Prepared by:
Dredged Material Management Office
Seattle District, U.S. Army Corps of Engineers

MEMORANDUM FOR RECORD **April 11, 2019**

SUBJECT: DETERMINATION REGARDING THE SUITABILITY OF PROPOSED DREDGED MATERIAL FROM THE LEHIGH HANSON SITE ALONG THE LOWER DUWAMISH WATERWAY, WASHINGTON, EVALUATED UNDER SECTION 404 OF THE CLEAN WATER ACT FOR UNCONFINED OPEN-WATER DISPOSAL AT THE ELLIOTT BAY OPEN-WATER DISPOSAL SITE.

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 Environmental Protection Agency) regarding the suitability of up to 4,000 cubic yards (CY) of dredged material from Lehigh Hanson Inc. (Lehigh Hanson) facility (Site) in Seattle, Washington (Figure 1) for disposal at the Elliott Bay non-dispersive site and compliance of the sediment surface to be exposed by this dredging with the State of Washington's antidegradation standard.

2. **Background**. Lehigh Hanson operates a cement/aggregate facility along eastern shore of the Lower Duwamish Waterway (LDW) at 5225 East Marginal Way South, Seattle, Washington 98134. The Site is built upon fill material underlain by marsh deposits and is bordered by Manson Construction to the north, East Marginal Way South to the east, United Western Supply to the South, and the LDW to the west. The LDW is the downstream portion of the Duwamish River and is both a CERCLA (Superfund) site and a State of Washington Model Toxics Control Act (MTCA) site. Remedial investigation and feasibility studies of the LDW are ongoing to assess risks to human health and the environment and to evaluate cleanup alternatives.

   Current operations at the Site included the manufacturing and distribution of Portland cement, concrete, concrete blocks, sand and gravel. Cement, sand, and gravel are regularly received by barge. Dry cement is piped ashore and stored in silos and conveyed to the ready-mix plant via an underground pipe network. Sand and gravel are transported from the barges into trucks and moved to stockpiles at the Site. Periodic maintenance dredging is needed to remove shoaled sediment and aggregate spilled from the conveyor to provide navigational depths for vessel ingress and egress.

   Sediment characterization was last conducted in 2004, when 9000 CY of sediment was removed from the berthing area (DMMP, 2004). Two surface and one subsurface Dredged Material Management Units (DMMUs) were characterized (DMMP, 2004). One surface DMMU for 3000 CY was determined to be unsuitable; the other surface DMMU and the subsurface DMMU, which together accounted for 6,000 CY, was determined suitable for open water disposal. The Site was subsequently dredged to a depth of -20 feet MLLW (plus 1 foot allowed overdredge)

   Before the most recent dredging event in 2004, dredging was conducted at the facility in 1978, when 2,150 CY of sediment were removed down to a depth of -20 ft Mean Lower Low Water

(MLLW). Subsequent dredging in 1991 and 1995 reclaimed approximately 500 CY of accumulated gravel at the face of the Lehigh Hanson pier.

In June 2018, Anchor QEA notified the DMMP agencies on behalf of Lehigh Hanson, Inc., that maintenance dredging of the existing berth (Main Berth) and a berth area to the south of the facility (South Berth) was needed (Figure 2). Dredging of the South Berth is being considered for maintenance dredging and infrastructure upgrades to allow for operational interactions with two barges simultaneously. Both berth areas are currently owned by King County, and the Main Berth is leased by King County to Manson Construction, who in turn leases the berth area to Lehigh Hanson. The South Berth dredging and upgrades were subsequently removed from the project scope.

This memorandum documents the evaluation of the shoaled sediment for open-water disposal and the new surface to be exposed by dredging for compliance with the State of Washington's antidegradation standard. Because this project is located within the Lower Duwamish Waterway (LDW) Superfund site, sampling and testing requirements were coordinated with the EPA remedial project manager (RPM) to ensure the project meets applicable cleanup requirements.

3. **Project Summary**. Table 1 provides project summary and tracking information.

