CENWS-OD-TS-DMMO

MEMORANDUM FOR: RECORD January 8, 2015

SUBJECT: DETERMINATION REGARDING THE SUITABILITY OF PROPOSED DREDGED MATERIAL FROM PHASE 1 OF THE PORT OF TACOMA PIER 4 CLEANUP AND RECONFIGURATION PROJECT EVALUATED FOR UNCONFINED OPEN-WATER DISPOSAL AT THE COMMENCEMENT BAY DISPOSAL SITE OR BENEFICIAL USE

1. Introduction. This memorandum reflects the consensus determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington State Department of Ecology, Washington State Department of Natural Resources, and the U.S. Environmental Protection Agency) regarding the suitability of up to 11,300 cubic yards (cy) of dredged material from Phase 1 of the Port of Tacoma's Pier 4 Cleanup and Reconfiguration project for open-water disposal at the Commencement Bay nondispersive site or for beneficial use, and for compliance with the State of Washington Antidegradation Policy.

2. Background. In early 2013 the Port of Tacoma proposed dredging of approximately 550,000 cy of material to cutback and reconfigure Pier 4 to be in alignment with Pier 3 within Husky Container Terminal on the Blair Waterway (see Figure 1 for project location and extent). During sediment sampling in April 2013 for characterization of the proposed dredged material, levels of porewater tributyltin (TBT) were found in the in-water DMMU A exceeding the DMMP screening level (SL) for porewater TBT of 0.15 μg/L. Subsequent sampling events in August and November 2013 to determine the extent of TBT contamination revealed very high levels of TBT in bulk sediment analysis, up to 50,000 μg/kg, nearly three orders of magnitude above the DMMP bulk TBT SL of 73 μg/kg.

   A fourth sampling event in July 2014 was conducted under an Agreed Order on Consent (AOC) between the Environmental Protection Agency (USEPA) and the Port of Tacoma to determine the vertical and horizontal extent of TBT contamination at Pier 4. Following review of the preliminary results of the July sampling event, USEPA determined that the cleanup of the TBT-contaminated sediments was to proceed as a Time Critical Removal Action. Therefore, the work occurring at Pier 4 will have two distinct work phases: (1) the Phase 1 Removal Action, which includes a USEPA-ordered cleanup of contaminated sediment, and (2) the Phase 2 Reconfiguration Project , which includes reconfiguration of the existing pier. A brief description of the work associated with each phase of the project follows:

   Phase 1
   Removal of approximately 49,000 cy of TBT-contaminated sediment will be removed under an AOC between the Port of Tacoma and USEPA (Floyd|Snider, 2014). Prior to removal of the contaminated material along the slope and at the pier face, the upper portion of the slope must be removed to maintain slope stability. This suitability determination applies only to the 11,300 cy of top-of-slope dredged material, see Figure 2.

Phase 2
Following the removal of the 49,000 cy of TBT-contaminated sediments, the Port will continue work to cutback Pier 4 to be in alignment with Pier 3. This work, which will include dredging of approximately 500,000 cy of material, is subject to review and permitting under Section 404 of the Clean Water Act, and will receive a separate suitability determination from the DMMP agencies at a future date.

3. Project Summary. Table 1 includes project summary and tracking information.

Table 1. Project Summary

Project ranking	High
Proposed dredging volume	11,300 cy
Proposed dredging depth	Upslope from -2 ft MLLW, with a depth of 8,9, or 11 ft. (plus 1 ft of overdepth) in the southern, northern, and middle sections, respectively
Sampling dates	April 11-19, 2013
	August 8-9. 2013
	November 13-16, 2013
	June 30 - July 9, 2014
Draft suitability memo	September 18, 2014
Comments provided on draft suitability memo	October 6, 2014
Second draft suitability memo	November 13, 2014
Comments provided on 2nd draft memo	December 1, 2014
Third draft suitability memo	December 5, 2014
Comments on 3rd draft suitability memo	December 17, 2014
Final suitability memo received	December 22, 2014
EIM Study ID	POTP413
Recency Determination (high rank = 3 years)	July 2017

4. Project Ranking and Sampling Requirements. This project was originally ranked moderate by the DMMP agencies according to a review of previous testing results and the guidelines set out in the DMMP User Manual for areas on the Blair Waterway (DMMP, 2013). However, as a result of the extremely high levels of TBT found in the sediments along Pier 4, the area is now considered a high ranked area.

In a high-ranked area the number of samples and analyses are calculated using the following guidelines (DMMP, 2013):

- 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) = 4,000 cubic yards

- Maximum volume of sediment represented by each analysis in the subsurface portion of the dredging prism = 12,000 cubic yards

Samples representing the proposed dredged material were collected over several sampling events as described in section 5 below and in detail in the Pier 4 Phase 2 Reconfiguration Project Sediment Characterization Report (Floyd|Snider, 2014a). Nevertheless, the total number of samples collected from within the proposed dredge footprint is sufficient to meet the DMMP requirements for a high ranked project. Five samples were collected from within the dredge prism and were analyzed individually to represent the 11,300 cy of material. See Table 2 for sample locations and Table 3 for collection dates, type of equipment used, mudline elevations and sample intervals collected for each bore.

5. Sampling. As mentioned above, sampling over the entire project area took place over four events between April 2013 and July 2014. A detailed description of the activities and results from each sampling event can be found in the Pier 4 Phase 2 Reconfiguration Project Sediment Characterization Report (Floyd|Snider, 2014a). Figure 4.1 includes all the results from all sampling events.

The sample locations considered in this suitability determination are shown in Figures 2 & 3 and are summarized below:

- In April 2013 samples C1 and C2 were collected to represent the upland cutback material by direct push boring. Both of these samples were collected in 4 foot intervals from the surface to 20 feet depth and composited together to represent surface DMMU P4-C1 and subsurface DMMUs P4-C2 and P4-C3.
- In November 2013 sample locations A12 and A14 were collected by roto-sonic boring after cutting a hole in the deck of the pier. This method of sampling was used in order to penetrate the rip rap slope armoring on the surface beneath the pier.
- In July 2014 a final sampling event took place as part of a site removal action evaluation under an AOC between USEPA and the Port. During this sampling event samples A18, B14 and B15 were collected by roto-sonic boring and samples C3, C4 and C5 were collected by direct-push soil boring.

All upland soil borings were advanced by Cascade Drilling of Woodinville, WA and collected in 4 or 5 foot intervals using a direct-push Geoprobe equipped with a disposable sample tube liner. All samples were photographed and documented on field boring log forms using the Unified Soil Classification System (USCS). A dark gray fine sand unit with red and white grains and occasional shell and wood fragments was assumed to be native material.

All under-pier roto-sonic sediment borings were advanced by Holt Services, Inc. of Edgewood, WA. Roto-sonic drilling uses resonant sonic energy to exploit weaknesses in hard materials such as rip rap, allowing collection of the sediment beneath the armored under-pier slope. Samples were collected continuously from the steel casing within the drill rods, which were lined with disposable polyethylene liners. All sample units and material types encountered were photographed and documented on a boring log form according to the USCS.

At the three under-pier locations representing the clean dredged material (A18, B14, and B15), sample recovery was poor due to the difficulty of sampling through the rock armor. At two of these three locations the surface sediment interval (immediately beneath the rip rap layer) could not be collected. As explained in the Sediment Characterization Report, "At under-pier Sampling Locations A18 and B15, the presence of surface riprap prevented sediments located within and underlying the riprap from being recovered and sampled because the sediments were not dense enough to push the riprap up through the core barrel. However, the surface intervals were able to be recovered at under-pier Sampling Location B14 because a large piece of riprap at 3 feet prevented further downward movement of the core barrel. The driller was able to pull up the core barrel with the top 3 feet of rock and intermixed sediment that was intact and the material was sampled. This differed from Sampling Locations A18 and B15 in that the riprap completely plugged the core barrel, preventing any additional material from being captured and retained. Samples were collected at approximately 2-foot intervals where sediment was recovered below the riprap slope armor." (Floyd|Snider, 2014)

6. Chemical Analysis. Analysis of conventionals, standard DMMP COCs and both bulk and porewater TBT was conducted by Analytical Resources, Inc. of Tukwila, WA.

   The conventional results from composited upland DMMU C showed that the dredged material is predominantly sand with 64-93% percent sand, 4-14% percent silt and 0.4-2.6% percent clay. Total organic carbon (TOC) was 0.12-0.285 % in the composited DMMU. Results from individual under-pier boring locations show that the proposed dredged material is predominantly gravel in the upper sections and predominantly sand in the deeper intervals. TOC was highest at the surface at location C3 and C4 and quickly dropped at depth. See Table 6 for TOC and grain size results.

   Results of the initial April 2013 sampling found that the only COC present in the project area was TBT. All other DMMP COCs in all upland and in-water sample locations were below DMMP screening levels (SLs). Sample locations C1 and C2, composited to represent DMMU C, are upland from the proposed dredged material, but are the closest samples to the dredge prism with analysis of the full DMMP suite of chemicals. Results from DMMU C are presented in Tables 4 and 5. Dioxin results for DMMU C were lower than the DMMP site management objective of 4 pptr TEQ (DMMP, 2010), as were dioxin results for all composited DMMUs (Floyd|Snider, 2014a). Based on these results it was determined that subsequent sampling events would only analyze for TBT.

   TBT results are presented in Table 6. All samples collected from within the proposed dredge prism (A18, B14, B15, C4 and C5) are below the DMMP SL of 73 μg/kg and the majority of those results were undetected. In addition, results from A12 and A14, downslope of the proposed dredge prism and from C3, landward of the proposed dredge prism, were all less than the DMMP SL.

7. Rock Armoring. There is a 2 foot layer (2,300 cy) of approximately 18" rip rap armoring the slope within the proposed dredge prism. As outlined in the DMMP User Manual (DMMP, 2014) disposal of debris is not allowed at DMMP disposal sites. This includes all floatable debris and large non-floatable debris such as logs, piling, rip-rap and concrete.

   Therefore, following pier demolition, the rip rap layer (2,300 cy) will be removed for reuse or upland disposal. Only then will the underlying 9,000 cy of clean material be dredged.

8. Dredging Residuals. Prior to dredging the majority of Pier 4 will be demolished and removed along with the supporting piles. In total, approximately 1,047 concrete piles, 87 creosote-treated timber piles and 22 steel piles will be removed by vibratory pile extraction, including the removal of piles from within the areas of highest TBT contamination.

   The DMMP agencies expressed concern over the possibility that contaminated sediment could be suspended during pile extraction and deposited over the area of proposed clean dredged material at the top of the slope. To address these concerns, Floyd|Snider provided the following lines of evidence supporting the conclusion that pile removal is unlikely to affect clean top of slope sediments:
   - The proposed Phase 1 clean dredged material will remain isolated from pier removal influences and any potential resuspension due to an overlying 2 foot layer of rip rap. Following pier demolition, the rip rap layer (2,300 cy) will be removed for reuse or upland disposal. Only then will the underlying 9,000 cy of clean material be dredged.
   - Vibratory pile extraction shears sediment from the sides of the piles, resulting in very little sediment remaining attached to the pile, thereby reducing the amount of sediment available to be resuspended and deposited on the top of slope sediments.
   - No sediment cover was found on the rock armoring within the top 30% of the slope, indicating that during normal tide cycles and operating conditions at Pier 4 resuspended sediment does not travel up slope far enough to reach the proposed dredge prism.
   - The estimated the worst case scenario of how much contaminated sediment could be resuspended and deposited on the top-of slope clean material results in TBT concentrations in the top 1-ft of material that are less than the TBT SL. The details of these calculations, including all assumptions, can be found in Appendix A: Proposed Suitability of the Pier 4 Phase 1 Removal Action Project Clean Material Memo.

   Therefore, based on these lines of evidence, the DMMP agencies determined using best professional judgment that the proposed dredged material is not likely to be contaminated during pile extraction.

9. Sediment Exposed by Dredging. 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).

   A first tier evaluation of antidegradation is to compare the dredged material to the DMMP Marine guidelines. As demonstrated by the results of the above analyses, the chemical concentrations in the project dredged material at the depth of the new exposed surface are below DMMP SLs. Therefore the sediment to be exposed by dredging is not considered to be degraded relative to the currently exposed sediment surface.

   Note, the sediment that will be exposed after dredging of the Phase 1 top-of-slope clean material will only be exposed to the environment for a limited time. The final exposed surface will be the surface that remains after the completion of Phase 2 dredging. The antidegradation status of the final exposed surface will be evaluated in the forthcoming DMMP suitability determination for Phase 2 of the Port of Tacoma Pier 4 Reconfiguration Project.

10. Suitability Determination. This memorandum documents the evaluation of the suitability of sediment proposed for dredging from Phase 1 of the Port of Tacoma Pier 4 cleanup and reconfiguration project for unconfined open-water disposal at the Commencement Bay site. The approved sampling and analysis plans were followed and the data gathered were deemed sufficient and acceptable for regulatory decision-making under the DMMP program.

