

## MEMORANDUM

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**To:** Lisa Pearson, Washington State Department of Ecology  
**Date:** March 8, 2010  
**From:** Dan Berlin, Anchor QEA, LLC  
Tom Wang, Anchor QEA, LLC  
**Project:** 080166-01  
**Cc:** Joanne Snarski, Port of Olympia  
**Re:** 9-Month Monitoring Results - Berths 2 and 3 Interim Cleanup Action Pilot Study

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This memorandum summarizes the results of sediment chemistry monitoring and a bathymetric conditions survey performed by the Port of Olympia (Port) as part of the Berths 2 and 3 Interim Cleanup Action Pilot Study (Interim Action) in West Bay in Olympia, Washington. This monitoring and survey work was conducted 9 months following completion of the Interim Action, as required in the Water Quality Monitoring and Sediment Sampling Plan (Sampling Plan; Anchor Environmental 2008). This memorandum includes sediment chemistry and bathymetry results. Previous sampling was conducted 3 months following completion of the Interim Action (Anchor QEA 2009a). Sampling conducted as part of the Interim Action is documented in the Completion Report – Berths 2 and 3 Interim Action Cleanup (Anchor QEA 2009b).

### 1 BACKGROUND

The Port entered into an Agreed Order (AO) (No. DE 6083) with the Washington State Department of Ecology (Ecology) to complete an interim cleanup action to address cleanup of West Bay sediments adjacent to the Port's Berths 2 and 3 in South Budd Inlet, Olympia, Washington, and to accomplish maintenance dredging to a minimum of -39 feet below mean lower low water (MLLW). The Interim Action was completed on March 3, 2009 with final placement of clean sand cover in the dredged area. Previous chemical sampling and bathymetric data collection was conducted prior to dredging (September 2008), following dredging (February 2009), and following placement of the clean sand cover (March 2009). Those results are included in the Completion Report (Anchor QEA 2009b). Sampling was also conducted 3 months following completion of the Interim Action in June 2009 (Anchor

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QEA 2009a). This memorandum contains results from sediment monitoring and bathymetric data collection conducted in December 2009.

## **2 SEDIMENT MONITORING**

Per the Sampling Plan (Anchor Environmental 2008), sediment sampling was conducted on surface sediment (0 to 10 centimeters [cm]) in the berth area (BA-24, BA-25, BA-26, and BA-27B), underpier area (UP-20, UP-21, UP-22, and UP-23B), and at ambient locations outside of the berth area (BI-C16, BI-S27, and AM-28). The methodology was identical to that used for samples collected during the post-cover sampling in March 2009 and during the 3-month monitoring event in June 2009.

Coordinates of each location sampled in December 2009 are provided in Table 1. Sample locations from the June 2009 post-cover sampling event were revisited. Sediment chemistry results are presented in Table 2 and Figure 1. Laboratory results and validation reports are included in Attachments A and B, respectively.

Sampling was conducted for 8 of the 11 samples on December 4, 2009. However, three underpier stations (UP-20, UP-22, and UP-23B) were inaccessible on December 4, 2009 due to rising tides. Sampling at the remaining three underpier stations occurred at the earliest possible date between Marine Terminal vessel calls and during acceptable tidal conditions on December 16, 2009. One duplicate sample was collected for chemical and conventional concentrations at BA-26.

As shown in Table 3, the surface sediment chemistry results from the 9-month post-cover sampling are similar to the 3-month monitoring event in the underpier area and at the ambient sample locations. Underpier samples from the 9-month monitoring event (mean 36.7 parts per trillion toxic equivalency [TEQ]) were similar to the 3-month monitoring (mean 37.1 TEQ) and the post-cover sampling (mean 38.9 TEQ). Ambient samples from the 9-month monitoring event (mean 21.8 TEQ) were also similar to the 3-month monitoring (mean 22.7 TEQ) and the post-cover sampling (mean 23.8 TEQ).