Table 1. Project Summary

Project ranking	High
Conceptual design target depth[1]	-20 ft MLLW (plus 2 ft of overdepth)
Calculated volume to -22 ft (-20 ft plus 2 ft overdepth)	Main berth 2,466 CY South Berth 2,006 CY (area removed from project scope)
Characterized volume (based on rank and sampling frequency)	Main berth: 4,000 South Berth: Not characterized
1st draft SAP received	May 11, 2018
Comments provided on 1st draft SAP	May 25, 2018
2nd draft SAP received	June 26, 2018
Comments provided on 2nd draft SAP	July 6, 2018
Final SAP received	July 12, 2018
SAP approved	July 18, 2018
Sampling dates	August 27, 2018
Draft Sediment Characterization Report (SCR) received	February 4, 2019
DMMP comments provided on draft SCR	February 19, 2019

[1] The target depth was subsequently revised to -19 ft (+ 2 ft over-dredge) to accommodate an EPA-required 1 ft clean sand layer. This will leave a final post-cover placement elevation between -18 and -20 ft MLLW.

Final SCR received	March 8, 2019
DMMO tracking number	LEHIG-1-A-F-402
EIM Study ID	LEHIG18
USACE Permit Application Number	NWS-2018-1040
Recency Expiration Date (high rank = 3 years)	August 2021

4. **Project Ranking and Sampling Requirements**. With the exception of a portion of the federal navigation channel and Delta Marine Industries, projects downstream of the turning basin on the Duwamish River are ranked "high" (DMMP, 2018).

   For a high-ranked project, the requirements for the number of field samples and dredged material management units (DMMUs) are as follows (DMMP, 2018):
   - Maximum volume of sediment represented by each field sample = 4,000 cubic yards
   - Maximum volume of sediment represented by each DMMU in the upper 4-feet of the dredging prism (surface sediment) = 4,000 cubic yards
   - Maximum volume of sediment represented by each DMMU in the subsurface portion of the dredging prism = 12,000 cubic yards

   The calculated project volume in the project area using the original conceptual dredging design (-20 ft + 2 ft OD) was 4,472 CY. Two DMMUs were allocated to characterize this material: the Main Berth area (DMMU1; 2,466 CY) and the South Berth area (DMMU2; 2,006 CY). Two core locations were selected within each berth area for a total of four cores (two cores per berth/DMMU). No subsurface DMMU was determined necessary.

   For DMMU-1 (Main Berth), a single core sample (location C-1) was required to characterize the dredge prism. Previous testing had shown the likelihood that the sediment surface exposed by dredging would be contaminated, so concurrent chemical testing of the Z-sample from location C-1 was required. In addition, a second Z-sample was collected from location C-2 to characterize the leave surface beneath the aggregate high spot. Per consultation with the CERCLA RPM, the two-foot Z-samples collected for DMMP testing were also considered acceptable to fulfil the CERCLA requirement for characterization of the 0 to 60 centimeter (cm) leave surface.

   For DMMU-2 (South Berth), two samples were sited with plans to collect material from both the dredge prism and z-layer at both sample locations. Lehigh Hanson subsequently decided not to dredge the South Berth, so this area was removed from the field sampling effort.

   The total volume for each DMMU tested – based on the maximal volume allowed per DMMU and the maximum volume allowed per field sample – is 4,000 CY.

5. **Sampling and Analysis**. Sampling was conducted using a vibracorer on August 27, 2018 aboard the *R/V Discovery*, operated by Gravity Marine Services. Figure 2 shows the proposed and actual coring locations and Table 2 lists the location coordinates.

   One coring attempt was sufficient at location C-1, for which a core recovery of 80% was achieved.

As anticipated, the sediment was difficult to core at location C-2 close to the aggregate mound and three attempts were required to achieve the SAP-required 75% minimum recovery rate. On the third attempt, core recovery was 96%. Core collection data and sampling intervals are provided in Tables 2 and 3, respectively. Sample processing occurred on the same day as collection. All samples were submitted to Analytical Resources Inc. of Tukwila, WA, for analysis.

Data Validation. Data validation (Stage 2B) was conducted by Laboratory Data Consultants, Inc. Only minor issues were documented and all data were considered usable, as qualified, by the data validator.

