as a result of the sheet pile wall minimizing the influence of sloughed underpier sediments.

Placement of cover in these areas will result in a decrease in COC concentrations as follows:

- Average dioxin TEQ drops from 5.12 pptr TEQ in the prism to 2.51 pptr TEQ in the uncovered areas.
- Average bulk TBT drops from 275 ppb in the prism to 52.8 ppb in the uncovered areas.
- Average total PCBs drop from 186 ppb in the prism to 54.4 ppb in the uncovered areas.

7. Summary:
   - All 7,490 cubic yards of dredged material are unsuitable for open-water disposal.
   - A minimum 6" sand cover must be placed from 1+50 to 9+00 (DMMU 1) and from 23+40 to the northern extent of dredging (approximately 150 feet north of 29+00), representing a total of approximately 1,460 lineal feet.

8. This memorandum documents the suitability determination for the proposed maintenance dredging at the Port of Seattle Terminal 5 for unconfined open-water disposal at the Elliott Bay non-dispersive disposal site. It also documents the requirement to cover portions of the post-dredge surface following dredging. However, this

suitability determination does not constitute final agency approval of the project. A dredging and cover 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 an alternatives analysis is done under Section 404(b)(1) of the Clean Water Act.

9. References.

DMMP, 2010. *Determination on the Suitability of Supplemental Characterization of Proposed Maintenance Dredged Material from the Port of Seattle Terminal 5 (Corps Application: NWS-2009-1559-WRD) Dredging Project in Elliott Bay, Washington Evaluated under Section 404 of the Clean Water Act for Open-Water Disposal at a DMMP Non-Dispersive Open-Water Disposal Site.* Prepared by the Dredged Material Management Office for the DMMP Agencies, May 2010.

Windward, 2013a. *Terminal 5: Maintenance Dredging Sampling and Analysis Plan*. Prepared by Windward Environmental for the Port of Seattle, May 2013.

Windward, 2013b. *T-5 Maintenance Dredging Pre-Dredge Characterization Results*. Prepared by Windward Environmental for the Port of Seattle, September 2013.

Concur:

The signed document is on file in the Dredged Material Management Office.

Date	David Fox, P.E., Seattle District Corps of Engineers
Date	Erika Hoffman, Environmental Protection Agency
Date	Laura Inouye, Ph.D., Washington Department of Ecology
Date	Celia Barton, Washington Department of Natural Resources

Copied furnished:

DMMP signatories
Olivia Romano, Seattle District Regulatory
Jon Sloan, Port of Seattle
Susan McGroddy, Windward Environmental
Piper Peterson-Lee, EPA/CERCLA

Table 2. Sampling Coordinates, Mudline Elevations and Dredge Depths

Core ID	Sampling Station Location		Measured Mudline Elevation (ft. MLLW)	Dredge Depth (including 1 ft advance maintenance and 1 ft overdepth)
	Latitude	Longitude		
T513-S1-01	47.575290	122.361365	-44.7	-47
T513-S1-02	47.575949	122.361332	-45.6	-47
T513-S2-01	47.577117	122.361318	-51.0	-52
T513-S3-01	47.578201	122.361285	-51.7	-52
T513-S3-02	47.579494	122.361332	-48.3	-52
T513-S3-03	47.580218	122.361352	-48.9	-52
T513-S4-01	47.581233	122.361331	-50.0	-52
T513-S4-02	47.581668	122.361382	-50.8	-52

Table 3. Sample Identification

Core ID	Volume (cy)	Composite Sample ID (DMMU)	Z-layer Sample ID (Depth in ft MLLW)
T513-S1-01	365	These stations were not included in DMMU composites	T513-S1-Z1 (-47 to -49)
T513-S1-02			T513-S1-Z2 (-47 to -49)
T513-S2-01			T513-S2-Z2 (-52 to -54)
T513-S3-01	3,475	T513-S3-CS (mudline to -52 ft MLLW)	T513-S3-Z1 (-52 to -54)
T513-S3-02			T513-S3-Z2 (-52 to -54)
T513-S3-03			T513-S3-Z3 (-52 to -54)
T513-S4-01	3,650	T513-S4-CS (mudline to -52 ft MLLW)	T513-S4-Z1 (-52 to -54)
T513-S4-02			T513-S4-Z2 (-52 to -54)

Table 4. Conventional and grain size results (Windward, 2013b)