Concentrations in berth area sediments increased from the 3-month monitoring event, as was anticipated based on the presence of higher ambient surrounding concentrations than

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the berth area concentrations following cover placement and at the 3-month monitoring event. The mean concentration in the berth area was 2.4 TEQ during the 3-month monitoring event, and continued to increase to a mean of 12.9 TEQ during the 9-month monitoring. The largest increases occurred at stations BA-26 and BA-27B. Station BA-27B increased from 1.7 TEQ at the 3-month event to 17.1 TEQ at the 9-month event. Duplicate results from station BA-26 measured 1.1 TEQ (BA-26) and 35.2 TEQ (BA-26 (DUP)) in the 9-month event. The average of these two samples was 18.1 TEQ, which was above the 3-month event concentration of 1.5 TEQ. All berth area samples contained approximately 2 cm of silt overlying sand cover material, except for BA-26 (DUP), which contained slightly sandy silt throughout the upper 10 cm. Samples indicate that there continues to be a discrete silt layer depositing over the clean sand cover, and samples indicated minimal to no mixing of the silt layer into the clean sand cover.

The difference in duplicate sample concentrations is likely not the result of collection of one sample within the dredge and sand covered area versus one sample from an undredged area. The two sample locations were within several feet of each other based on GPS, which was approximately 25 feet from the boundary of dredging and placement of clean cover. Based on the post-cover sediment profile imaging (SPI) survey and other documentation of adequate sand placement included in the Completion Report (Anchor QEA 2009b), the sand cover was placed throughout the dredged area, making it unlikely that sample BA-26 (DUP) was collected from the undredged surface. Although some inherent variability of positioning exists when revisiting a station by boat, especially in water depths on the order of the berth area, the absence of strong winds or currents during the sampling suggests that sample BA-26 (DUP) was not collected from the undredged area located 25 feet to the southwest.

The elevated concentration in BA-26 (DUP) may be the result of fine-grained sediment sloughing (i.e., falling down the underpier slope) onto the sand cover from the adjacent underpier area. Concentrations in the underpier area ranged from 33.4 TEQ to 43.9 TEQ (mean 36.7 TEQ), which is in the range of the higher BA-26 (DUP) concentration. This sample is located approximately 25 feet from the pierface. Accumulation of sediment within the first 10 feet of the toe of the underpier slope can easily be seen on the December 2009 bathymetry survey in the vicinity of BA-26, but there does not appear to be significant

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accumulation of sediment beyond 10 feet from the pierface. However, the accuracy of bathymetric surveys is typically accurate to 3-6 inches vertically.

Another potential explanation for the thicker silt deposit at BA-26 (DUP) may be from redistribution of undredged sediments that are located close to the sample. Redistribution may be the result of currents or propwash from tugs berthing vessels. The nearest surface sediment concentration from the undredged area was collected from POC-C12 in 2007 (Figure 1), which had a concentration of 30 TEQ in the upper 2-foot interval.

Natural deposition of sediments will continue to occur within West Bay including within the berth area. Ecology's sediment characterization study indicated that average sediment concentrations in West Bay were 19.0 TEQ (SAIC 2008). It is expected that surface concentrations within the berth area will continue to equilibrate to background concentrations of West Bay sediments as normal sediment deposition continues and as additional underpier sloughing continues to occur (though underpier sloughing is anticipated to have more localized effects at the toe of the underpier slope).

### **3 BATHYMETRIC SURVEY RESULTS**

Multibeam bathymetric surveys were conducted just after the placement of the sand cover (March 12, 2009), 3 months following placement (June 24, 2009), and 9 months following placement (December 10, 2009). The March, June, and December surveys were conducted by eTrac Engineering using a multibeam sonar system. The surveys included the dredged portions of the berth area as well as the underpier area. The surveys were conducted in accordance with requirements presented in the Sampling Plan (Anchor Environmental 2008).

Results of the December bathymetric survey are provided in Figures 2 through 7. Figure 2 presents a plan view of the bathymetry results along with cross section locations. Ten cross sections are presented in Figures 3 through 7. Figure 8 presents a comparison of the June and December surveys.

As part of the Interim Action, the area immediately adjacent to the pierface was dredged to between -40 and -41 feet MLLW; however, sloughing from the underpier slope resulted in

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an accumulation of material at the pierface shortly after the dredging was completed. The approach to dredge at the pierface to allow the slope to slough in a controlled manner was discussed with Ecology during development of the Interim Action Plan. This approach was determined to be the most environmentally protective and present the least risk to the pile-supported structure. However, the slope sloughed less than expected during construction. As discussed with Ecology during plan development, this outcome meant that sloughing was likely to continue after dredging was complete until the slope reached equilibrium.

Table 4 provides a summary of bathymetry measurement comparisons between the June and December surveys. Based on the cross sections from the June survey, sediment elevations at the pierface within the dredged berth area range from -34.9 to -38.2 feet MLLW, except at the northern-most corner (which measured -30.2 feet MLLW). The mean depth was -36.0 feet MLLW.