    In summary, based on the results of the previously described testing, the DMMP agencies conclude that **up to 9,000 cy of dredged material from Phase 1 of the Port of Tacoma's Pier 4 cleanup are suitable** for open-water disposal at the Commencement Bay non-dispersive disposal site or for beneficial use. Approximately **2,300 cy of riprap from the top two feet of the dredge prism is unsuitable** for open-water disposal, and must be disposed of in an approved manner. After removal of the top two feet of rip rap, any incidental rip rap mixed with sediment within the dredged material will be allowed to be disposed of at the Commencement Bay disposal site as long as the rip rap is less than 2' x 2'. Sorting of dredged material through a mesh screen may be required.

    A determination regarding the suitability of material for upland disposal must be coordinated with the local Health Department.

    *This suitability determination does **not** constitute final agency approval of the project. 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 must be developed and submitted to the Agencies at least 7 days prior to the pre-dredge meeting. A DNR site use authorization must also be acquired.*

11. References.

DMMP, 2014. *Dredged Material Evaluation and Disposal Procedures (Users Manual)*. Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, December 2014.

DMMP, 2010. *Dredged Material Management Program New Interim Guidelines for Dioxins*. December 6, 2010.

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

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

Floyd|Snider, 2014a. Pier 4 Phase 2 Reconfiguration Project Sediment Characterization Report. Prepared for the Port of Tacoma by Floyd|Snider. November 24, 2014.

Floyd|Snider, 2014b. Memorandum regarding the Proposed Suitability of the Pier 4 Phase 1 Removal Action Project Clean Material. December 22, 2014.

12. Agency Signatures.

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

Concur:

_____	_____
Date	Kelsey van der Elst - Seattle District Corps of Engineers
_____	_____
Date	Justine Barton - Environmental Protection Agency
_____	_____
Date	Erika Hoffman - Environmental Protection Agency
_____	_____
Date	Laura Inouye, Ph.D. - Washington Department of Ecology
_____	_____
Date	Celia Barton - Washington Department of Natural Resources

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Table 2. Sample Locations and Collection Information

Station	Coordinates		Mudline elevation (ft MLLW)	Total length of boring (ft)	Total Project Volume (CY)
	Northing	Easting			
A18	713043.0	1166941.389	-2	0-13	11,300
B14	712954.5	1167089.387	-3	0-10	
B15	712850.6	1167263.0	-2.2	0-15.5	
C4	712918.3	1167068.0	17	0-6	
C5	712813.5	1167243.223	17	0-6	
A12	713261.5	1166701.1	-30.6	0-10	
A14	713236.2	1166689.1	-17.6	0-5	
C1	712933.8	1166950.1	17	0-20	
C2	712728.3	1167258.7	17	0-20	
C3	712995.6	1166897.699	17	0-6	

Notes:

Coordinates are in Washington State Plane S, US Feet.

Table 3. Sampling Date, Equipment and Sample Intervals Collected

Station	Sampling Date	Sample type	Mudline elevation (ft MLLW)	Bore intervals collected
A12	November 2013	Roto-sonic boring	-30.6	1.5 - 3
				3-5
				9-10
A14			-17.6	2-4
				4-5
A18	July 2014	Roto-sonic boring	-2	7-9
				9-10
				11-13
B14			-3	0-2
				2-3
				8-10
B15			-2.2	9-10
				11.5-13.5
				13.5-15.5
C1	April 2013	Direct push boring - composited into DMMU C	17	0-4
				4-8
				8-12
				12-16
				16-20
C2			17	0-4
				4-8
				8-12
				12-16
				16-20
C3	July 2014	Direct push boring	17	0-2
				2-4
				4-6
C4			17	0-2
				2-4
				4-6
C5			17	0-2
				2-4
				4-6

Table 4. Chemical results compared to DMMP regulatory guidelines.

CHEMICAL	DMMP Guidelines			P4-C1 0-4 ft		P4-C2 4-8 ft		P4-C3 8-12 ft	
	SL	BT	ML	conc	LQ	conc	LQ	conc	LQ
CONVENTIONALS									
Gravel, %				18.8		1.6		1.6	
Sand, %				64.4		89.9		93.3	
Silt, %				14.2		7.9		4.2	
Clay, %				2.6		0.4		1	
Fines (Silt + Clay), %				16.8		8.4		5.1	
Total Solids, %				92.4		94.55		86.8	
Volatile Soilids, %				1.18		0.88		0.84	
Total Organic Carbon, %				0.136		0.136		0.12	
Total Sulfides, mg/kg				1.53	J	2.17	J	1.08	UJ
Total Ammonia, mg N/kg				0.1	U	0.1	U	0.11	U
METALS (mg/kg dry)									
Antimony	150	---	200	5	UJ	5	UJ	6	UJ
Arsenic	57	507	700	5	U	5	U	6	U
Cadmium	5.1	11.3	14.0	0.4		0.3		0.3	
Chromium	260	260	---	15.7		12.2		11.2	
Copper	390	1,027	1,300	13.4		10.9		9.8	
Lead	450	975	1,200	4		2	U	2	U
Mercury	0.41	1.5	2.3	0.02	U	0.02	U	0.02	U
Selenium	---	3	---	0.5	U	0.5	U	0.6	U
Silver	6.1	6.1	8.4	0.3	U	0.3	U	0.3	U
Zinc	410	2,783	3,800	22		22		18	
ORGANOMETALLIC COMPOUNDS (ug/kg)									
Tributyltin (bulk)	0.15	0.15	---	3.4	U	3	U	3.2	U
PAHs (ug/kg dry)									
Total LPAH	5,200	---	29,000	19	U	19	U	18	U
Naphthalene	2,100	---	2,400	19	U	19	U	18	U
Acenaphthylene	560	---	1,300	19	U	19	U	18	U
Acenaphthene	500	---	2,000	19	U	19	U	18	U
Fluorene	540	---	3,600	19	U	19	U	18	U
Phenanthrene	1,500	---	21,000	19	U	19	U	18	U
Anthracene	960	---	13,000	19	U	19	U	18	U
2-Methylnaphthalene	670	---	1,900	19	U	19	U	18	U
Total HPAH	12,000	---	69,000	21	J	37	U	36	U
Fluoranthene	1,700	4,600	30,000	19	U	19	U	18	U
Pyrene	2,600	11,980	16,000	9.7	JQ	19	U	18	U
Benzo(a)anthracene	1,300	---	5,100	11	JQ	37	U	36	U
Chrysene	1,400	---	21,000	19	U	19	U	18	U
Total benzofluoranthenes	3,200	---	9,900	19	U	19	U	18	U
Benzo[a]pyrene	1,600	---	3,600	4.8	U	4.6	U	4.5	U
Indeno(1,2,3-c,d)pyrene	600	---	4,400	19	U	19	U	18	U
Dibenzo(a,h)anthracene	230	---	1,900	19	U	19	U	18	U
Benzo(g,h,i)perylene	670	---	3,200	19	U	19	U	18	U
CHLORINATED BENZENES (ug/kg dry)									
1,2-Dichlorobenzene	35	---	110	4.8	U	4.6	U	4.5	U
1,4-Dichlorobenzene	110	---	120	4.8	U	4.6	U	4.5	U
1,2,4-Trichlorobenzene	31	---	64	4.8	U	4.6	U	4.5	U
Hexachlorobenzene	22	168	230	0.92	U	0.94	U	0.95	U

CHEMICAL	DMMP Guidelines			P4-C1 0-4 ft		P4-C2 4-8 ft		P4-C3 8-12 ft	
	SL	BT	ML						
PHTHALATE ESTERS (ug/kg dry)									
Dimethyl phthalate	71	---	1,400	4.8	U	4.6	U	4.5	U
Diethyl phthalate	200	---	1,200	48	U	46	U	45	U
Di-n-butyl phthalate	1,400	---	5,100	19	U	19	U	18	U
Butyl benzyl phthalate	63	---	970	4.8	U	4.6	U	4.5	U
Bis(2-ethylhexyl)phthalate	1,300	---	8,300	24	U	14	JQ	22	U
Di-n-octyl phthalate	6,200	---	6,200	19	U	19	U	18	U
PHENOLS (ug/kg dry)									
Phenol	420	---	1,200	19	U	19	U	18	UJ
2 Methylphenol	63	---	77	4.8	U	4.6	U	4.5	UJ
4 Methylphenol	670	---	3,600	19	U	19	U	18	UJ
2,4-Dimethylphenol	29	---	210	19	U	19	U	18	J
Pentachlorophenol	400	504	690	48	UJ	46	UJ	45	UJ
MISCELLANEOUS EXTRACTABLES (ug/kg dry)									
Benzoic acid	650	---	760	390	U	370	U	360	UJ
Benzyl alcohol	57	---	870	19	U	19	U	18	U
Dibenzofuran	540	---	1,700	19	U	19	U	18	U
Hexachlorobutadiene	11	---	270	0.92	U	0.94	U	0.95	U
Hexachloroethane	---	---	---	19	U	19	U	18	U
N-Nitrosodiphenylamine	28	---	130	19	U	19	U	18	U
PESTICIDES (ug/kg dry)									
Aldrin	10	---	---	0.46	U	0.47	U	0.47	U
Total Chlordane	3	37	---	0.46	U	0.47	U	0.47	U
Dieldrin	2	---	---	0.92	U	0.94	U	0.95	U
Heptachlor	2	---	---	0.46	U	0.47	U	0.47	U
p,p'-DDE	9	---	---	0.92	U	0.94	U	0.95	U
p,p'-DDD	16	---	---	0.92	U	0.94	U	0.95	U
p,p'-DDT	5	---	---	0.92	U	0.94	U	0.95	U
Total DDT		50	69	0.92	U	0.94	U	0.95	U
PCBs (ug/kg dry)									
Total PCBs	130	---	3,100	3.8	U	3.7	U	3.7	U
Total PCBs (mg/kg OC)	---	38	---	na		na		na	

J = estimated concentration
U = undetected
OC = organic carbon
SL = screening level
BT = bioaccumulation trigger
ML = maximum level
na = TOC outside the range of 0.5 - 2% used for carbon normalization

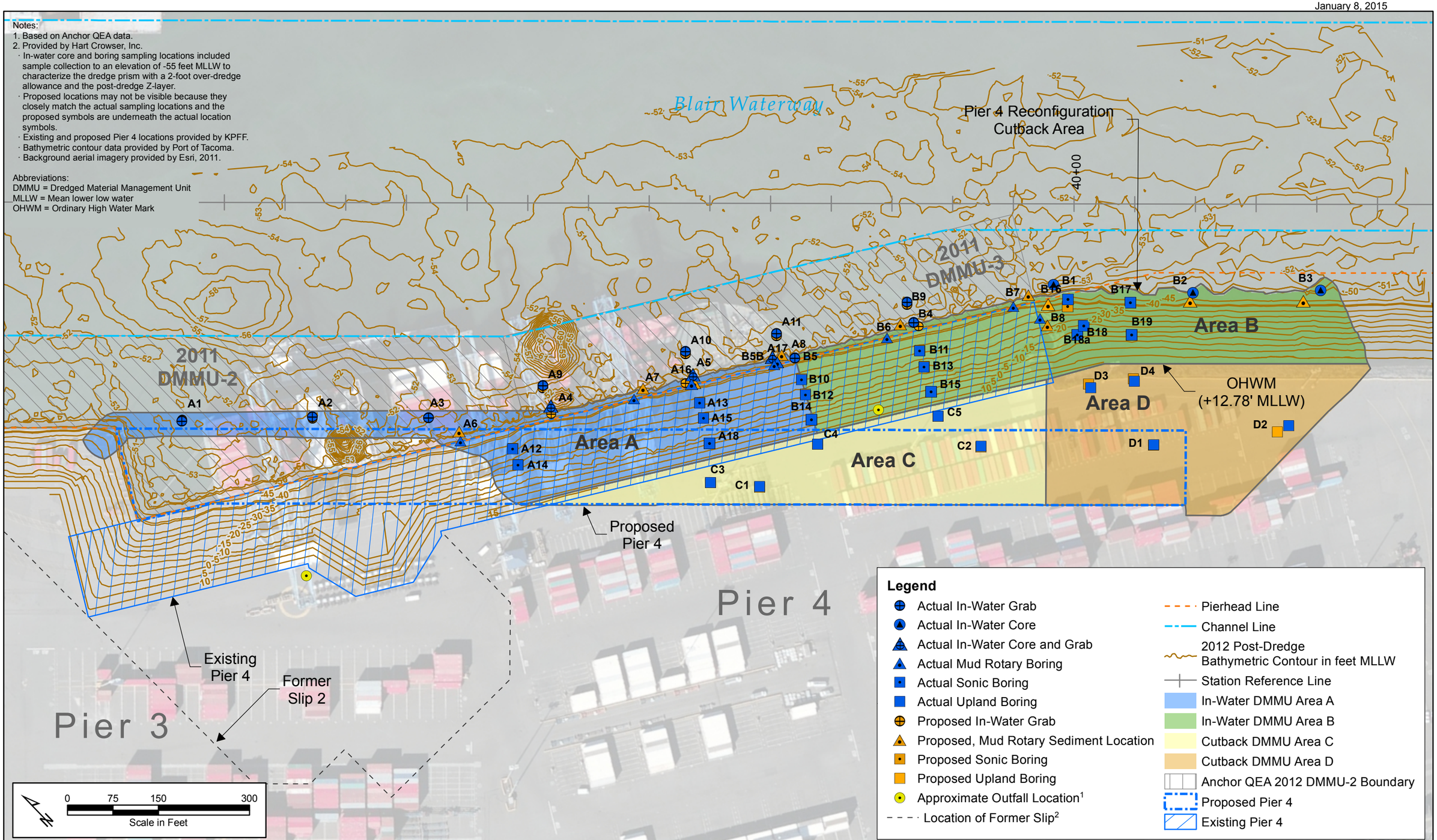
Table 5. Dioxin Results from composited DMMU C