Chemical	Unit	Composite Samples		Z-layer Samples							
		T513-S3-CS	T513-S4-CS	T513-S1-Z1	T513-S1-Z2	T513-S2-Z1	T513-S3-Z1	T513-S3-Z2	T513-S3-Z3	T513-S4-Z1	T513-S4-Z2
Grain size											
Total gravel	% dw	1.2	0.8	5.7	1.9	1.4	2.5	0.6	1.1	0.9	0.7
Total sand	% dw	83.1	74.3	70.2	87.8	44.9	76.7	86.3	81.4	74.7	67.9
Total silt	% dw	10.7	16.9	17.6	7.5	44.5	14.5	10.5	12.0	18.9	22.1
Total clay	% dw	4.9	7.9	6.4	2.9	9.1	6.1	2.6	5.7	5.6	9.1
Total fines	% dw	15.6	24.9	24.0	10.4	53.6	20.6	13.1	17.7	24.5	31.2
Conventionals											
Ammonia	mg-N/kg dw	11.8	7.97	6.72	24.7	25.7	6.83	24.9	7.49	5.27	17.3
TOC	% dw	1.33	1.39	1.85	0.802	0.506	1.44	1.77	1.58	1.01	1.39
Total solids	% ww	72.17	67.97	65.35	74.18	73.85	70.85	77.39	73.41	72.79	69.63
Total solids (preserved)	% ww	68.88	71.53	67.59	76.32	74.77	75.45	73.79	71.78	71.17	63.85
Total sulfides	mg/kg dw	762	515	1,370	541	236	890	248	769	284	1,130
Total volatile solids	% dw	2.43	3.28	4.53	1.49	2.64	2.56	2.00	2.55	2.59	2.92

dw – dry weight
ww – wet weight
TOC – total organic carbon

Table 5. Chemistry results for DMMU composite samples compared to DMMP guidelines (Windward, 2013b)

Chemical	SL	BT	ML	T513-S3-CS	T513-S4-CS
Metals (mg/kg dw)					
Antimony	150	nc	200	7 UJ	7 UJ
Arsenic	57	507.1	700	7 U	9
Cadmium	5.1	11.3	14	0.3	0.3
Chromium	260	260	nc	18.1	19.8
Copper	390	1,027	1,300	42.6	50.7
Lead	450	975	1,200	19	29
Mercury	0.41	1.5	2.3	0.18 J	0.33 J
Nickel	nc	nc	nc	11	12
Selenium	nc	3	nc	0.7 U	0.7 U
Silver	6.1	6.1	8.4	0.4 U	0.4 U
Zinc	410	2,783	3,800	58	71
Organometals					
TBT as ion (µg/L) porewater	nc	0.15	nc	0.5	0.097
TBT as ion (µg/kg dw) sediment	nc	73	nc	390	160
PAHs (µg/kg dw)					
2-Methylnaphthalene	670	nc	1,900	16 J	39
Acenaphthene	500	nc	2,000	19 J	46
Acenaphthylene	560	nc	1,300	20 U	39 U
Anthracene	960	nc	13,000	38	81
Benzo(a)anthracene	1,300	nc	5,100	59	140
Benzo(a)pyrene	1,600	nc	3,600	120	210
Benzo(g,h,i)perylene	670	nc	3,200	70	110
Total benzofluoranthenes	3,200	nc	9,900	230	420
Chrysene	1,400	nc	21,000	82	200
Dibenzo(a,h)anthracene	230	nc	1,900	26	47
Dibenzofuran	540	nc	1,700	19 J	55
Fluoranthene	1,700	4,600	30,000	120	300
Fluorene	540	nc	3,600	19 J	49
Indeno(1,2,3-cd)pyrene	600	nc	4,400	62	110
Naphthalene	2,100	nc	2,400	47	130
Phenanthrene	1,500	nc	21,000	86	230
Pyrene	2,600	11,980	16,000	280	490
Total HPAHs	12,000	nc	69,000	1,050	2,030
Total LPAHs	5,200	nc	29,000	209 J	540
Phthalates (µg/kg dw)					
Bis(2-ethylhexyl)phthalate	1,300	nc	8,300	61	90
Butyl benzyl phthalate	63	nc	970	20 U	19 U