Based on the cross sections from the December survey, elevations at the pierface ranged from -34.5 to -37.3 feet MLLW, except at the northern-most corner. Section 15+40 is located at the very northern edge of the dredge area (Figure 7) and is shallower than other areas (-30.9 feet MLLW at the pierface). The mean depth at the pierface along the project area was -35.5 feet MLLW. The mudline elevation along the pierface increased an average of 0.5 feet between June and December (Table 4). The increase in elevation along the pierface is attributed to additional sloughing from the underpier areas. The increased sediment elevation at the pierface and underpier sloughing is shown in the comparison of the June and December bathymetric surveys in Figure 8.

As expected, the data suggest that sloughing continues to occur under the pier. Based on the cross sections from the June survey, the horizontal distance under the pier to the top of the sloughing ranged from 7.5 to 13 feet, except at the northern-most corner (which had no sloughing in June). The average horizontal distance of sloughing underpier was 9.0 feet. Based on the cross sections from the December survey, the horizontal distance under the pier to the top of the sloughing ranged from 8.5 to 18 feet. The average horizontal distance of sloughing underpier was 12.6 feet, which is approximately 3.6 feet greater than the average from the June survey. This increase from the average distance in the June survey suggests that the slope continues to flatten.

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Sloughing is likely to continue until the slope reaches equilibrium. The Port has installed temporary mooring camels along the pierface as an interim measure to provide an offset from the toe of slope to allow berthing for vessels. The degree and timing of additional sloughing could warrant additional dredging along the pierface. The Port will continue to take regular leadline measurements at the pierface and will coordinate with Ecology if increases in mudline elevations at the pierface create challenges to berthing. If so, additional dredging may be warranted, pending discussion with Ecology.

#### **4 NEXT STEPS**

Monitoring events will continue at 6-month intervals through December 2010. The next event will be conducted in June 2010 and will consist of surface sediment sampling and bathymetric surveying. In the event that navigation becomes limited on the berth area due to sloughing, the Port will inform Ecology and coordinate next steps.

#### **6 REFERENCES**

Anchor Environmental, L.L.C. 2008. Water Quality Monitoring and Sediment Sampling Plan. Prepared for the Port of Olympia. September.

Anchor QEA, LLC. 2009a. Memorandum Summarizing 3-Month Monitoring Results - Berths 2 and 3 Interim Cleanup Action Pilot Study. Prepared for the Port of Olympia. September.

Anchor QEA, LLC. 2009b. Completion Report – Berths 2 and 3 Interim Action Cleanup. Prepared for the Port of Olympia. June.

SAIC. 2008. Sediment Characterization Study, Budd Inlet, Olympia, WA, Final Data Report. Prepared for the Washington State Department of Ecology. March 12.

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# ATTACHMENTS

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**Table 1**  
**9-Month Post-Cover Surface Sediment Sample Locations**

Station ID		Water Depth (feet MLLW)	Actual Coordinates <sup>1</sup>			
			Latitude (°N)	Longitude (°W)	Northing (feet)	Easting (feet)
Underpier	PO-UP-20-SE	-24.5	47 03.2034	122 54.3436	636401	1040845
	PO-UP-21-SE	-19.4	47 03.2457	122 54.3508	636659	1040823
	PO-UP-22-SE	-22.5	47 03.2790	122 54.3557	636862	1040809
	PO-UP-23B-SE	-28.0	47 03.3133	122 54.3608	637071	1040794
Berth Area	PO-BA-24-SE	-37.4	47 03.1999	122 54.3603	636382	1040775
	PO-BA-25-SE	-37.1	47 03.2271	122 54.3604	636547	1040780
	PO-BA-26-SE	-37.9	47 03.2770	122 54.3652	636851	1040769
	PO-BA-27B-SE	-39.1	47 03.3122	122 54.3764	637066	1040729
Ambient	PO-AM-28-SE	-39.1	47 03.3428	122 54.3997	637255	1040638
	BI-S37	-31.5	47 03.2883	122 54.4481	636930	1040427
	BI-C16	-32.0	47 03.2226	122 54.3922	636524	1040647

Notes:

1 Washington South Zone, NAD 83 geographic and state plane coordinates – U.S. survey feet



**Table 2**  
**9-Month Post-Cover Sediment Chemistry Results**

Sample Sample Date Depth	Berth Area				Underpier Area					Ambient Samples		
	BA-24	BA-25	BA-26	BA-26 (DUP)	BA-27B	UP-20	UP-21	UP-22	UP-23B	BI-C16	BI-S37	AM-28
	12/4/09 0 - 10 cm	12/4/09 0 - 10 cm	12/4/09 0 - 10 cm	12/4/09 0 - 10 cm	12/4/09 0 - 10 cm	12/16/09 0 - 10 cm	12/4/09 0 - 10 cm	12/16/09 0 - 10 cm	12/16/09 0 - 10 cm	12/4/09 0 - 10 cm	12/4/09 0 - 10 cm	12/4/09 0 - 10 cm
<b>Conventional Parameters (pct)</b>												
Total organic carbon	2.6	1.6	0.83	4.2	3.7	4.6	4.9	5.1	5.2	3.5	3.6	3.6
Total solids	47	67	79	28	36	28	28	33	24	28	25	28
<b>Grain Size (pct)</b>												
Cobbles	0	0	0	--	0	0	0	0	0	0	0	0
Gravel	6.5	17	28	--	5.7	17	8.6	11	1.5	0	0	0.3
Sand	55	67	66	--	35	17	16	18	6.5	7.2	1.2	10
Silt	31	12	4.3	--	43	48	60	55	73	74	77	69
Clay	8.1	3.7	1.4	--	16	18	5.4	16	19	18	22	21
Total Fines (silt + clay)	39.1	15.7	5.7	--	59	66	65.4	71	92	92	99	90
<b>Dioxin Furans (ng/kg)</b>												
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	0.315 J	0.122 J	0.0694 U	0.887 J	0.543	0.791	0.927 U	0.82	0.732	0.596 J	0.609 J	0.703
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1.73 J	0.658 J	0.111 U	4.97	2.35	4.44	5.12	4.23	5.17	3.19	3.26	3.32
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	2.51	1.25 J	0.347 J	17.8	3.69	8.26	11.7	7.85	9.73	4.63	4.82	5.24
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	13.9	5.57	1.85 J	39	21.3	35.8	39	38.3	41.3	28	27.3	26.3
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	5.99	2.56	0.83 J	17.8	8.81	17.9	21.1	15.3	21.7	11.6	11	11.4
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	345	131	36.5	1060	478	1230	1780	1130	1110	642	586	627
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	2920	1160	315	9130	3860	12100	21100	9670	9470	5360	4700	4800
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	1.13 J	0.437 J	0.148 J	3.47 J	1.67 J	2.57	2.01 J	2.78	2.88	2.49	2.5 J	2.43
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	1.15 J	0.406 J	0.129 J	3.63	1.61 J	2.52	2.9	2.92	3	2.34	2.23 J	2.37 J
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	2.23 J	0.93 J	0.0539 U	0.1448 U	3.81	0.1481 U	4.16 J	0.1294 U	7.83	4.91	4.73	0.1636 U
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	5.65	2.35	0.6 J	20.2	9.17	13.7	14.9	17.1	21.1	11.6	11.3	11.6
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	2.56	0.865 J	0.331 J	8.35	4.02	6.42	7.82	6.63	8.27	5.3	5.16	5.19
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.2856 U	0.1855 U	0.124 U	3.76	0.342 U	0.4679 U	1.6 U	0.5568 U	0.397 U	0.2551 U	0.4014 U	0.3953 U
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	4.08	1.62 J	0.561 J	13.2	5.99	10.3	9.58	11.2	13.1	8.46	8.1	8.29
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	97.3	36.8	13.5	319	145	239	239	256	290	200	188	197
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	3.58	1.63 J	0.0923 U	12.4	5.28	9.79	12.4	11.1	14.4	7.05	7.25	7.07
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	192	71.6	22.9	660	266	574	764	590	816	346	305	363
Total Tetrachlorodibenzo-p-dioxin (TCDD)	12.6 J	5.61 J	1.55 J	34.3 J	22.4 J	26.8 J	14.9 J	25.8 J	26.3 J	25.8 J	27.8 J	28.2 J
Total Pentachlorodibenzo-p-dioxin (PeCDD)	24.4 J	10.4 J	2.53 J	77 J	39.1 J	55.7	57.8 J	52	56.5 J	50.1	51.2 J	49 J
Total Hexachlorodibenzo-p-dioxin (HxCDD)	141	55 J	16.6 J	477	200	476	721	387	379	264	257	258 J
Total Heptachlorodibenzo-p-dioxin (HpCDD)	999	368	96.4	2850	1180	5220	9720	3550	2960	1730	1400	1550
Total Tetrachlorodibenzofuran (TCDF)	19.4 J	7.09 J	1.91 J	55.3 J	27.8 J	41.1 J	25.4 J	44 J	45 J	39 J	38.4 J	36.1 J
Total Pentachlorodibenzofuran (PeCDF)	27.8 J	11.1 J	3.55 J	98.2 J	45.3 J	71.1 J	63.7 J	82.4 J	89.2 J	62.4	58.5 J	61.6 J
Total Hexachlorodibenzofuran (HxCDF)	115	44.7 J	14.6 J	382	177	277	288 J	315 J	361 J	236	237 J	235
Total Heptachlorodibenzofuran (HpCDF)	264	98.2 J	33.5	884	383	699	762 J	746	904	532	496	518 J
Total Dioxin/Furan TEQ (U = 0)	11.7	4.6	1.1	35.2	17.1	33.4	43.9	32.1	37.4	22.7	21.7	21.0