CHEMICAL	TEF	P4-C1 0-4 ft				P4-C2 4-8 ft				P4-C3 8-12 ft			
DIOXINS/FURANS		conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)	conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)	conc	VQ	TEQ (U = 0)	TEQ (U = 1/2 RL)
2,3,7,8-TCDD	1	0.168	U	0	0.084	0.152	U	0	0.076	0.0279	U	0	0.01395
1,2,3,7,8-PeCDD	1	0.737	J	0.737	0.737	0.0819	U	0	0.04095	0.0739	U	0	0.03695
1,2,3,4,7,8-HxCDD	0.1	0.707	J	0.0707	0.0707	0.0899	J	0.00899	0.00899	0.0439	U	0	0.002195
1,2,3,6,7,8-HxCDD	0.1	1.88		0.188	0.188	0.244	J	0.0244	0.0244	0.194	U	0	0.0097
1,2,3,7,8,9-HxCDD	0.1	1.32		0.132	0.132	0.174	J	0.0174	0.0174	0.0699	U	0	0.003495
1,2,3,4,6,7,8-HpCDD	0.01	35.2		0.352	0.352	4.26	U	0	0.0213	3.79	U	0	0.01895
OCDD	0.0003	321		0.0963	0.0963	42.5	U	0	0.006375	41.9	U	0	0.006285
2,3,7,8-TCDF	0.1	0.42	U	0	0.021	0.0779	U	0	0.003895	0.0659	U	0	0.003295
1,2,3,7,8-PeCDF	0.03	0.402	U	0	0.00603	0.0819	U	0	0.0012285	0.0559	J	0.001677	0.001677
2,3,4,7,8-PeCDF	0.3	0.384	J	0.1152	0.1152	0.0639	U	0	0.009585	0.0339	U	0	0.005085
1,2,3,4,7,8-HxCDF	0.1	1.01		0.101	0.101	0.176	J	0.0176	0.0176	0.12	J	0.012	0.012
2,3,4,6,7,8-HxCDF	0.1	0.763	J	0.0763	0.0763	0.0619	U	0	0.003095	0.0499	U	0	0.002495
1,2,3,7,8,9-HxCDF	0.1	0.332	U	0	0.0166	0.0579	U	0	0.002895	0.0619	U	0	0.003095
1,2,3,4,6,7,8-HpCDF	0.01	7.5		0.075	0.075	0.977	J	0.00977	0.00977	1.27		0.0127	0.0127
1,2,3,6,7,8-HxCDF	0.1	0.503	J	0.0503	0.0503	0.0779	U	0	0.003895	0.0419	U	0	0.002095
1,2,3,4,7,8,9-HpCDF	0.01	0.681	U	0	0.003405	0.0799	U	0	0.0003995	0.0818	U	0	0.000409
OCDF	0.0003	17	U	0	0.00255	2.33	U	0	0.0003495	2.78	U	0	0.000417
TOTAL TEQ				1.994	2.127			0.078	0.248			0.026	0.135

Table 6. TBT and grrain size results.

Station	Mudline elevation (ft MLLW)	Core intervals collected	Tributyltin (bulk; µg/kg)		Total Organic Carbon (%)		% Gravel		% Sand		% Silt		% Clay	
			Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ	Result	VQ
A12	-30.6	1.5 - 3	8.4		0.605		55.9		30.2		9.8		4.1	
		3-5	3.4		0.474		1.2		72.6		20		6	
		9-10	6.6		1.09		8.4		64.8		18.3		8.6	
A14	-17.6	2-4	4.4		0.739		34.5		43.9		14.8		6.8	
		4-5	3.6		0.258		0.1		54.3		39.6		6	
A18	-2	7-9	3.4	U	0.699	U	49.7		42.2		5.8		2.3	
		9-10	3.5	U	0.042	U	44.9		53.2		2	U	2	U
		11-13	3.5	U	---		---		---		---		---	
B14	-3	0-2	4.7		0.224		51		43.7		3		2.4	
		2-3	4.8		---		---		---		---		---	
		8-10	3.7	U	0.116		36		63.4		0.7	U	0.7	U
B15	-2.2	9-10	18		0.658		51.6		41.2		3.9		3.3	
		11.5-13.5	3.5	U	0.069		60.7		37.9		1.4	U	1.4	U
		13.5-15.5	3.6	U	---		---		---		---		---	
C1 and C2 composite	17	0-4	3.4	U	0.285		18.8		64.4		14.2		2.6	
		4-8	3	U	0.136		1.6		89.9		7.9		0.4	
		8-12	3.2	U	0.12		1.6		93.3		4.2		1	
		12-16	---		---		---		---		---		---	
		16-20	---		---		---		---		---		---	
C3	17	0-2	3.3	UJ	1.94		33.4		57.2		7.4		2.1	
		2-4	3.4	UJ	---		---		---		---		---	
		4-6	3.5	UJ	0.674		6.4		85.2		6.7		1.7	
C4	17	0-2	2.2	JQ	6.25		80.3		16.3		2.3		0.9	
		2-4	3.4	U	---		---		---		---		---	
		4-6	3.4	U	0.239		2.4		77.6		16.1		3.9	
C5	17	0-2	3.3	UJ	6.27		87.1		10.5		2.4	U	2.4	U
		2-4	3.4	U	---		---		---		---		---	
		4-6	3.4	U	1.23		38.9		51.9		6.6		2.6	

--- not analyzed



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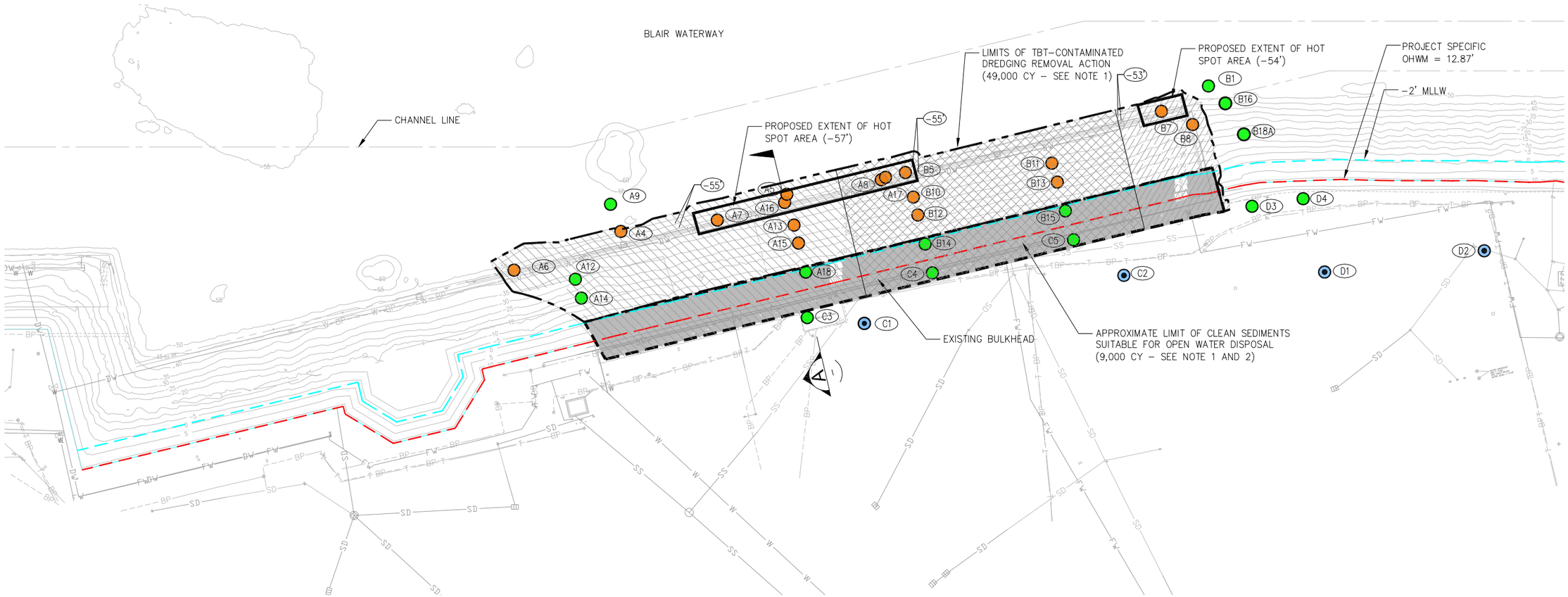
Sediment Characterization Report
Pier 4 Phase 2 Reconfiguration Project
Tacoma, Washington

Figure 1
Pier 4 DMMU Areas and Targeted and Actual Sampling Locations



PHASE 1 DREDGE PLAN

SCALE: 1"=150'

LEGEND

- EXISTING CONTOUR
- -51' TOE OF DREDGE, SEE NOTE 3
- XX SAMPLE LOCATION
- DREDGE SEDIMENT ALONG DEMOLISHED PIER FACE TO -55' MLLW AND UPPER 9FT OF SLOPE, SEE NOTE 3
- DREDGE SEDIMENT ALONG DEMOLISHED PIER FACE TO -55' MLLW AND UPPER 11FT OF SLOPE, SEE NOTE 3
- DREDGE SEDIMENT ALONG DEMOLISHED PIER FACE TO -53' MLLW AND UPPER 8FT OF SLOPE, SEE NOTE 3
- A CROSS SECTION LOCATION
- SAMPLE LOCATIONS WITH SEDIMENT SAMPLES CONTAINING TBT CONCENTRATIONS GREATER THAN THE DMMP SCREENING LEVEL OF 73 UG/KG
- SAMPLE LOCATIONS WHERE THERE ARE NO TBT EXCEEDANCES OF THE DMMP TBT SCREENING LEVEL (73 UG/KG) (SAMPLES ANALYZED FOR TBT ONLY)
- SAMPLE LOCATIONS WHERE THERE ARE NO CHEMICAL EXCEEDANCES OF THE DMMP SCREENING LEVELS FOR THE DMMP SUITE OF CHEMICALS OF CONCERN

NOTES

1. VOLUME IS APPROXIMATE AND INCLUDES THE 1-FOOT OVERDREDGE ALLOWANCE.
2. THE 2-FOOT RIP RAP ARMORED SLOPE MATERIAL (APPROXIMATELY 2,3000 CY) HAS BEEN DEDUCTED FROM THE VOLUME.
3. DREDGE DEPTHS DO NOT INCLUDE THE 1-FOOT OVERDREDGE ALLOWANCE.