6. **Analytical Results**. The conventional and chemistry results for DMMU-1 (sample C-1-A) and the two Z-samples (C-1-Z and C-2-Z) are presented alongside the DMMP marine guidelines, the Sediment Management Standards (SMS), and the applicable Superfund Remedial Action Levels (RALs) in Table 4. Only comparisons to the DMMP screening levels (SLs) are discussed in this sub-section.

   Grain Size and Sediment Conventionals. All samples were analyzed for the conventional sediment parameters of total organic carbon (TOC), total solids, total volatile solids, ammonia, sulfides, and grain size. TOC results ranged between a low of 0.74% in the DMMU sample (C-1) and up to 2.12% in Z-sample C-2-Z. Grain size analysis indicated that the DMMU sample was primarily composed of sand (46.7%) with moderate gravel (24.8%) and fines (28.5%) whereas both Z-samples were primarily composed of fines and were low in sand and gravel.

   Standard DMMP Chemicals of Concern. Polychlorinated biphenyls (PCBs) were detected in the DMMU composite sample and both Z-samples at concentrations that exceeded the DMMP marine SL. PCB concentrations in the two Z-samples (C-1-Z and C-2-Z) also exceeded the DMMP bioaccumulation trigger (BT).

   Mercury concentrations exceeded the DMMP SL in both Z-samples C-1-Z and C-2-Z. N-nitrosodiphenylamine and multiple PAHs exceeded the DMMP SL in C-1-Z.

   Polychlorinated biphenyls (PCBs) exceeded the DMMP SL in both the DMMU composite and the two Z-samples. In addition, the detected concentration in C-2-Z (134 ppm organic-carbon normalized) exceeded the DMMP BT.

   Dioxins/furans. Dioxins/furans were detected in the DMMU composite and both Z-samples, with the calculated Toxic Equivalents (TEQs) exceeding the DMMP's bioaccumulation trigger (BT = 10 ng/kg TEQ) in all samples. Dioxin TEQ for the surface DMMU was 20.7 pptr TEQ and increased with depth. The Z-sample dioxin TEQs were 395 and 60.8 pptr TEQ for C -1-Z and C-2-Z respectively.

7. **Biological Testing**. Based on the evaluation of chemical testing, further biological testing (including both bioassays for toxicity testing and bioaccumulation testing for PCBs and dioxins) would need to be conducted – and passed – if the material were to be considered for open water disposal. Lehigh Hanson chose not to pursue further testing and to dispose of all proposed dredged material at an upland location. No biological testing was conducted.

8. **Sediment Exposed by Dredging**. The sediment to be exposed by dredging must either meet the State of Washington Sediment Management Standards (SMS) or the State's Antidegradation standard (Ecology, 2013) as outlined by DMMP guidance (DMMP, 2008). Organic carbon (OC)-normalized chemistry results are included in Table 4 for comparison to OC-normalized SMS benthic chemistry criteria.

   For this project, two Z-samples (C-1-Z-180827 and C-2-Z-180827) were collected and analyzed concurrently with the dredge prism composite. Significant chemical exceedances are summarized below:

   - Both Z-samples exceeded DMMP SLs for mercury, dioxins, and total PCBs. In addition, the Z-sample C-1-Z exceeded the SL for n-nitrosodiphenylamine and multiple PAHs.
   - Both Z-samples exceeded SMS Cleanup Screening Levels (CSL) for mercury, dioxins, and total PCBs (OC-normalized). In addition, C-1-Z exceeded the CSL for cPAH TEQ and various PAHs.
   - Both Z-samples exceeded the LDW RALs for mercury, dioxins, and PCBs. In addition, Z-sample C-1-A exceeded the LDW RALs for select PAHs and cPAH TEQ.

   The PCB, dioxin, and PAH chemical concentrations in the two Z-samples were consistently greater than their concentrations in the overlying dredged material, which itself had chemical concentration exceedances for dioxins and PCBs. This evidence, when combined with the observation of multiple Z-sample chemical exceedances of the DMMP SLs, the state CSLs, and the LDW RALs has led the DMMP to conclude that the sediment exposed by dredging does not meet the state anti-degradation requirement.

   For dredging to proceed to the conceptual design depth, the project proponent must coordinate a dredging plan with the DMMP agencies that will meet the state anti-degradation requirement. Suggested options include over-dredging and capping with a clean sand layer.