Notes:

**Bold = Detected result**

J = Estimated value

U = Compound analyzed, but not detected above detection limit

Totals are calculated as the sum of all detected results (U=0). If all results are not detected, the highest reporting limit value is reported as the sum.

Toxicity Equivalency (TEQ) values as of 2005, World Health Organization.

Level III data validation applied

**Table 3**  
**2009 Post-Cover Surface Sediment Results**

	Post-Cover Survey (March 2009)	3-Month Post-Cover Survey (June 2009)	9-Month Post-Cover Survey (December 2009)
<b>Underpier Area</b>			
UP-20	39.4	39.0	33.4
UP-21	46.0	37.3	43.9
UP-22	32.3	36.2	32.1
UP-23B	37.8	36.0	37.4
Average	38.9	37.1	36.7
<b>Berth Area</b>			
BA-24	0.1	4.7	11.7
BA-25	0.5	1.8	4.6
BA-26	0.0	1.5	1.1 / 35.2 *
BA-27B	0.0	1.7	17.1
Average #	0.2	2.4	12.9
<b>Ambient Samples</b>			
BI-C16	24.7	21.3	22.7
BI-S37	23.3	22.9	21.7
AM-28	23.3	23.8	21.0
Average	23.8	22.7	21.8

Notes:

TEQ values calculated using World Health Organization (2005)

\* A field duplicate was collected at BA-26

# Average for Berth Area samples was calculated using the mean of the duplicate samples collected at BA-26

**Table 4  
Bathymetry Comparison**

	Post-Construction Elevation (feet MLLW)			Change in Mudline Elevation at Pierface (feet)	Distance Under Pier to Top of Sloughed Slope (from fender line; feet)			Increase in Lateral Distance to Top of Sloughed Slope (feet)
	Post-Cover	3-Month Survey	9-Month Survey		Mar 9, 2009	Jun 24, 2009	Dec 10, 2009	
	Mar 9, 2009	Jun 24, 2009	Dec 10, 2009	Jun - Dec 2009				Jun - Dec 2009
<b>Cross Section</b>								
7+40	-35.2	-34.9	-34.5	0.4	7.0	8.0	16.5	8.5
7+90	-39.9	-38.2	-37.1	1.1	11.0	11.5	14.5	3.0
8+90	-37.6	-37.3	-36.6	0.7	9.0	11.0	13.0	2.0
9+70	-35.6	-36.6	-35.3	1.3	1.5	8.5	11.5	3.0
10+90	-37.7	-36.2	-35.9	0.3	12.0	12.0	15.0	3.0
11+90	-39.6	-37.5	-37.3	0.2	4.0	7.5	10.0	2.5
12+90	-36.8	-35.9	-35.3	0.6	13.0	13.0	18.0	5.0
13+90	-37.7	-36.7	-35.9	0.8	10.0	10.0	10.0	0.0
14+90	-39.0	-36.6	-36.1	0.4	7.0	8.0	8.5	0.5
15+40	-31.8	-30.2	-30.9	-0.7	0.0	0.0	9.0	9.0
Minimum	-39.9	-38.2	-37.3	-0.7	0.0	0.0	8.5	0.0
Average	-37.1	-36.0	-35.5	0.5	7.5	9.0	12.6	3.6
Maximum	-31.8	-30.2	-30.9	1.3	13.0	13.0	18.0	9.0