PROJECT NORTH

kpff Consulting Engineers
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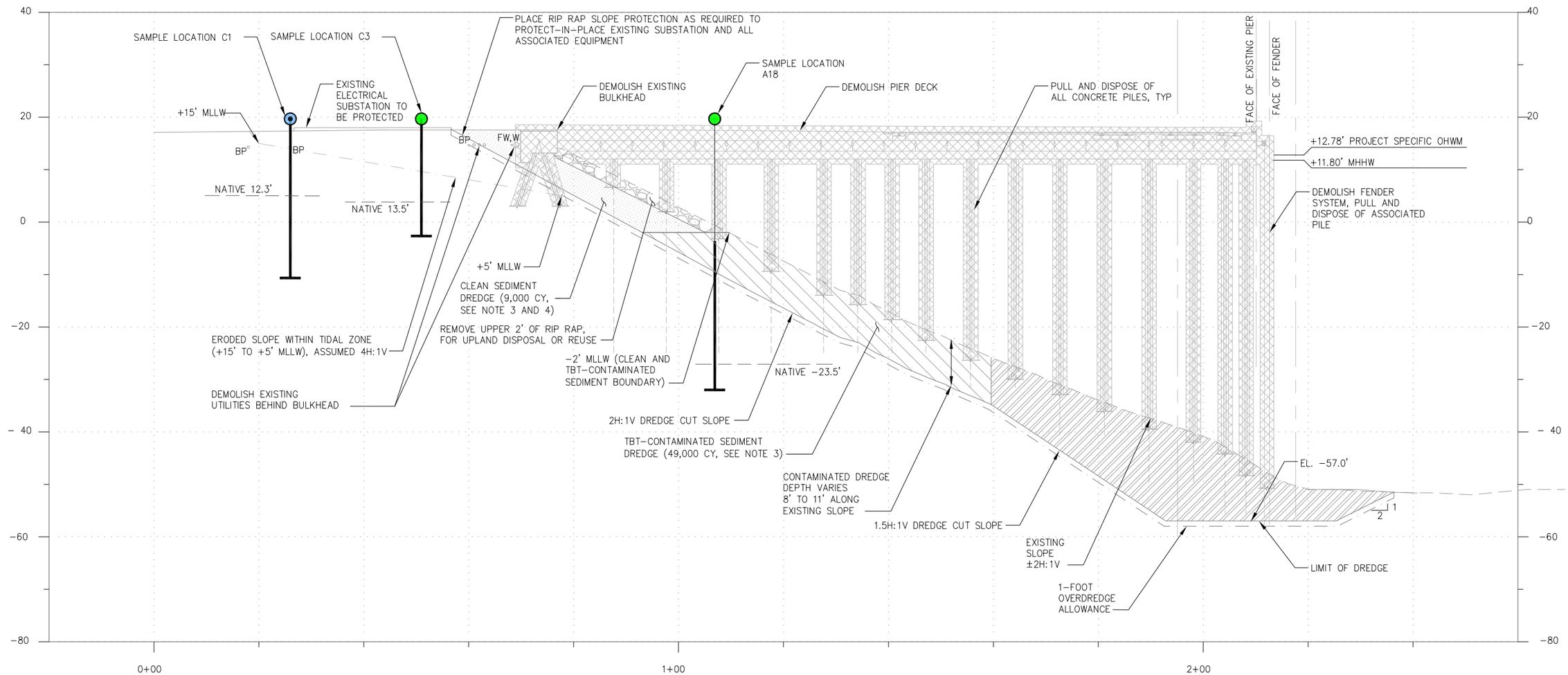
(206) 382-0600 Fax (206) 382-0500

PROPOSED SUITABILITY OF PHASE 1 PROJECT
CLEAN MATERIAL
TACOMA, WASHINGTON

Figure 2 PHASE 1 DREDGE PLAN

DATE: DECEMBER 2014 | SCALE: 1" = 150'-0"



DREDGE SECTION A

SCALE: 1"=10'

LEGEND:

- EXISTING PIER TO BE DEMOLISHED DURING PHASE 1
- APPROXIMATE LOCATION OF CONTAMINATED SEDIMENT TO BE DREDGED (49,000 CY)
- APPROXIMATE LOCATION OF CLEAN SEDIMENT TO BE DREDGED (9,000 CY)
- LOCAL HOT SPOT (INCLUDED IN 49,000 CY)
- BP — BURIED POWER CONDUIT
- FW — FIRE WATER LINE
- W — WATER LINE
- SAMPLE LOCATIONS WHERE THERE ARE NO TBT EXCEEDANCES OF THE DMMP TBT SCREENING LEVEL (73 UG/KG) (SAMPLES ANALYZED FOR TBT ONLY)
- SAMPLE LOCATIONS WHERE THERE ARE NO CHEMICAL EXCEEDANCES OF THE DMMP SCREENING LEVELS FOR THE DMMP SUITE OF CHEMICALS OF CONCERN

NOTES:

1. THE BOUNDARY BETWEEN THE CLEAN, NON-TBT CONTAMINATED SEDIMENTS AND THE TBT-CONTAMINATED SEDIMENTS AT -2 FT MLLW IS BASED ON THE LOCATION OF UNDER-PIER SEDIMENT CORES WHERE THE RESULTS OF THE TBT CHEMICAL ANALYSIS OF COLLECTED SAMPLES SHOWED THAT TBT WAS NOT DETECTED OR DETECTED AT CONCENTRATIONS BELOW THE DMMP TBT SCREENING LEVEL OF 73 UG/KG.
2. ONLY SAMPLE LOCATIONS BOUNDING THE CONTAMINATED SEDIMENT FROM THE CLEAN SEDIMENT ARE SHOWN.
3. VOLUME IS APPROXIMATE AND INCLUDES THE 1-FOOT OVERDREDGE ALLOWANCE.
4. THE 2-FOOT RIP RAP ARMORED SLOPE MATERIAL (APPROXIMATELY 2,300 CY) HAS BEEN DEDUCTED FROM THE VOLUME.

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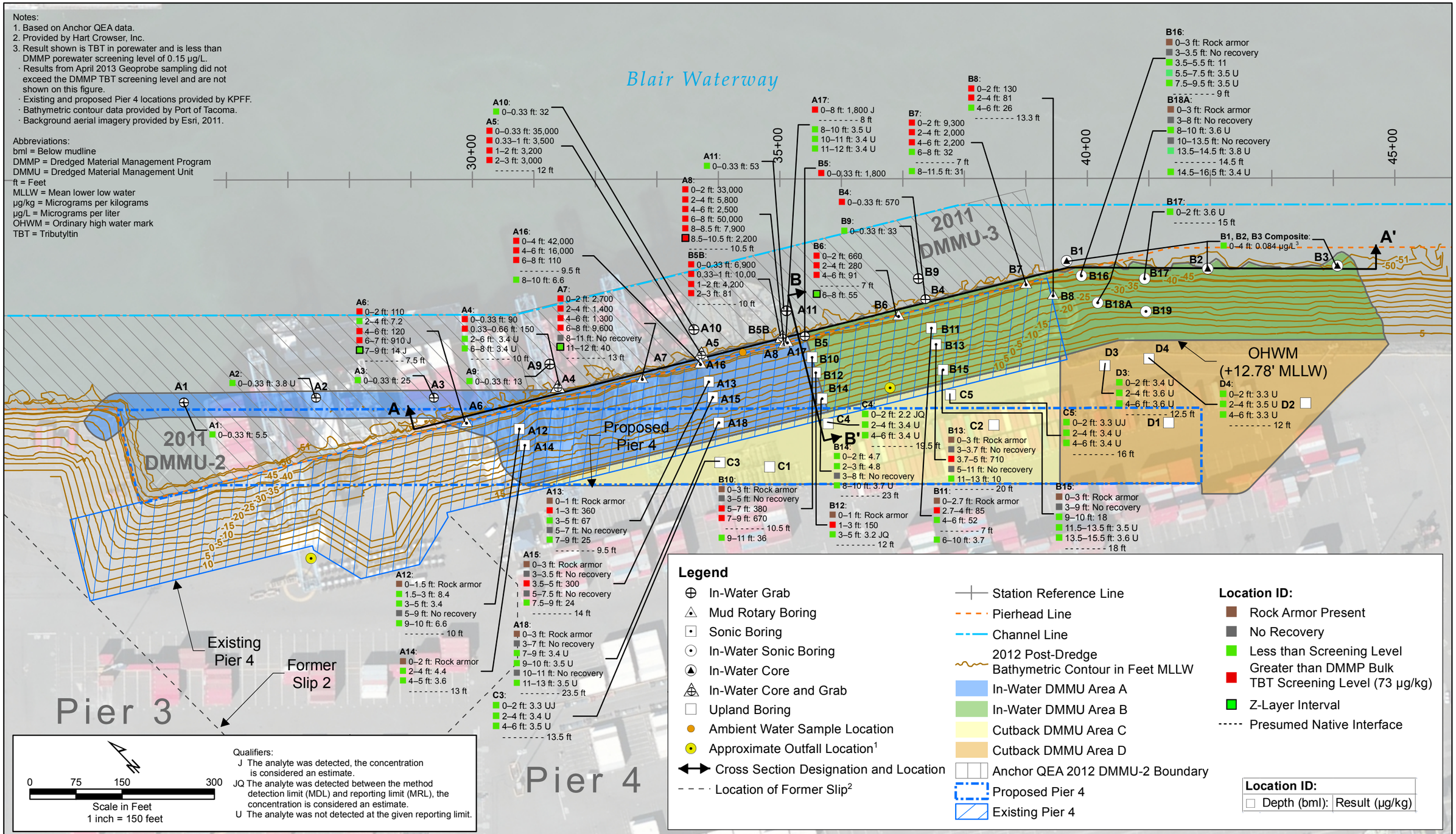
PROPOSED SUITABILITY OF PHASE 1 PROJECT
CLEAN MATERIAL
TACOMA, WASHINGTON
Figure 3 DREDGE SECTION A

DATE: DECEMBER 2014 | SCALE: 1" = 10'-0"



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Sediment Characterization Report
Pier 4 Phase 2 Reconfiguration Project
Tacoma, Washington

Figure 4.1
Pier 4 Sediment and Soil Sample TBT Results

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Appendix A

Memorandum

To: Kelsey van der Elst, Dredged Material Management Office (DMMO)

Copies: Scott Hooton, Port of Tacoma

From: Jessi Massingale, Floyd|Snider

Date: December 22, 2014

Project No: POT-Pier 4

Re: **Proposed Suitability of the Pier 4 Phase 1 Removal Action Project Clean Material**

INTRODUCTION

The purpose of this memorandum is to describe the portion of material located within the Port of Tacoma (Port) Pier 4 Phase 1 Removal Action Project (Phase 1 Removal Action) dredge prism that is clean and not contaminated with tributyltin (TBT), and request that this material be determined suitable for open-water disposal at the Commencement Bay open-water disposal site by the Dredged Material Management Program (DMMP). The three objectives of this memorandum are to (1) provide a brief summary of the project phases, (2) present the delineation and characterization of the clean non-TBT-contaminated sediments, (3) describe the construction sequence for the removal of the clean sediments, as well as the extraction of concrete piling located within the clean material footprint and the concrete piling located downslope within the TBT-contaminated material, and (4) present the results of a conservative (assumed worst-case) piling removal contaminated sediment suspension calculation.

BACKGROUND

As part of the conceptual design and permitting process for the reconfiguration of Pier 4 (Terminal 4) to be in alignment with Pier 3 within the Husky Container Terminal, Floyd|Snider, on behalf of the Port, conducted three soil and sediment sampling events in 2013 under the DMMP for the characterization of the project cutback material for open water disposal or beneficial habitat reuse. The results of the characterization events identified TBT-contaminated sediments underneath and at the face of Pier 4. In consultation with the U.S. Environmental Protection Agency (USEPA) and the DMMP representatives, based on the TBT concentrations detected at Pier 4, the Port entered into an Agreed Order on Consent (AOC) with USEPA in June 2014 for a site removal action evaluation, which included an additional soil, sediment, and ambient site water sampling event that was conducted in July 2014. Following the review of the

preliminary results of the July sampling event, USEPA determined that the cleanup of the TBT-contaminated sediments is to proceed as a Time Critical Removal Action.

The Port is proceeding with removal of approximately 49,000 cubic yards (CY) of TBT-contaminated sediments located under Pier 4 as part of a future AOC with USEPA, and then reconfiguring and reconstructing Pier 4 to be in alignment with Pier 3 within the Husky Container Terminal. Pier 4 is located on the west side of the northern portion of the Blair Waterway, which lies within the Port's Industrial Development District (Figure 1).

The work occurring at Pier 4 will have two distinct work phases: (1) the Phase 1 Removal Action, which includes a USEPA-ordered cleanup of contaminated sediment, and (2) the Phase 2 Reconfiguration Project (Phase 2 Project), which includes reconfiguration of the existing pier. The proposed project, including both phases, is planned to be completed over 3 years, with work tentatively scheduled to be conducted between 2015 and early 2018. The schedule and construction timing of Phase 2 is dependent upon the timing of the completion of the Phase 1 Removal Action, and will not start until the Phase 1 project is deemed complete by USEPA.

The Port is requesting that a portion of material located within the Phase 1 Removal Action dredge prism that is clean and not contaminated with TBT be determined suitable for open-water disposal via a suitability determination. The removal of the approximately 9,000[1] CY of clean sediments located at the top of the slope will occur prior to the removal of the approximately 49,000 CY of TBT-contaminated sediments and then post-dredge confirmational sampling (to be approved by both USEPA and the DMMP) will be conducted to confirm that the removal action achieved the project objectives and completion requirements. Post-dredge confirmational sampling will also be used to confirm the suitability of the underlying 500,000 CY of cutback material to be dredged under Phase 2 for open water disposal or beneficial use. As part of the Phase 2 Project, the Port will continue to work with the DMMP to secure a suitability determination for the Phase 2 cutback material for open-water disposal or beneficial use. Therefore, the Port is seeking to secure two separate suitability determinations, the first (described in this memorandum) for the Phase 1 Removal Action top of slope clean 9,000 CY and the second for the Phase 2 Project 500,000 CY of cutback material. The characterization of the Phase 2 cutback material, as well as sampling results to support the delineation of the top of slope clean 9,000 CY, is summarized in the Sediment Characterization Report (Floyd|Snider 2014a).