Chemical	SL	BT	ML	T513-S3-CS	T513-S4-CS
Diethyl phthalate	200	nc	1,200	50 U	47 U
Dimethyl phthalate	71	nc	1,400	20 U	19 U
Di-n-butyl phthalate	1,400	nc	5,100	20 U	19 U
Di-n-octyl phthalate	6,200	nc	6,200	20 U	19 U
Other SVOCs (µg/kg dw)					
1,2,4-Trichlorobenzene	31	nc	64	20 U	19 U
1,2-Dichlorobenzene	35	nc	110	20 U	19 U
1,4-Dichlorobenzene	110	nc	120	20 U	19 U
2,4-Dimethylphenol	29	nc	210	20 UJ	19 UJ
2-Methylphenol	63	nc	77	20 U	19 U
4-Methylphenol	670	nc	3,600	20 U	48
Benzoic acid	650	nc	760	400 U	380 U
Benzyl alcohol	57	nc	870	20 U	19 U
Hexachlorobenzene	22	168	230	4.8 U	5.0 U
Hexachlorobutadiene	11	nc	270	4.8 U	5.0 U
n-Nitrosodiphenylamine	28	nc	130	20 U	19 U
Pentachlorophenol	400	504	690	200 UJ	190 UJ
Phenol	420	nc	1,200	20 U	61
PCBs					
Total PCBs (µg/kg dw)	130	nc	3,100	**169**	**203**
Total PCBs (mg/kg OC)	nc	38	nc	12.7	14.6
Pesticides (µg/kg dw)					
4,4'-DDD	16	nc	nc	4.8 U	5.0 U
4,4'-DDE	9	nc	nc	4.8 U	5.0 U
4,4'-DDT	12	nc	nc	12 UJ	12 UJ
Total DDTs	nc	50	69	12 UJ	12 UJ
Aldrin	9.5	nc	nc	2.4 U	2.5 U
Dieldrin	1.9	nc	1,700	**4.8 U**	**5.0 U**
Total chlordane	2.8	37	nc	**4.8 U**	**5.0 U**
Heptachlor	1.5	nc	270	**2.4 U**	**2.5 U**
Dioxin/furan (ng TEQ/kg dw)					
Dioxin/furan TEQ[a] – mammal (half DL)	4	nc	nc	**4.08 J**	**6.15 J**

[a]Calculated using toxicity equivalency factors given by van den Berg et al. (2006).

Bold result indicates an exceedance of the DMMP SL.

Underlined Bold result indicates an exceedance of the DMMP BT.

BT – bioaccumulation trigger
DDD – dichlorodiphenyldichloroethane
DDE – dichlorodiphenyldichloroethylene
DDT – dichlorodiphenyltrichloroethane
DMMP – Dredged Material Management Program
DMMU – dredged material management unit
na – not applicable
nc – no criteria
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
OC – organic carbon
SL – screening level

dw – dry weight
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
J – estimated concentration
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
ML – maximum level
SVOC – semivolatile organic compound
TBT – tributyltin
TEQ – toxic equivalent
U – result undetected at reporting limit shown
UJ – result undetected at the estimated reporting limit shown

Table 6. Z-layer samples compared to SMS and DMMP guidelines (Windward, 2013b)

Chemical	SQS	CSL	T513-S1-Z1	T513-S1-Z2	T513-S2-Z1	T513-S3-Z1	T513-S3-Z2	T513-S3-Z3	T513-S4-Z1	T513-S4-Z2
Metals (mg/kg)										
Antimony	nc	nc	7 UJ	6 UJ	6 UJ	7 UJ	6 UJ	6 UJ	6 UJ	7 UJ
Arsenic	57	93	9	6 U	6	9	6 U	7	7	8
Cadmium	5.1	6.7	0.4	0.3 U	0.2 U	0.3 U	0.3 U	0.3 U	0.3	0.4
Chromium	260	270	20.8	10.0	17.1	17.7	11.4	21.7	20.4	21.9
Copper	390	390	59.1	11.1	23.6	49.0	12.5	45.3	43.6	52.9
Lead	450	530	45	3 U	4	20	3 U	29	20	28
Mercury	0.41	0.59	0.21 J	0.03 UJ	0.05 J	0.17 J	0.03 UJ	0.23 J	0.18 J	0.64 J
Nickel	nc	nc	14	7	13	12	8	11	14	15
Selenium	nc	nc	0.7 U	0.6 U	0.6 U	0.7 U	0.6 U	0.7 U	0.7 U	0.7 U
Silver	6.1	6.1	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Zinc	410	960	81	22	32	59	21	60	58	71
Organometals										
TBT porewater (µg/L)	0.15[a]	nc	0.22	na	na	na	na	na	na	na
TBT sediment (µg/kg dw)	73[a]	nc	490	140	5.5	140	13	420	140	130
PAHs (mg/kg OC)										
2-Methylnaphthalene	38	64	7.6	4.1	3.8 U	1.5	0.96 J	1.6	3.3	2.5
Acenaphthene	16	57	11	5.4	3.8 U	1.9	2.1	2.5	3.6	3.6
Acenaphthylene	66	66	2.5 U	2.5 U	3.8 U	1.3 U	1.2	2.1 U	2.7 U	2.5 U
Anthracene	220	1,200	7.6	4.7	3.8 U	2.8	12	4.4	5.7	6.0
Benzo(a)anthracene	110	270	9.2	8.1	2.2 J	5.5	34	8.9	9.9	12
Benzo(a)pyrene	99	210	16	19	3.2 J	13	37	16	18	18
Benzo(g,h,i)perylene	31	78	9.2	10	1.9 J	7.6	11	8.2	8.8	8.6
Total benzofluoranthenes	230	450	38	40	7.1 J	26	46	33	37	36
Chrysene	110	460	14	12	3.2 J	9.0	56	13	15	16
Dibenzo(a,h)anthracene	12	33	3.0	4.0	3.8 U	3.1	6.8	3.0	3.4	3.2