9. **CERCLA Coordination.** Due to the project's location within the LDW Superfund Site, coordination with EPA Region 10's CERCLA RPM was conducted during the SAP development and execution to ensure that the resulting data would address Superfund's concerns and data needs with respect to this project. Based on the results of the sampling described in this report, the applicant has prepared a separate CERCLA Coordination memo (Feb 14, 2019) documenting the proposed sampling and analysis of the exposed surface sediments that will be conducted after dredging. This memo also documents the revised design depth of the Main Berth to -19 ft MLLW (plus 2 ft overdredge) to provide for a minimum thickness of 2-feet of cleaner material above the contaminated z-layer (Anchor, 2019a).

9. **Suitability and Antidegradation Determination**. This memorandum documents the evaluation of the suitability of sediment proposed for dredging from Lehigh Hanson's Duwamish River facility for open-water disposal at the Elliott Bay DMMP disposal site. 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 have concluded that **all 4,000 CY of characterized material from Lehigh Hanson Inc.'s Duwamish River facility are unsuitable** for open-water disposal and must be disposed at an approved upland location. Additional requirements of the selected receiving entity may apply.

With regard to antidegradation, the DMMP agencies have determined that the sediment to be exposed by dredging **does not meet the state antidegradation standard.**

With respect to CERCLA requirements, additional sampling and testing of the exposed post-dredge surface will be required and shall be coordinated directly with EPA Region 10 (Erika Hoffman; 360-753-9540).

Dredged material proposed for beneficial use must be approved by the entity receiving the material. Additional coordination with resource agencies may be required.

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

A pre-dredge meeting with DNR, Ecology 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 Regulatory Branch of the Seattle District Corps of Engineers at least 7 days prior to the pre-dredge meeting.

9. References.

Anchor, 2018. Sampling and Analysis Plan, Lehigh Hanson, Inc. – Duwamish River Facility Navigational Maintenance Sediment Characterization. Prepared for Lehigh Hanson Inc. by Anchor QEA, July 2018.

Anchor, 2019a. Memorandum Re: Lehigh Hanson Duwamish River Facility CERCLA Coordination. Prepared by Anchor QEA for the USEPA. February 1, 2019.

Anchor, 2019b. Lehigh Hanson, Inc – Duwamish River Facility Navigational Maintenance Sediment Characterization Sediment Characterization Data Report. Prepared for Lehigh Hanson Inc. by Anchor QEA, March 2019.

DMMP, 2004. Determination of the Suitability of Dredged Material Tested under DMMP Evaluation Procedures for Lehigh Northwest Inc. (Cadman Site) Dredging Project (DAIS #LEHIG-1-B-F-196) with Proposed Disposal at the Elliott Bay Open Water Disposal Site. Prepared by the Dredged Material Management Office for the Dredged Material Management Program, April 17, 2004.

DMMP, 2016. *Dredged Material Evaluation and Disposal Procedures (User Manual)*. Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, August 2016.

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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.

10. Agency Signatures.

signed copy on file in DMMO - Seattle District office

Concur:

_____ _____
Date Heather Whitney Fourie – Seattle District Corps of Engineers, Seattle District

_____ _____
Date Erika Hoffman - Environmental Protection Agency

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

_____ _____
Date Celia Barton - Washington Department of Natural Resources

Copies furnished:
DMMP signatories
Joy Dunay, Anchor QEA
Christy McDonough, Lehigh Hanson Inc.
Rory Lee, USACE Regulatory Project Manager

Table 2

Core Collection Data

DMMU	Station	Date	Location[1]		Measured Water Depth (feet)	Water Level (feet MLLW)[2]	Mudline Elevation (feet MLLW)	Drive Penetration (feet)	Recovery Measurement (feet)	Recovery (%)
			X Coordinate	Y Coordinate						
DMMU-1	C-1	8/27/2018	1267948	206253	29.4	11.2	-18.2	6.5	5.2	80
	C-2	8/27/2018	1268009	206090	27.5	10.1	-17.4	7.0	6.7	96

Notes:

1. Coordinates are in North American Datum of 1983 Washington State Plane North, US feet.
2. Preliminary observed water level for Seattle, WA (NOAA station 9447130).