TOP OF SLOPE MATERIAL PROPOSED SUITABILITY

As part of the Phase 1 Removal Action, prior to removal of the TBT-contaminated sediments under the pier and at the pier face, the majority of the existing pier structure will be demolished (Figure 2). In order to facilitate the dredging of the approximately 9,000 CY of clean sediments, prior to dredging, the 2-foot layer of riprap armor (approximately 2,300 CY) will be removed and

[1] The approximately 9,000 CY of clean sediments does not include the upper 2 feet of riprap armoring that will be removed separately from the clean material. The volume does include an assumed 1-foot over-dredge allowance.

disposed of upland at an appropriate facility or reused by the Port. In order to access the approximately 49,000 CY of TBT-contaminated sediments located under the mid- to lower-slope of the pier and the pier face, approximately 9,000 CY of clean material will be removed from the existing bulkhead, down to an elevation of -2 feet mean lower low water (MLLW). This cut of clean material will be the full length of the existing pier, approximately 1,000 feet long, extending downslope approximately 30 feet, and to a variable depth of 8 to 11 feet. If this clean material were left in place when the contaminated material downslope is dredged it would create an unstable slope, which would likely collapse; therefore, this clean material must be removed prior to the dredging of the downslope TBT-contaminated sediment. It is this top of slope 9,000 CY that the Port is requesting be considered for suitability for disposal at the Commencement Bay open-water disposal site.

Soil and Sediment Characterization Results

The characterization sampling results to support the delineation of the top of slope clean 9,000 CY is summarized in the Sediment Characterization Report (Floyd|Snider 2014a). Table 1 provides a summary of the TBT sediment and soil analytical results. Additionally, Figure 3 shows the dredge plan of the top of slope 9,000 CY of clean, non-TBT-contaminated sediments, and the downslope TBT-contaminated sediments. Figure 4 shows a cross section of the boundary of clean and TBT-contaminated sediments upslope of the proposed hot spot, in line with Locations A16 and A5.

In general, field characterization events have not encountered any unique fill or debris material and no visual indications of contamination (e.g., paint chips, sheen, odor, etc.) have been observed in any upland or sediment location.

Soil sampling conducted in April 2013 found no exceedances of any of the DMMP screening levels (SLs) in any upland location, as shown by the blue symbols in Figures 3 and 4.

In July 2014, five upland borings (C3, C4, C5, D3, and D4) were advanced in order to define the boundary between the upland DMMUs and the in-water DMMUs. Sample Locations C3, C4, and C5 were positioned in-line with and shoreward of under-pier Sample Locations A18, B14, and B15 (described below). Based on previous sampling events, native material has been confirmed to be clean. Native material was encountered at depths ranging from 13.5 to 19 feet below ground surface (bgs). The top three samples collected from C3, C4, and C5 were analyzed for bulk TBT. TBT was detected at 2.2 micrograms per kilogram (µg/kg) in the surface sample collected from C4, and remaining sample results for all locations were non-detect at laboratory reporting limits ranging from 3.3 to 3.5 µg/kg. These sample locations are shown as green symbols on Figure 3.

In November 2013, rows of roto-sonic borings were advanced through holes in the pier deck at approximately -33 feet MLLW and -29 feet MLLW. These borings encountered riprap rock armor, which prevented recovery in most of the surface intervals. TBT contamination greater than the DMMP SL was encountered in the central and southern portions of the under-pier slope. At the

northern end of the pier, detected TBT concentrations were less than the DMMP SL (Figure 3). Sample recovery was generally good immediately below the riprap rock armor in this area. At Sample Location A12, TBT was detected at 8.4 µg/kg in the shallowest sample, 1.5 to 3 feet below mudline (bml), able to be collected from below the riprap rock armor and at 3.4 µg/kg in the underlying 3 to 5 feet bml sample. At Sample Location A14, TBT was detected at 4.4 µg/kg in the shallowest, 2 to 4 feet bml sample able to be collected and 3.6 µg/kg in the underlying 4 to 6 feet bml sample. Native material was encountered at -40 feet MLLW at A12 and -30 feet MLLW at A14. These sample locations are shown as green symbols on Figure 3.

In the July 2014 event, an additional row of roto-sonic borings were advanced through holes in the pier deck at -2 feet MLLW to provide upslope delineation of the under-pier TBT contamination encountered during the November 2013 sampling event at Sample Locations A15, B12, and B13, as shown in Figure 3. During the July 2014 sampling event, the under-pier roto-sonic borings were advanced at their planned locations; however, the riprap also resulted in poor recovery at most locations during this event, primarily in the surface intervals. At Sample Locations A18 and B15, the presence of surface riprap prevented the "soupy" nature of the sediments located within and underlying the riprap from being recovered and sampled because the sediments were not dense enough to push the riprap up through the core barrel. However, the surface intervals were able to be recovered at Sample Location B14 because a large piece of riprap at 3 feet prevented further downward movement of the core barrel. The driller was able to pull up the core barrel with the top 3 feet of rock and intermixed sediment that was intact and the material was sampled. This differed from Sample Locations A18 and B15 in that the riprap completely plugged the core barrel, preventing any additional material from being captured and retained. B14 is the sampling location upslope and closest to the central hot spot, thereby providing confirmation that the upper intervals at this elevation are not impacted by the down slope TBT concentrations. The upper intervals of material at Sampling Locations A18 and B15 that were not able to be recovered are presumed to consist of approximately 2 feet of riprap, with the underlying non-recovered interval presumed to be a mix of small gravel and sediment, based on how the driller could physically feel the change in resistance between riprap and sediment.

Native material at Sample Locations A18, B14, and B15 was encountered at elevations between -20 feet and -26 feet MLLW. The top four samples that were able to be collected from Sample Locations A18, B14, and B15 were analyzed for bulk TBT. TBT was detected in the top (0 to 2 feet bml) and the 2 to 3 feet bml samples collected from B14 (4.7 µg/kg and 4.8 µg/kg, respectively). At B15, TBT was detected at 18 µg/kg in the uppermost (9 to 10 feet bml) sample able to be collected. All TBT detections were significantly less than the DMMP TBT SL of 73 µg/kg. TBT was not detected in the samples collected from A18, or deeper samples collected from B14 and B15, at laboratory reporting limits ranging from 3.4 to 3.7 µg/kg. These sample locations are shown as green symbols on Figure 3.

Therefore, TBT contamination has been determined to not be present in sediments at elevation -2 feet MLLW as supported by sample results from A18, B14, and B15 located at this elevation and from A12 and A14 located downslope of -2 feet MLLW at the northern end of the pier. No

assumptions were made about the clean material extending downslope and this elevation forms the basis for the downslope/waterward boundary between clean, non-TBT-contaminated sediment and TBT-contaminated material. The results from the upland locations described above confirm the upper, shoreward boundary of the clean, non-TBT-contaminated sediment.

Phase 1 Removal Action Construction Sequence

The majority of the existing pier structure will be demolished prior to the removal of any underlying sediment (Figure 2). This demolition includes the removal of approximately 140,550 square feet of pier structure and vibratory extraction of approximately 1,047 concrete piles, 87 creosote-treated timber piles, and 22 steel piles associated with the existing pier.

The Phase 1 Removal Action construction sequence for demolition, pile extraction, and dredging includes the following:

- Demolition of the existing fender system (located at the pier face), utilities, and other appurtenances, and existing crane beam, bull rail, and all crane appurtenances.
- Demolition of the pier deck, deck beams, and pile caps. The bulkhead will also be demolished and removed, along with the pier structure, as the pier deck demolition progresses.
- Vibratory extraction of the pier face fender system timber and steel piling and the slope concrete piling.
- Removal of the 2-foot layer of riprap armor on top of the 9,000 CY of clean, non-TBT contaminated sediment (approximately 2,300 CY).
- Removal of the top of slope 9,000 CY of clean, non-TBT-contaminated sediments.
- Removal of the mid-slope to toe of slope 49,000 CY of TBT-contaminated sediments.
- Surveying and post-dredge confirmational sediment sampling to confirm the removal of the TBT-contaminated sediments.

Figure 3 shows the dredge plan of the top of slope 9,000 CY of clean, non-TBT-contaminated sediments, and the downslope TBT-contaminated sediments. Also shown on Figure 3 are the material characterization sample locations, as described above. Removal of the clean top of slope material will be conducted either from the uplands with the use of a crawler crane or from a mechanical bucket dredge on a floating derrick barge. The thickness of the dredge cut along the slope through the entire Phase 1 dredge prism varies based on the depth of detected TBT concentrations greater than the DMMP SL. The slope dredge cut thicknesses of 9 feet, 11 feet, and 8 feet, as indicated on Figures 3 and 4, apply to both the top of slope clean material and the downslope TBT-contaminated material.

Figure 4 also shows the location of the pier face fender system, which includes creosote-treated timber and steel piles, as well as the under-pier 16.5-inch-diameter concrete piles. The piles

located within the clean, top of slope material and the downslope TBT-contaminated material, are concrete piles until the pier face.

SLOPE CONCRETE PILE EXTRACTION AND CONTAMINATED SEDIMENT SUSPENSION

During initial discussion of the potential suitability of the top of slope clean material for open-water disposal with the DMMP, a question arose regarding the possibility that during vibratory pile extraction of the concrete piles located downslope of the clean top of slope material, TBT-contaminated sediment could be suspended and deposited on the top of slope material. The question as discussed on the August 28, 2014 conference call was:

> *Could TBT-contaminated sediment particles that were attached to the concrete slope piling be suspended in the water column and transported upslope to be deposited on the clean top of slope material proposed for open water disposal at a concentration of concern?*

The following sections are presented to address this question by providing concrete piling extraction methodology information, relevant site condition information, and a conservative, assumed worst-case calculation that determines the thickness of TBT-contaminated sediment that could be suspended during pile extraction and deposited as a thin veneer over the top of slope clean material footprint, as well as what concentration of TBT would have to be present within that deposited sediment to result in the top 1 foot of the dredge prism sediment exceeding the DMMP TBT SL of 73 µg/kg.

Concrete Piling Extraction Methodology

The methodology that will be used to extract large structural concrete piles will be to vibrate them out using a “vibro-hammer” or “vibratory driver/extractor.” Such a device consists of three main components: (1) the clamp that attaches the device to the top of the pile, (2) the vibrating mechanism consisting of weights that are spun generating an oscillating force in the up or down direction (up direction for extraction), and (3) the suspension system that isolates the crane from the vibrating mechanism for safety of the crane. The vibro-hammer is provided power by a diesel engine driving a hydraulic pump. Although typically there is little-to-no sound or visible operation of the vibro-hammer during piling extraction, a substantial amount of energy is transferred directly into the pile, making the pile vibrate up and down approximately ¾ of an inch at a time.

The effect of this transfer of energy to the pile and significant weight included in both the vibrating parts of the hammer and the pile itself (e.g., on the order of tens of thousands of pounds) is to shear the sediment away from the sides of the pile and “liquefy” the sediment in the immediate surrounding area. This results in minimal sediment remaining attached to the piling, particularly the concrete piles. The suspension system and crane can then pull up the pile and extract it from the sediment.

The vibratory methodology results in a breaking of the suction between the pile and the surrounding sediments the pile is embedded in, and, as described above, shears sediment from the sides of the pile, limiting the amount of sediment adhering to the pile sides. The primary sediment composition at Pier 4, which consists of silty sands and riprap underlain by more sandy sediments with some silt and gravel lenses, further reduces the potential for sediment remaining attached to the piles. Additionally, the piling at Pier 4 will be pulled up through riprap rock, which acts to scrape sediment residue off the pile before that portion of the pile encounters the water column, further reducing suspension of any attached sediment.

Photograph 1 below shows the limited amount of clay attached to a recently extracted concrete pile from Gulf Port, Mississippi. As sand will tend not to adhere to the pile, much less sediment would be expected to adhere to the concrete piling at Pier 4 relative to a sediment composed primarily of clay. Photograph 2 shows an extracted concrete pile from Port of Long Beach sediments with a lower clay content, and relatively little attached sediment on the right end of the pile and marine growth on the left, upper end of the pile.