Chemical	SQS	CSL	T513-S1-Z1	T513-S1-Z2	T513-S2-Z1	T513-S3-Z1	T513-S3-Z2	T513-S3-Z3	T513-S4-Z1	T513-S4-Z2
Dibenzofuran	15	58	12	6.0	3.8 U	2.2	2.8	2.3	4.3	3.8
Fluoranthene	160	1,200	29	21	5.3	9.0	73	20	23	25
Fluorene	23	79	9.7	5.0	3.8 U	1.6	2.1	2.5	3.9	3.5
Indeno(1,2,3-cd)pyrene	34	88	8.1	9.2	3.8 U	6.9	7.9	8.2	8.7	8.6
Naphthalene	99	170	34	29	2.8 J	4.9	3.6	6.3	13	7.9
Phenanthrene	100	480	27	15	4.0	6.3	6.8	14	15	18
Pyrene	1,000	1,400	97	120	24	36	190	31	37	41
Total HPAHs	960	5,300	220	243	47 J	115	460	142	159	168
Total LPAHs	370	780	89.2	59	6.7 J	17.5	28	30	41	39
Phthalates (mg/kg OC)										
Bis(2-ethylhexyl)phthalate	47	78	33	8.4	4.7 U	4.3	1.6	5.2	6.6	6.8
BBP	4.9	64	2.5	5.7	3.8 U	0.90 J	1.1 U	1.2 U	1.9 U	0.72 J
Diethyl phthalate	61	110	2.6 U	6.2 U	9.5 U	3.3 U	2.6 U	3.0 U	4.8 U	3.4 U
Dimethyl phthalate	53	53	1.0 U	2.5 U	3.8 U	1.3 U	1.1 U	1.2 U	1.9 U	1.4 U
Di-n-butyl phthalate	220	1,700	0.92 J	2.5 U	3.8 U	5.7	1.1 U	1.2 U	1.9 U	1.4 U
Di-n-octyl phthalate	58	4,500	0.86 J	2.5 U	3.8 U	1.3 U	1.1 U	1.2 U	1.9 U	1.4 U
Other SVOCs (mg/kg OC)										
1,2,4-Trichlorobenzene	0.81	1.8	1.0 U	2.5 U	3.8 U	1.3 U	1.1 U	1.2 U	1.9 U	1.4 U
1,2-Dichlorobenzene	2.3	2.3	1.0 U	2.5 U	3.8 U	1.3 U	1.1 U	1.2 U	1.9 U	1.4 U
1,4-Dichlorobenzene	3.1	9	0.97 J	2.5 U	3.8 U	1.3 U	1.1 U	1.2 U	1.9 U	1.4 U
2,4-Dimethylphenol[b]	29	29	18 J	20 UJ	19 UJ	19 UJ	10 J	19 UJ	19 UJ	19 UJ
2-Methylphenol[b]	63	63	10 J	20 U	19 U	19 U	19 U	19 U	19 U	19 U
4-Methylphenol[a]	670	670	47	20 U	19 U	13 J	11 J	19 U	19 U	20
Benzoic acid[b]	650	650	110 J	400 U	390 U	380 U	370 U	390 U	380 U	100 J
Benzyl alcohol[b]	57	73	19 U	20 U	19 U	19 U	19 U	19 U	19 U	19 U
Hexachlorobenzene	0.38	2.3	0.27 U	0.60 U	0.19 U	0.34 U	0.27 U	0.30 U	0.49 U	0.35 U
Hexachlorobutadiene	3.9	6.2	0.27 U	0.60 U	0.19 U	0.34 U	0.27 U	0.30 U	0.49 U	0.35 U