DMMU: Dredge Material Management Unit

MLLW: mean lower low water

Source: Table 1 of Sediment Characterization Data Report (Anchor, 2019)

Lehigh Hanson - Duwamish River Facility Navigational Maintenance Dredging Sediment Characterization

Table 3
Core Sampling Intervals and Analysis

DMMU	Station	Design 2-foot Overdrege Elevation (feet MLLW)	Dredged Material Surface Sample (A) Elevation Interval (feet MLLW)[1]	Z-layer Sample Elevation Interval (feet MLLW)[1]	Samples and Analyses
DMMU-1	C-1	-22	-18.2 to -22.0	-22.0 to -24.0	C-1-A-180827: Marine DMMP[2], D/F, TBT-
					C-1-Z-180827: Marine DMMP[2], D/F, TBT-
	C-2	-22	N/A[3]	-22.0 to -24.0	C-2-Z-180827: Marine DMMP[2], D/F, TBT-

Notes:

1. Sample intervals were corrected for length based on core recovery. Cores are assumed to have uniform compaction through the core.

2. Marine DMMP testing parameters include semivolatile organic compounds, polycyclic aromatic hydrocarbons, pesticides, polychlorinated biphenyls, metals, sulfide, ammonia, total organic carbon, grain size, total volatile solids, and total solids.

3. Sample not collected in aggregate material.

D/F: dioxins furans
DMMP: Dredged Material Management Program DMMU: Dredged Material Management Unit
MLLW: mean lower low water
TBT: tributyltin

Source: Table 2 of Sediment Characterization Data Report (Anchor, 2019)