Photograph 1. Port of Gulfport Restoration Program - West Pier Wharf Upgrade (September 2013)

Photograph 2. Port of Long Beach Pier T Demolition

Pier 4 Under-Pier Diver Sediment Survey Findings

The Pier 4 wharf overlies a 2:1 riprap armored slope with variable thicknesses of accumulated sediment on top of the riprap. In July 2014 an underwater inspection of the concrete piles and a survey of the depth of sediment cover over riprap was conducted within the area of the structure to be demolished, or the majority of the pier (Echelon 2014). The July 2014 diver survey was conducted by probing the sediments along individual and representative bents (rows of concrete piles extending from top of slope to the pier face toe of slope) at approximate 10-bent intervals. The data were obtained by inserting a calibrated 6-foot-long, 1/8-inch-diameter steel probe into the sediment and pushing it down until refusal. The sediment thickness was recorded to the nearest ¼ foot.

No sediment cover was found throughout the upper/shoreward 30 percent of the concrete pile bents, or approximate shoreward 40 feet of the pier structure. This upper 30 percent extends outward to an elevation below -2 feet MLLW. Therefore, even under existing conditions of tidal fluctuation and vessel berthing with associated water movement, sediment has not been deposited within this top of slope area. Down slope of the 9,000 CY clean non-TBT-contaminated sediment dredge prism, for the remaining approximately 90 feet of the pier, the sediment depth was found to range from less than ¼ foot near the interface of the riprap and sediment, to approximately 4 to 6 feet at the pier face (Echelon 2014).

Conservative (Worst-Case) Pile Extraction and Suspended Sediment Calculation

As described above, the July 2014 diver survey documented that no sediment cover was found throughout the upper/shoreward 30 percent of the concrete pile bents, which includes the 9,000 CY clean non-TBT-contaminated sediment dredge prism. This is consistent with the expectation that the probable location and direction of deposition of suspended sediment would be on the lower portions of the slope and outward to the toe of slope and not upslope. However, to address the DMMP suspended sediment question, a calculation was performed to determine the assumed worst-case thickness of TBT-contaminated sediment that could be suspended during pile extraction and deposited as a thin veneer over the top of slope clean material footprint, as well as what concentration of TBT would have to be present within that deposited sediment to result in the top 1 foot of the clean dredge prism sediment exceeding the DMMP TBT SL of 73 µg/kg. The site information and assumptions used in the calculation are presented in Table 2 and in summary include the following:

- Concrete pile size of slope piles to be removed: 16.5 inches in diameter.
- Average thickness of TBT-contaminated sediment located on the lower slope: 10 feet.
- Conservative assumed worst case assumed thickness of sediment attached to 10 feet of the piling surface: 0.25 inches.
- Approximate number of concrete piles located within TBT-contaminated sediment: 691 piles or approximately two thirds of the 1,047 total concrete piles to be removed.
- 100 percent of the TBT-contaminated sediment attached to the concrete piles is suspended in the water column (not removed from the pile as it is extracted through the slope armoring, nor remaining attached to the pile as it is pulled up and out of the water column).
- 100 percent of the TBT-contaminated sediment suspended in the water column from the pile is carried up slope and deposited within the footprint of the top of slope clean material dredge prism.
    - The TBT-contaminated sediment that is deposited upslope is spread uniformly over the clean material dredge prism surface.

Under the assumptions and site pile information identified above, the results of the conservative calculation include the following:

- The maximum volume of TBT-contaminated sediment that could be suspended and deposited over the clean material dredge prism surface is approximately <u>24 CY</u>.
    - This is 24 CY spread over 43,300 square feet and a total clean material dredge prism volume of 9,000 CY (approximately 0.2 percent of the dredge prism volume).

- The maximum thickness of TBT-contaminated sediment that could be deposited over the clean material dredge prism surface as a thin veneer is approximately 0.18 inches.
  - Existing conditions with tidal fluctuations and vessel berthing and water movement, as determined in the July 2014 survey, have resulted in no sediment cover over the top of slope area.
- The TBT-concentration of the sediment resulting from extracting piles from the contaminated downslope area and subsequent deposition over the clean material dredge prism that would result in a TBT concentration in the top 1 foot of the clean material dredge prism exceeding the DMMP SL (73 µg/kg) is 4,540 µg/kg. The TBT-concentration of the top 1 foot for the dredge prism is calculated using the following equation, where the concentration in the top 1 foot is 73 µg/kg, the contaminated depth is 0.18 inches (0.015 feet), the clean depth is 0.985 feet, and the assumed clean concentration is 5 µg/kg.

$$TBT\text{-}conc.\,of\ sed = \frac{top\ 1\ foot\ conc.\ \times\ 1\ foot - clean\ depth\ \times\ clean\ conc.}{contaminated\ depth}$$

  - The average TBT sediment concentration of samples collected from the under-pier area (excluding the pier face samples) is 127 µg/kg, which is substantially less than the 4,540 µg/kg determined necessary to result in the top 1 foot of the clean material dredge prism exceeding the DMMP TBT SL.
  - The average TBT sediment concentration of all samples collected from within the dredge prism (including the pier face samples and hot spot areas located approximately 90 feet from the waterward edge of the clean material dredge prism) is 3,250 µg/kg; less than the 4,540 µg/kg determined necessary to result in the top 1 foot of the clean material dredge prism exceeding the DMMP TBT SL.
- The thickness of TBT-contaminated sediment that would have to be suspended and deposited over the clean material dredge prism, if the average TBT sediment concentration of samples collected from the under-pier area (127 µg/kg)[2] was assumed, is approximately 6.7 inches.
  - Based on the calculation assumptions and pile information (the pile diameter size, the thickness of slope contaminated sediment, assumed sediment thickness attached to piles, and 100 percent sediment transport and deposition, etc.) the maximum thickness of TBT-contaminated sediment that could be deposited over the clean material dredge prism surface as a thin veneer is approximately 0.18 inches, which is less than 3 percent of the thickness necessary to result in the

[2] The TBT chemical results collected from the sampling borings located under the pier and within the dredge prism were used to calculate the average concentration of 127 µg/kg. Samples collected from locations A13, A15, A18, B10, B11, B12, B13, B14, and B15.

surface exceedance (6.7 inches) using the average TBT sediment concentration of samples collected from the under-pier area.

CLEAN DREDGING ADDITIONAL BEST MANAGEMENT PRACTICES

In addition to the dredge best management practices (BMPs) that are described in the *Final Pier 4 Phase 1 Removal Action Project - Phase 1 Project Description Document* (Floyd|Snider 2014b) to be implemented during the Phase 1 Removal Action, during the dredging of the top of slope clean 9,000 CY, prior to the dredging of TBT-contaminated sediments, the following BMPs will be implemented:

- Following removal of the overlying pier structure and riprap and during the beginning of dredging, a visual inspection of the clean material to be dredged will be conducted by verifying depth and visually monitoring the dredge material on the barge to ensure there is no debris present at the surface of the dredge prism.
- If the dredging is conducted at dusk or at night, the Contractor shall ensure that sufficient light is provided for visual monitoring of the dredge prism for turbidity and to visually inspect for debris or large rocks within the disposal barge.

CONCLUSION

Based on the results of the sediment characterization sampling that has been conducted under both the DMMO and USEPA programs, the results of the July 2014 diver survey, and the physical location and site conditions of the top of slope 9,000 CY, the Port proposes the top of slope 9,000 CY material is suitable for disposal at the Commencement Bay open-water disposal site. The proposed suitability of the top of slope clean 9,000 CY is specifically based on the following characterization results and physical conditions:

- TBT contamination has been determined to not be present in sediments at elevation -2 feet MLLW. No assumptions were made about the clean material extending downslope and this elevation forms the basis for the downslope/waterward boundary between clean, non-TBT-contaminated sediment and TBT-contaminated material.
    - As described above, multiple feet at the surface of Sample Locations A18 and B15 was not recovered due to the presence of rock armor on the slope. However, the surface 3 feet of rock and intermixed sediment was recovered and analyzed for TBT at Sample Location B14. The resulting TBT concentrations were less than 5 µg/kg, just greater than the analytical reporting limit. Sample Location B14 is located upslope and closest to the pier face Sample Location A8 with the maximum TBT concentration of 50,000 µg/kg (Table 1). Therefore, the results of the analysis of samples collected from this location support the conclusion that the extent of TBT contamination does not extend to the -2 feet MLLW sampling elevation.

- During the July 2014 diver survey, no sediment cover was found throughout the upper slope including the footprint of the 9,000 CY clean, non-TBT-contaminated sediment dredge prism. Therefore, even under existing conditions of tidal fluctuation and vessel berthing with associated water movement, sediment has not been deposited within this top of slope area. The results of the sampling events conducted to date indicate that the TBT-contaminated sediment located downslope of the 9,000 CY clean non-TBT-contaminated sediment dredge prism is associated with sediment located directly over and under riprap armoring. The lack of sediment cover on the clean dredge prism further supports that this area has not been impacted by the downslope TBT contamination.
- The 9,000 CY clean sediment dredge prism is located from top of slope at approximate elevation of 18 feet MLLW down to elevation -2 feet MLLW. During the majority of the tidal cycle, this upper portion of the slope is not inundated with water and is in the dry, above the water level of the waterway. This also reduces the potential for suspension and deposition of downslope sediment on top of the proposed clean sediment dredge prism.

Additionally, the concrete piling vibratory extraction methodology, relevant site conditions, and results of the conservative contaminated sediment and pile extraction calculation provide multiple lines of evidence that even under assumed worst-case calculation scenarios, the suspension of contaminated sediment during pile extraction prior to the removal of the clean material dredge prism will not result in recontamination of the clean top of slope 9,000 CY of material.

REFERENCES

Echelon Engineering, Inc. (Echelon). 2014. Pier 4 Relocation Pile *Inspection*. Prepared for KPFF Consulting Engineers. July.

Floyd|Snider. 2014a. *Sediment Characterization Report, Pier 4 Reconfiguration Project, Blair Waterway, Tacoma, Washington*. Prepared for Port of Tacoma. 24 November.

Floyd|Snider. 2014b. *Final Pier 4 Phase 1 Removal Action Project Phase 1 Project Description Document*. Prepared for Port of Tacoma. 12 September.

TABLES

Table 1 Summary of Tributyltin Analytical Results in Sediment and Soil Samples

Table 2 Potential Sediment Suspension and Tributyltin Concentrations Results from Concrete Pile Extraction

FIGURES

Figure 1 Site Location Map of Pier 4

Figure 2 Phase 1 Site Plan

Figure 3 Phase 1 Dredge Plan

Figure 4 Dredge Section A

Tables

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Table 1
Summary of Tributyltin Analytical Results in Sediment and Soil Samples

Pier Face—Power Grab and Mud Mole Core Samples

			DMMU Sampling Location	A4					A5					B4	B5	B5-B			
			Sample ID	A4-01	A4-01A	A4-02	A4-03A	A4-04A	A5-01	A5-01A	A5-02A	A5-03A	A5-04A	B4-01	B5-01A	B5-01B	B5-02B	B5-03B	B5-04B
			Sample Date	1/0/1900	8/8/2013	4/19/2013	8/8/2013	8/8/2013	4/19/2013	8/8/2013	8/8/2013	8/8/2013	8/8/2013	8/9/2013	8/9/2013	8/9/2013	8/9/2013	8/9/2013	8/9/2013
			Depth (bml)	0–10 cm	0–10 cm	10–20 cm	2–6 ft	6–8 ft	0–10 cm	0–10 cm	10 cm–1 ft	1–2 ft	2–3 ft	0–10 cm	0–10 cm	0–10 cm	10 cm–1 ft	1–2 ft	2–3 ft
		DMMP Criteria																	
Chemical	Unit	SL	BT																
Tributyltin (Bulk)	µg/kg	73	73	90	17 J	150	3.4 U	3.4 U	7,000	35,000	3,500	3,200	3,000	570	1,800	6,900	10,000	4,200	81
Tributyltin (Interstitial Water)	µg/L	0.15	0.15	NA	0.037	NA	0.018 JQ	NA	NA	3.8	5.1	0.73 UJ	0.2	0.12	1	1.5 UJ	NA	NA	NA

Pier Face—Mud Rotary Boring Samples

			DMMU Sampling Location	A6					A7					A8					
			Sample ID	A6-01	A6-02	A6-03	A6-04	A6-05	A7-01	A7-02	A7-03	A7-04	A7-05	A8-01	A8-02	A8-03	A8-04	A8-05	A8-06
			Sample Date	11/15/2013	11/15/2013	11/15/2013	11/15/2013	11/15/2013	11/15/2013	11/15/2013	11/15/2013	11/15/2013	11/15/2013	11/16/2013	11/16/2013	11/16/2013	11/16/2013	11/16/2013	11/16/2013
			Depth (bml)	0–2 ft	2–4 ft	4–6 ft	6–7 ft	7–9 ft	0–2 ft	2–4 ft	4–6 ft	6–8 ft	11–12 ft	0–2 ft	2–4 ft	4-6 ft	6–8 ft	8–8.5 ft	8.5–10.5 ft
		DMMP Criteria																	
Chemical	Unit	SL	BT																
Tributyltin (Bulk)	µg/kg	73	73	110	7.2	120	910 J	14 J	2,700	1,400	1,300	9,600	40	33,000	5,800	2,500	50,000	7,900	2,200