Chemical	SQS	CSL	T513-S1-Z1	T513-S1-Z2	T513-S2-Z1	T513-S3-Z1	T513-S3-Z2	T513-S3-Z3	T513-S4-Z1	T513-S4-Z2
n-Nitrosodiphenylamine	11	11	1.0 U	2.5 U	3.8 U	1.3 U	1.1 U	1.2 U	1.9 U	1.4 U
Pentachlorophenol[b]	360	690	190 UJ	200 UJ	190 UJ	190 UJ	190 UJ	190 UJ	190 UJ	190 UJ
Phenol[a]	420	1,200	75	9.9 J	19 U	12 J	16 J	14 J	10 J	28
PCBs (mg/kg OC)										
Total PCB Aroclors	12	65	16	17.2	3.6 U	8.82	1.0 U	8.9 U	12.3	17
Pesticides (µg/kg dw)										
4,4'-DDD	16[a]	nc	5.0 U	4.8 U	0.98 U	4.9 U	4.8 U	4.7 U	4.9 U	4.9 U
4,4'-DDE	9[a]	nc	5.0 U	4.8 U	0.98 U	4.9 U	4.8 U	4.7 U	4.9 U	4.9 U
4,4'-DDT	12[a]	nc	9.3 UJ	4.8 U	0.98 U	4.9 U	4.8 U	10 UJ	6.4 UJ	14 UJ
Total DDTs	nc	69[c]	9.3 UJ	4.8 U	0.98 U	4.9 U	4.8 U	10 UJ	6.4 UJ	14 UJ
Aldrin	9.5[a]	nc	2.5 U	2.4 U	0.49 U	2.5 U	2.4 U	2.4 U	2.5 U	2.4 U
Dieldrin	1.9[a]	1,700[c]	5.0 U	4.8 U	0.98 U	4.9 U	4.8 U	4.7 U	4.9 U	4.9 U
Total chlordane	2.8[a]	nc	5.0 U	4.8 U	0.98 U	4.9 U	4.8 U	4.7 U	4.9 U	4.9 U
Heptachlor	1.5[a]	270[c]	2.5 U	2.4 U	0.49 U	2.5 U	2.4 U	2.4 U	2.5 U	2.4 U
Dioxin/furan (ng TEQ/kg dw)										
Dioxin/furan TEQ[d] - mammal (half DL)	4[a]	nc	12.3 J	2.36 J	1.04 J	5.34 J	1.16	9.03 J	5.08 J	6.66 J