Table 3. Sample Results Summary

								Sample ID	C-1-A-180827	C-1-Z-180827	C-2-Z-180827
								Sample Date	8/27/2018	8/27/2018	8/27/2018
	Method	DMMP SL	DMMP BT	DMMP ML	SMS Marine SCO	SMS Marine CSL	LDW Superfund RALs Category 1 Areas	Dioxin Furans TEF			
Conventional Parameters (mg/kg)											
Ammonia as nitrogen	SM4500NH3H	--	--	--	--	--	--	--	**16.3**	**45.8**	**75.7**
Sulfide	SM4500S2D	--	--	--	--	--	--	--	**1350**	**5310**	**3180**
Conventional Parameters (pct)											
Total organic carbon	Plumb 1981	--	--	--	--	--	--	--	**0.74 J**	**1.64 J**	**2.12 J**
Total Solids	SM2540G	--	--	--	--	--	--	--	**71.64**	**69.52**	**63.8**
Total volatile solids	PSEP	--	--	--	--	--	--	--	**3.09**	**4.91**	**6.7**
Grain Size (pct)											
Gravel	PSEP	--	--	--	--	--	--	--	**24.8**	**7.9**	**10.3**
Sand, very coarse	PSEP	--	--	--	--	--	--	--	**4.3**	**2.7**	**4.9**
Sand, coarse	PSEP	--	--	--	--	--	--	--	**11.5**	**3.4**	**3.5**
Sand, medium	PSEP	--	--	--	--	--	--	--	**20**	**5.5**	**4.5**
Sand, fine	PSEP	--	--	--	--	--	--	--	**8.5**	**3.4**	**2.4**
Sand, very fine	PSEP	--	--	--	--	--	--	--	**2.5**	**1.9**	**2.1**
Total sands	Calculated	--	--	--	--	--	--	--	**46.8**	**16.9**	**17.4**
Silt, coarse	PSEP	--	--	--	--	--	--	--	**2.3**	**5.2**	**8**
Silt, medium	PSEP	--	--	--	--	--	--	--	**3.8**	**12.1**	**10.8**
Silt, fine	PSEP	--	--	--	--	--	--	--	**7.9**	**21.6**	**18**
Silt, very fine	PSEP	--	--	--	--	--	--	--	**4.3**	**12.4**	**12.3**
Clay, coarse	PSEP	--	--	--	--	--	--	--	**2.6**	**7.2**	**6.6**
Clay, medium	PSEP	--	--	--	--	--	--	--	**2.4**	**5.2**	**5.1**
Clay, fine	PSEP	--	--	--	--	--	--	--	**5.2**	**11.4**	**11.3**
Total fines (silts and clays)	Calculated	--	--	--	--	--	--	--	**28.5**	**75.1**	**72.1**
Metals (mg/kg)											
Antimony	SW6020A	150	--	200	--	--	--	--	0.26 UJ	0.27 UJ	0.31 UJ
Arsenic	SW6020A	57	507.1	700	57	93	57	--	**7.18**	**13.1**	**22.1**
Cadmium	SW6020A	5.1	11.3	14	5.1	6.7	5.1	--	**0.38**	**1.76**	**2.07**
Chromium	SW6020A	260	260	--	260	270	260	--	**22.4**	**47.2**	**57.5**
Copper	SW6020A	390	1027	1300	390	390	390	--	**42.6**	**76.8**	**187**
Lead	SW6020A	450	975	1200	450	530	450	--	**23.5**	**51.2**	**82.1**
Mercury	SW7471B	0.41	1.5	2.3	0.41	0.59	0.41	--	**0.146 J**	**0.847 J**	**0.722 J**
Selenium	SW6020A	--	3	--	--	--	--	--	**1.18**	**1.75**	**1.86**
Silver	SW6020A	6.1	6.1	8.4	6.1	6.1	6.1	--	**0.49 J**	**2.41 J**	**2.82 J**
Zinc	SW6020A	410	2783	3800	410	960	410	--	**77.5**	**132**	**162**
Organometallic Compounds (µg/kg)											
Tributyltin (ion)	SW8270DMSIM	--	73	--	--	--	--	--	**10.4**	3.77 U	**1.71 J**
Semivolatile Organics (µg/kg)											
1,2,4-Trichlorobenzene	SW8270DSIM	31	--	64	--	--	--	--	4.9 U	**3.5 J**	**7.6**
1,2-Dichlorobenzene	SW8270DSIM	35	--	110	--	--	--	--	4.9 U	**1.7 J**	**5.7**
1,4-Dichlorobenzene	SW8270DSIM	110	--	120	--	--	--	--	4.9 UJ	**4.8 J**	**8.4 J**
2,4-Dimethylphenol	SW8270DSIM	29	--	210	29	29	29	--	24.3 U	**6.2 J**	**7.9 J**
2-Methylphenol (o-Cresol)	SW8270DSIM	63	--	77	63	63	--	--	4.9 U	**3 J**	**3.5 J**
4-Methylphenol (p-Cresol)	SW8270DSIM	670	--	3600	670	670	670	--	**4 J**	**22.9**	**21.2**
Benzoic acid	SW8270DSIM	650	--	760	650	650	650	--	97.2 UJ	**78.4 J**	**96.5 J**
Benzyl alcohol	SW8270DSIM	57	--	870	57	73	57	--	19.4 U	**6.3 J**	19.7 U

Source: Table 2 of Sediment Characterization Data Report (Anchor, 2019)