			DMMU Sampling Location	A16				A17					B6				B7				
			Sample ID	A16-01	A16-02	A16-03	A16-04	A17-01	X17-01 (dup)	A17-02	A17-03	A17-04	B6-01	B6-02	B6-03	B6-04	B7-01	B7-02	B7-03	B7-04	B7-05
			Sample Date	7/11/2014	7/11/2014	7/11/2014	7/11/2014	7/10/2014	7/10/2014	7/10/2014	7/10/2014	7/10/2014	11/16/2013	11/16/2013	11/16/2013	11/16/2013	11/14/2013	11/14/2013	11/14/2013	11/14/2013	11/14/2013
			Depth (bml)	0–4 ft	4–6 ft	6–8 ft	8–10 ft	0–8 ft	0–8 ft	8–10 ft	10–11 ft	11–12 ft	0–2 ft	2–4 ft	4–6 ft	6–8 ft	0–2 ft	2–4 ft	4–6 ft	6–8 ft	8–11.5 ft
		DMMP Criteria																			
Chemical	Unit	SL	BT																		
Tributyltin (Bulk)	µg/kg	73	73	42,000	16,000	110	6.6	1,800 J	340 J	3.5 U	3.4 U	3.4 U	660	280	91	55	9,300	2,000	2,200	32	31

S. Pier End—Mud Rotary Boring Samples (at Midslope)

			DMMU Sampling Location	B18A			
			Sample ID	B18A-01[1]	X18A-01[1] (dup)	B18A-02	B18A-03
			Sample Date	7/1/2014	7/1/2014	7/1/2014	7/1/2014
			Depth (bml)	8–10 ft	8–10 ft	13.5–14.5 ft	14.5–16.5 ft
		DMMP Criteria					
Chemical	Unit	SL	BT				
Tributyltin (Bulk)	µg/kg	73	73	3.6 U	3.6 U	3.8 U	3.4 U

S. Pier End—Mud Rotary Boring Samples (at approx. -28 ft MLLW)

			DMMU Sampling Location	B8		
			Sample ID	B8-01	B8-02	B8-03
			Sample Date	11/13/2013	11/13/2013	11/13/2013
			Depth (bml)	0–2 ft	2–4 ft	4–6 ft
		DMMP Criteria				
Chemical	Unit	SL	BT			
Tributyltin (Bulk)	µg/kg	73	73	130	81	26

S. Pier End—Mud Rotary Boring Samples (at Midslope)

			DMMU Sampling Location	B16			B17
			Sample ID	B16-01[1]	B16-02	B16-03	B17-01
			Sample Date	7/1/2014	6/30/2014	6/30/2014	7/1/2014
			Depth (bml)	3.5–5.5 ft	5.5–7.5 ft	7.5–9.5ft	0–2 ft
		DMMP Criteria					
Chemical	Unit	SL	BT				
Tributyltin (Bulk)	µg/kg	73	73	11	3.5 U	3.5 U	3.6 UJ

			DMMU Sampling Location	A1	A2	A3
			Sample ID	A1-01	A2-01	A3-01
			Sample Date	4/19/2013	4/19/2013	4/19/2013
			Depth (bml)	0–10 cm	0–10 cm	0–10 cm
		DMMP Criteria				
Chemical	Unit	SL	BT			
Tributyltin (Bulk)	µg/kg	73	73	5.5	3.8U	25
Tributyltin (Interstitial Water)	µg/L	0.15	0.15	NA	NA	NA

Berth Outside of Dredge Prism—Power Grab Samples

			DMMU Sampling Location	A9	A10	A11	B9
			Sample ID	A9-01	A10-01	A11-01	B9-01
			Sample Date	11/14/2013	11/14/2013	11/14/2013	11/14/2013
			Depth (bml)	0–10 cm	0–10 cm	0–10 cm	0–10 cm
		Criteria					
Chemical	Unit	SL	BT				
Tributyltin	µg/kg	73	73	13	32	53	33
Tributyltin	µg/kg	73	73	13	32	53	33

Under Pier—Roto-sonic Boring Samples (at approx. -33 ft MLLW)

			DMMU Sampling Location	A12			A13				B10				B11			
			Sample ID	A12-01	A12-02	A12-03	A13-01	A13-02	R13-02 (dup)	A13-03	B10-01	B10-02	B10-03	R10-03 (dup)	B11-01	B11-02	B11-03	R11-03 (dup)
			Sample Date	11/15/2013	11/15/2013	11/15/2013	11/15/2013	11/15/2013	11/15/2013	11/15/2013	11/14/2013	11/14/2013	11/14/2013	11/14/2013	11/13/2013	11/13/2013	11/13/2013	11/13/2013
			Depth (bml)	1.5–3 ft	3–5 ft	9–10 ft	1–3 ft	3–5 ft	3–5 ft	7–9 ft	5–7 ft	7–9 ft	9–11 ft	9–11 ft	2.7–4 ft	4–6 ft	6–10 ft	6–10 ft
		DMMP Criteria																
Chemical	Unit	SL	BT															
Tributyltin (Bulk)	µg/kg	73	73	8.4	3.4	6.6	360	45 J	67	25	380	670	36	13	85	52	3.4	3.7

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Table 1
Summary of Tributyltin Analytical Results in Sediment and Soil Samples

Under Pier—Roto-sonic Boring Samples (at approx. -19 ft MLLW)											
DMMU Sampling Location				A14		A15		B12		B13	
Sample ID				A14-01	A14-02	A15-01	A15-02	B12-01	B12-02	B13-01	B13-02
Sample Date				11/16/2013	11/16/2013	11/15/2013	11/15/2013	11/14/2013	11/14/2013	11/13/2013	11/13/2013
Depth (bml)				2–4 ft	4–5 ft	3.5–5 ft	7.5–9 ft	1–3 ft	3–5 ft	3.7–5 ft	11–13 ft
		DMMP Criteria									
Chemical	Unit	SL	BT								
Tributyltin (Bulk)	µg/kg	73	73	4.4	3.6	**300**	24	**150**	3.2 JQ	**710**	10

Under Pier—Roto-sonic Boring Samples (at approx. -2 ft MLLW)													
DMMU Sampling Location				A18			B14				B15		
Sample ID				A18-01[1]	A18-02	A18-03	B14-01	B-14-02	B14-03	X14-03 (dup)	B15-01[1]	B15-02	B-15-03
Sample Date				7/3/2014	7/3/2014	7/3/2014	7/3/2014	7/3/2014	7/3/2014	7/3/2014	7/3/2014	7/3/204	7/3/204
Depth (bml)				7–9 ft	9–10 ft	11–13 ft	0–2 ft	2–3 ft	8–10 ft	8–10 ft	9–10 ft	11.5–13.5 ft	13.5–15.5 ft
		DMMP Criteria											
Chemical	Unit	SL	BT										
Tributyltin (Bulk)	µg/kg	73	73	3.4 U	3.5 U	3.5 U	4.7	4.8	3.7 U	3.7 U	18	3.5 U	3.6 U

Shoreline Cutback—North Area												
DMMU Sampling Location				C3				C4			C5		
Sample ID				C3-01	C3-02	C3-03	X3-01 (dup)	C4-01	C4-02	C4-03	C5-01	C5-02	C5-03
Sample Date				7/9/2014	7/9/2014	7/9/2014	7/9/2024	7/9/2014	7/9/2014	7/9/2014	7/9/2014	7/9/2014	7/9/2014
Depth (bml)				0–2 ft	2–4 ft	4–6 ft	4–6 ft	0–2 ft	2–4 ft	4–6 ft	0–2 ft	2–4 ft	4–6 ft
		DMMP Criteria											
Chemical	Unit	SL	BT										
Tributyltin (Bulk)	µg/kg	73	73	3.3 UJ	3.4 U	3.5 U	3.3 U	2.2 JQ	3.4 U	3.4 U	3.3 UJ	3.4 U	3.4 U

Shoreline Cutback—South Area										
DMMU Sampling Location				D3			D4			
Sample ID				D3-01	D3-02	D3-03	D4-01	D4-02	X4-02 (dup)	D4-03
Sample Date				7/9/2014	7/9/2014	7/9/2014	7/9/2014	7/9/2014	7/9/2014	7/9/2014
Depth (bml)				0–2 ft	2–4 ft	4–6 ft	0–2 ft	2–4 ft	2–4 ft	4–6 ft
		DMMP Criteria								
Chemical	Unit	SL	BT							
Tributyltin (Bulk)	µg/kg	73	73	3.4 U	3.6 U	3.6 U	3.3 U	3.5 U	3.4 U	3.3 U

Note:
Bold red Indicates an exceedance of DMMP criteria.

Abbreviations:
- bml Below mudline
- BT Bioaccumulation trigger
- cm Centimeters
- DMMP Dredged Material Management Program
- DMMU Dredged Material Management Unit
- ft Feet
- µg/L Micrograms per liter
- µg/kg Micrograms per kilogram
- MLLW Mean lower low water
- NA Not applicable
- SL Screening level

Qualifiers:
- J The analyte was detected; the concentration is considered an estimate.
- JQ The analyte was detected between the method detection limit and the reporting limit; the concentration is considered an estimate.
- U The analyte was not detected at the given reporting limit.
- UJ The analyte was not detected; the concentration is the reporting limit, which is considered an estimate.

Table 2
Potential Sediment Suspension and Tributyltin Concentrations Results from Concrete Pile Extraction

Pier 4 Slope Concrete Pile Diameter	Perimeter Inches	Area per Foot of Pile (sf)	Thickness of Contaminated Layer (ft)	Contaminated Area of Pile (sf)	Thickness of Mud on Pile (inches)	Volume of Contaminated Sediment per Pile (cf)	Number of Concrete Piles Located within Contaminated Sediment	**Total CY of Contaminated Sediment Potential Suspended**	Area of Top of Slope Clean Material (SF)	**Possible Thickness of TBT-Contaminated Sediments on Clean Material Area (inches)**
16.5	54.6	4.6	10	45.5	0.25	0.95	691	**24.3**	43,400	**0.18**

Notes:

Gray shading indicates conservative contamination-related assumptions used for the calculation.

Bold Indicates key calculation results.

Abbreviations:

cf Cubic feet
CY Cubic yards
ft Feet
sf Square feet
TBT Tributyltin

Figures

Notes:
· Pier 4 location based on KPFF data.
· Background aerial imagery provided by Esri, August 1, 2011.

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Proposed Suitability of Phase 1 Clean Material
Pier 4 Phase 1 Removal Action Project
Tacoma, Washington

Figure 1
Site Location Map of Pier 4

I:\GIS\Projects\POT_Pier_4\MXD\Task 3030\Figure 1 Site Location Map of Pier 4.mxd 9/16/2014

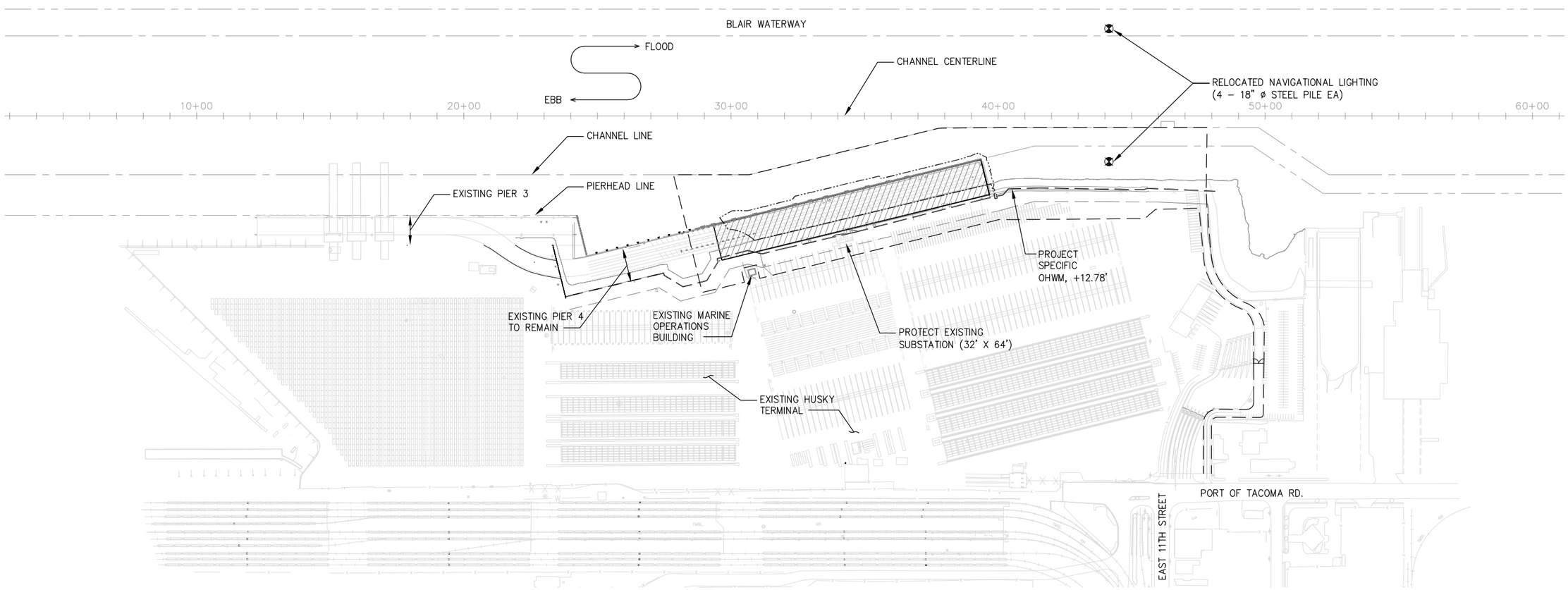
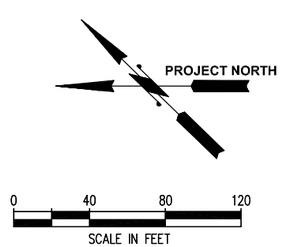