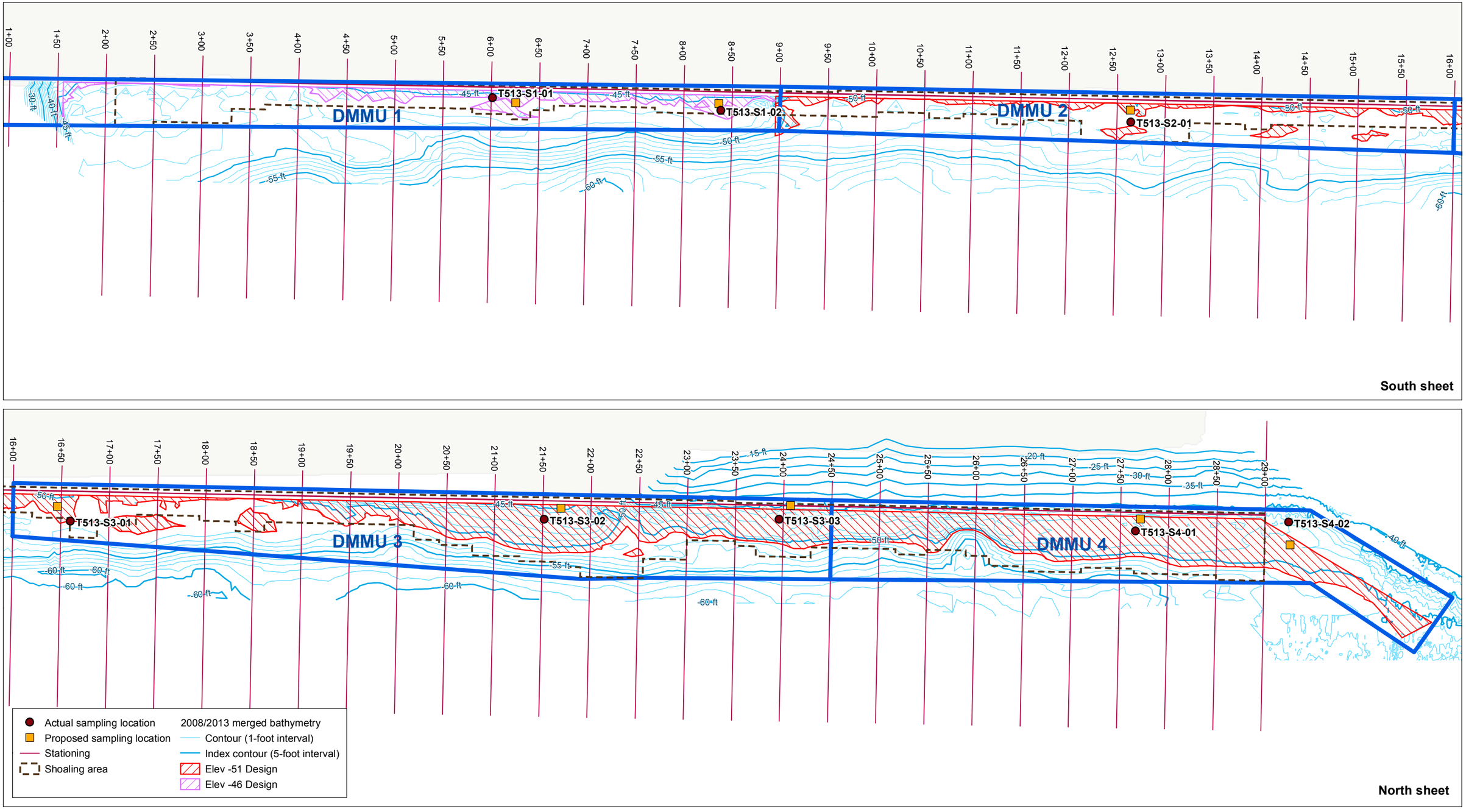
[a] DMMP SL value provided because no SQS value available.
[b] SMS values in units of µg/kg dw.
[c] DMMP ML value provided because no CSL value available.
[d] Calculated using toxicity equivalency factors given by van den Berg et al. (2006).

Bold result indicates exceedance of SQS or SL value

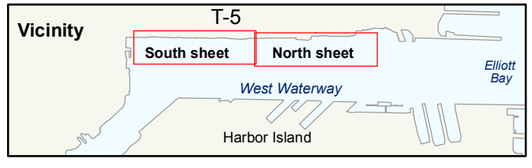
Underlined result indicates exceedance of the CSL or ML value.

BBP – butyl benzyl phthalate
CSL – cleanup screening level
DDD – dichlorodiphenyldichloroethane
DDE – dichlorodiphenyldichloroethylene
DDT – dichlorodiphenyltrichloroethane
DL – detection limit
DMMP – Dredged Material Management Program
J – estimated concentration
LPAH – low-molecular-weight polycyclic aromatic hydrocarbon
ML – maximum level
na – not applicable
nc – no criteria
OC – organic carbon
PAH – polycyclic aromatic hydrocarbon
SMS – Washington State Sediment Management Standards
SQS – sediment quality standards
SVOC – semivolatile organic compound
TBT – tributyltin
TEQ – toxic equivalent
U – result undetected at reporting limit shown
UJ – result undetected at the estimated reporting limit shown

dw – dry weight
HPAH – high-molecular-weight polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
SL – screening level



Wind Ward LLC environmental



0 50 100 150 200 Feet

0 10 20 30 40 Meters

N

Figure 1. Proposed and actual sediment sampling locations

Prepared by craigh, 8/26/2013; W:\Projects\Port of Seattle dredging on-call\Data\GIS\Maps_and_Analyses\T5 Data Report\Fig 1 5609 Proposed and actual locations.mxd