Table 3. Sample Results Summary

								Sample ID Sample Date	C-1-A-180827 8/27/2018	C-1-Z-180827 8/27/2018	C-2-Z-180827 8/27/2018
	Method	DMMP SL	DMMP BT	DMMP ML	SMS Marine SCO	SMS Marine CSL	LDW Superfund RALs Category 1 Areas	Dioxin Furans TEF			
Indeno(1,2,3-c,d)pyrene	SW8270D	600	--	4400	--	--	--	--	**80.8**	**1250**	**84**
Naphthalene	SW8270D	2100	--	2400	--	--	--	--	**33.4 J**	**455 J**	**66.5 J**
Phenanthrene	SW8270D	1500	--	21000	--	--	--	--	**213**	**1410**	**159**
Pyrene	SW8270D	2600	11980	16000	--	--	--	--	**659**	**6180**	**699**
Total cPAH TEQ (7 minimum CAEPA 2005) (U = 0)	Calculated	--	--	--	--	--	1000 µg TEQ/kg	--	**217**	**3356**	**274**
Total HPAH (DMMP) (U = 0)	Calculated	12000	--	69000	--	--	--	--	**1839**	**24534**	**2569**
Total LPAH (DMMP) (U = 0)	Calculated	5200	--	29000	--	--	--	--	**454 J**	**3579 J**	**452 J**
Polycyclic Aromatic Hydrocarbons (mg/kg-OC)											
2-Methylnaphthalene	SW8270D	--	--	--	38	64	38	--	**4.2**	**7.1**	**1.7**
Acenaphthene	SW8270D	--	--	--	16	57	16	--	**7.4**	**12.4**	**1.5**
Acenaphthylene	SW8270D	--	--	--	66	66	66	--	**1.6 J**	**5.9**	**1.5**
Anthracene	SW8270D	--	--	--	220	1200	220	--	**10.2 J**	**65.9 J**	**5.5 J**
Benzo(a)anthracene	SW8270D	--	--	--	110	270	110	--	**16.2**	**133.5**	**11.5**
Benzo(a)pyrene	SW8270D	--	--	--	99	210	99	--	**21.9**	**161.6**	**8.9**
Benzo(b,j,k)fluoranthenes	SW8270D	--	--	--	230	450	230	--	**41.4**	**180.5**	**21.3**
Benzo(g,h,i)perylene	SW8270D	--	--	--	31	78	31	--	**12.8**	**97.6**	**4.4**
Chrysene	SW8270D	--	--	--	110	460	110	--	**23.1**	**164.6**	**19.3**
Dibenzo(a,h)anthracene	SW8270DSIM	--	--	--	12	33	12	--	**3.7**	**24.0**	**1.5**
Dibenzofuran	SW8270D	--	--	--	15	58	15	--	**2.8**	**9.0**	**1.4**
Fluoranthene	SW8270D	--	--	--	160	1200	160	--	**29.5**	**281.1**	**17.4**
Fluorene	SW8270D	--	--	--	23	79	23	--	**8.8**	**20.3**	**2.2**
Indeno(1,2,3-c,d)pyrene	SW8270D	--	--	--	34	88	34	--	**10.9**	**76.2**	**4.0**
Naphthalene	SW8270D	--	--	--	99	170	99	--	**4.5 J**	**27.7 J**	**3.1 J**
Phenanthrene	SW8270D	--	--	--	100	480	100	--	**28.8**	**86.0**	**7.5**
Pyrene	SW8270D	--	--	--	1000	1400	1000	--	**89.1**	**376.8**	**33**
Total HPAH (SMS) (U = 0)	Calculated	--	--	--	960	5300	960	--	**248.5**	**1496**	**121.2**
Total LPAH (SMS) (U = 0)	Calculated	--	--	--	370	780	370	--	**61.3 J**	**218.2 J**	**21.3 J**
Pesticides (µg/kg)											
4,4'-DDD (p,p'-DDD)	SW8081B	16	--	--	--	--	--	--	1 UJ	0.96 UJ	0.99 UJ
4,4'-DDE (p,p'-DDE)	SW8081B	9	--	--	--	--	--	--	1 UJ	7.69 UJ	--
4,4'-DDT (p,p'-DDT)	SW8081B	12	--	--	--	--	--	--	7.99 UJ	*21.1 U*	--
Aldrin	SW8081B	9.5	--	--	--	--	--	--	0.5 UJ	0.48 UJ	3.97 UJ
Chlordane, alpha- (Chlordane, cis-)	SW8081B	--	--	--	--	--	--	--	0.5 U	0.48 U	2.98 U
Chlordane, beta- (Chlordane, trans-)	SW8081B	--	--	--	--	--	--	--	1 UJ	3.36 UJ	0.5 U
Dieldrin	SW8081B	1.9	--	1700	--	--	--	--	*3.49 UJ*	*7.21 UJ*	*29.8 UJ*
Heptachlor	SW8081B	1.5	--	270	--	--	--	--	0.5 U	0.48 U	0.5 U
Nonachlor, cis-	SW8081B	--	--	--	--	--	--	--	5.99 UJ	11.1 UJ	0.99 U
Nonachlor, trans-	SW8081B	--	--	--	--	--	--	--	1 U	0.96 U	0.99 U
Oxychlordane	SW8081B	--	--	--	--	--	--	--	1 U	0.96 U	0.99 U
Sum 4,4 DDT, DDE, DDD (U = 0)	Calculated	--	50	69	--	--	--	--	7.99 UJ	21.1 UJ	0.99 UJ
Total DMMP Chlordane (U = 0)	Calculated	2.8	37	--	--	--	--	--	*5.99 UJ*	*11.1 UJ*	*2.98 U*
Dioxin Furans (ng/kg)											
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	E1613B	--	--	--	--	--	--	1	**0.549 J**	**1.23 J**	**1.96 J**
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	E1613B	--	--	--	--	--	--	1	**1.38**	**8.4**	**6.38**
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	E1613B	--	--	--	--	--	--	0.1	**1.91**	**13**	**8.36**