FIGURE 2 - SITE PLAN
SCALE: 1"=200'

LEGEND

- PROJECT WORK LIMITS
- LIMITS OF DREDGING REMOVAL ACTION
- EXISTING PIER 4 DEMOLITION (140,550 SQ FT)



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PROPOSED SUITABILITY OF PHASE 1 PROJECT
CLEAN MATERIAL
TACOMA, WASHINGTON
FIGURE 2 - SITE PLAN

DATE: DECEMBER 2014	SCALE: 1" = 200'–0"

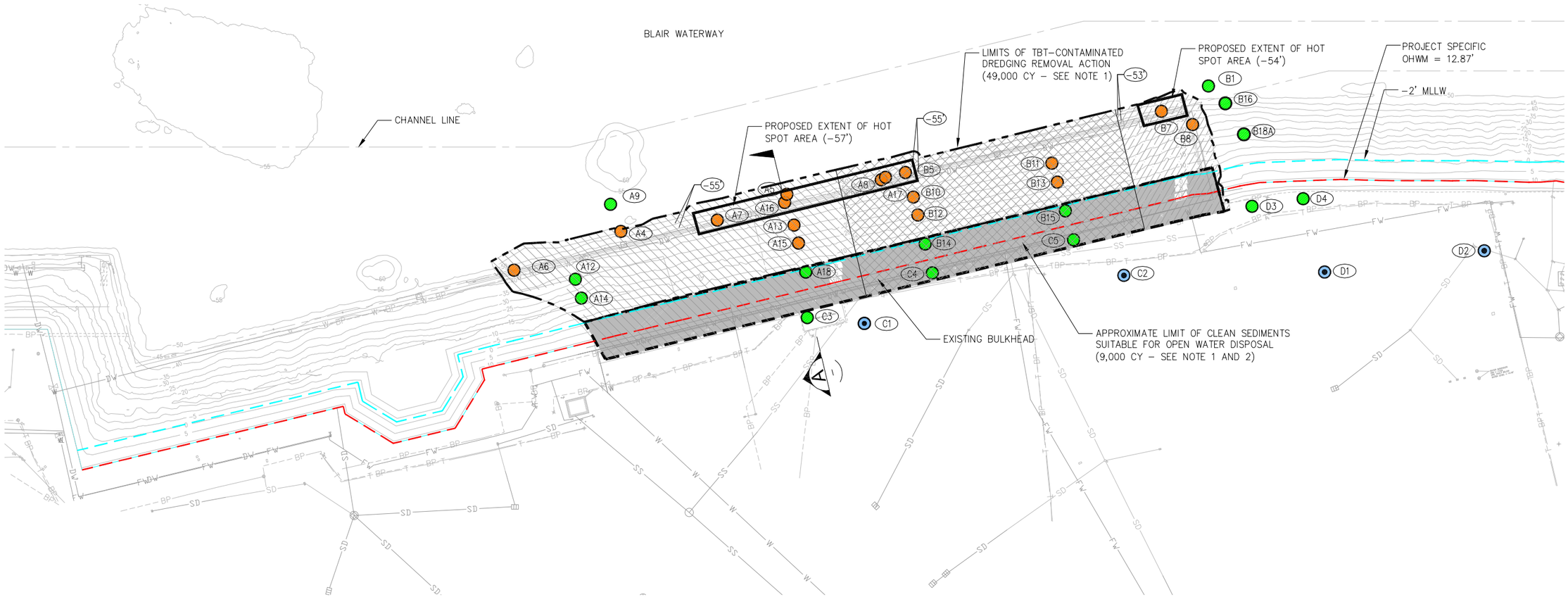

FIGURE 3 - PHASE 1 DREDGE PLAN

SCALE: 1"=150'

LEGEND

- EXISTING CONTOUR
- -51' TOE OF DREDGE, SEE NOTE 3
- XX SAMPLE LOCATION
- DREDGE SEDIMENT ALONG DEMOLISHED PIER FACE TO -55' MLLW AND UPPER 9FT OF SLOPE, SEE NOTE 3
- DREDGE SEDIMENT ALONG DEMOLISHED PIER FACE TO -55' MLLW AND UPPER 11FT OF SLOPE, SEE NOTE 3
- DREDGE SEDIMENT ALONG DEMOLISHED PIER FACE TO -53' MLLW AND UPPER 8FT OF SLOPE, SEE NOTE 3
- A CROSS SECTION LOCATION
- SAMPLE LOCATIONS WITH SEDIMENT SAMPLES CONTAINING TBT CONCENTRATIONS GREATER THAN THE DMMP SCREENING LEVEL OF 73 UG/KG
- SAMPLE LOCATIONS WHERE THERE ARE NO TBT EXCEEDANCES OF THE DMMP TBT SCREENING LEVEL (73 UG/KG) (SAMPLES ANALYZED FOR TBT ONLY)
- SAMPLE LOCATIONS WHERE THERE ARE NO CHEMICAL EXCEEDANCES OF THE DMMP SCREENING LEVELS FOR THE DMMP SUITE OF CHEMICALS OF CONCERN

NOTES

1. VOLUME IS APPROXIMATE AND INCLUDES THE 1-FOOT OVERDREDGE ALLOWANCE.
2. THE 2-FOOT RIP RAP ARMORED SLOPE MATERIAL (APPROXIMATELY 2,3000 CY) HAS BEEN DEDUCTED FROM THE VOLUME.
3. DREDGE DEPTHS DO NOT INCLUDE THE 1-FOOT OVERDREDGE ALLOWANCE.

PROJECT NORTH

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PROPOSED SUITABILITY OF PHASE 1 PROJECT
CLEAN MATERIAL
TACOMA, WASHINGTON
FIGURE 3 - PHASE 1 DREDGE PLAN

DATE: DECEMBER 2014 | SCALE: 1" = 150'-0"

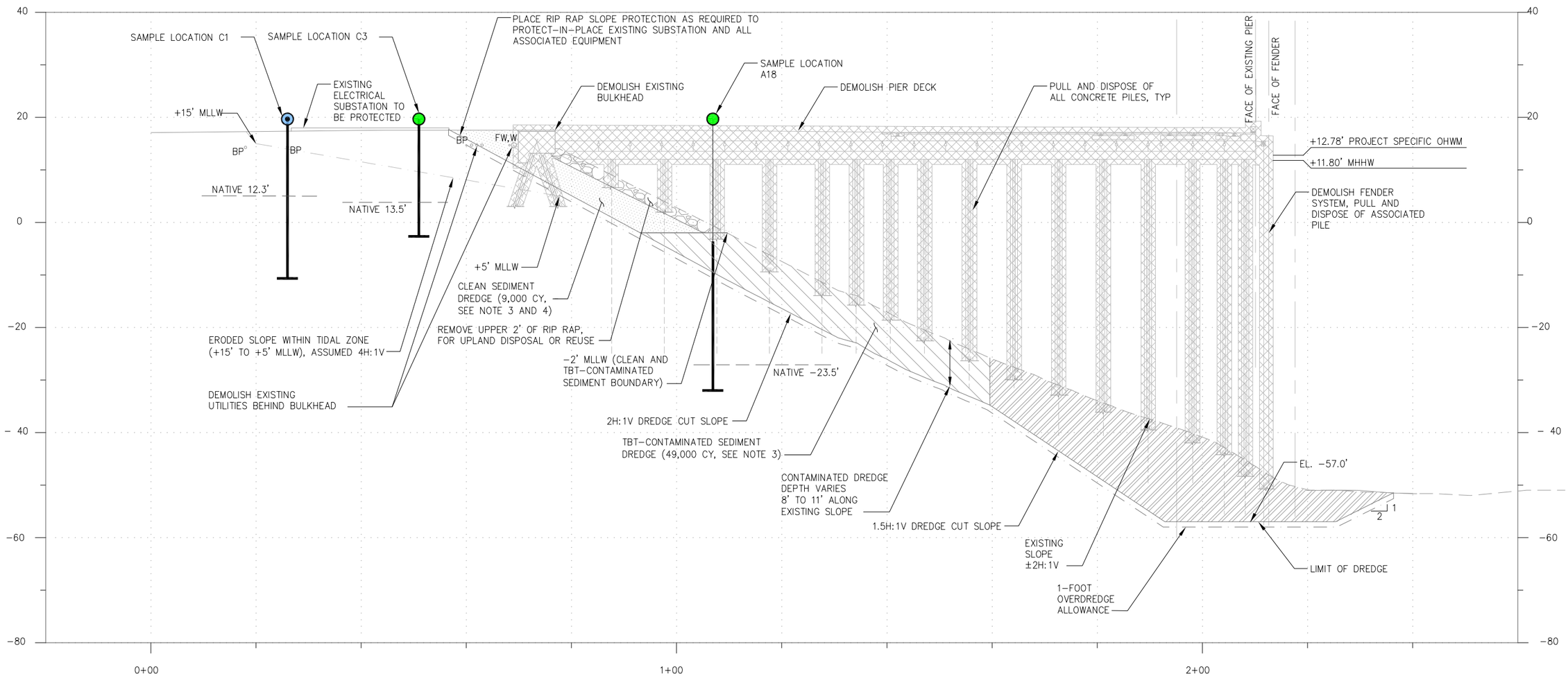

FIGURE 4 - DREDGE SECTION A

SCALE: 1"=10'

LEGEND:

- EXISTING PIER TO BE DEMOLISHED DURING PHASE 1
- APPROXIMATE LOCATION OF CONTAMINATED SEDIMENT TO BE DREDGED (49,000 CY)
- APPROXIMATE LOCATION OF CLEAN SEDIMENT TO BE DREDGED (9,000 CY)
- LOCAL HOT SPOT (INCLUDED IN 49,000 CY)
- BP — BURIED POWER CONDUIT
- FW — FIRE WATER LINE
- W — WATER LINE
- SAMPLE LOCATIONS WHERE THERE ARE NO TBT EXCEEDANCES OF THE DMMP TBT SCREENING LEVEL (73 UG/KG) (SAMPLES ANALYZED FOR TBT ONLY)
- SAMPLE LOCATIONS WHERE THERE ARE NO CHEMICAL EXCEEDANCES OF THE DMMP SCREENING LEVELS FOR THE DMMP SUITE OF CHEMICALS OF CONCERN

NOTES:

1. THE BOUNDARY BETWEEN THE CLEAN, NON-TBT CONTAMINATED SEDIMENTS AND THE TBT-CONTAMINATED SEDIMENTS AT -2 FT MLLW IS BASED ON THE LOCATION OF UNDER-PIER SEDIMENT CORES WHERE THE RESULTS OF THE TBT CHEMICAL ANALYSIS OF COLLECTED SAMPLES SHOWED THAT TBT WAS NOT DETECTED OR DETECTED AT CONCENTRATIONS BELOW THE DMMP TBT SCREENING LEVEL OF 73 UG/KG.
2. ONLY SAMPLE LOCATIONS BOUNDING THE CONTAMINATED SEDIMENT FROM THE CLEAN SEDIMENT ARE SHOWN.
3. VOLUME IS APPROXIMATE AND INCLUDES THE 1-FOOT OVERDREDGE ALLOWANCE.
4. THE 2-FOOT RIP RAP ARMORED SLOPE MATERIAL (APPROXIMATELY 2,300 CY) HAS BEEN DEDUCTED FROM THE VOLUME.

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PROPOSED SUITABILITY OF PHASE 1 PROJECT
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FIGURE 4 - DREDGE SECTION A

DATE: DECEMBER 2014 | SCALE: 1" = 10'-0"