Source: Table 2 of Sediment Characterization Data Report (Anchor, 2019)

Lehigh Hanson - Duwamish River Facility Navigational Maintenance Dredging Sediment Characterization

								Sample ID Sample Date	C-1-A-180827 8/27/2018	C-1-Z-180827 8/27/2018	C-2-Z-180827 8/27/2018
	Method	DMMP SL	DMMP BT	DMMP ML	SMS Marine SCO	SMS Marine CSL	LDW Superfund RALs Category 1 Areas	Dioxin Furans TEF			
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	E1613B	--	--	--	--	--	--	0.1	**19.1**	**269**	**51.2**
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	E1613B	--	--	--	--	--	--	0.1	**4.88**	**33**	**21**
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	E1613B	--	--	--	--	--	--	0.01	**742**	**9390**	**1770**
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	E1613B	--	--	--	--	--	--	0.0003	**6000 J**	**76500 J**	**14400 J**
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	E1613B	--	--	--	--	--	--	0.1	**0.971 J**	**8.33**	**6.33**
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	E1613B	--	--	--	--	--	--	0.03	**1.08**	**27.5**	**4.42**
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	E1613B	--	--	--	--	--	--	0.3	**3 J**	**98.3**	**17.1**
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	E1613B	--	--	--	--	--	--	0.1	**21.2**	**1000**	**60.2**
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	E1613B	--	--	--	--	--	--	0.1	**4.12**	**128**	**13.8**
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	E1613B	--	--	--	--	--	--	0.1	**2.8**	**112**	**7.62**
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	E1613B	--	--	--	--	--	--	0.1	**6.03**	**226**	**18.8**
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	E1613B	--	--	--	--	--	--	0.01	**197**	**4580**	**517**
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	E1613B	--	--	--	--	--	--	0.01	**17.1**	**531**	**38**
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	E1613B	--	--	--	--	--	--	0.0003	**1380 J**	**28200 J**	**3000 J**
Total Tetrachlorodibenzo-p-dioxin (TCDD)	E1613B	--	--	--	--	--	--	--	**6.53 J**	**45.5 J**	**32 J**
Total Pentachlorodibenzo-p-dioxin (PeCDD)	E1613B	--	--	--	--	--	--	--	**9.86**	**67.5**	**40.6**
Total Hexachlorodibenzo-p-dioxin (HxCDD)	E1613B	--	--	--	--	--	--	--	**102**	**980**	**329**
Total Heptachlorodibenzo-p-dioxin (HpCDD)	E1613B	--	--	--	--	--	--	--	**1330**	**14200**	**2940**
Total Tetrachlorodibenzofuran (TCDF)	E1613B	--	--	--	--	--	--	--	**29.5**	**122**	**358**
Total Pentachlorodibenzofuran (PeCDF)	E1613B	--	--	--	--	--	--	--	**45.4**	**1010**	**265**
Total Hexachlorodibenzofuran (HxCDF)	E1613B	--	--	--	--	--	--	--	**293**	**8520**	**792**
Total Heptachlorodibenzofuran (HpCDF)	E1613B	--	--	--	--	--	--	--	**1090**	**22700**	**2450**
Total Dioxin/Furan TEQ 2005 (Mammal) (U = 0)	Calculated	4	10	--	--	--	25	--	**20.7 J**	**395.3 J**	**60.8 J**
PCB Aroclors (mg/kg-OC)											
Total PCB Aroclors	Calculated	--	38	--	12	65	12	--	**35.4**	**44.2**	**133.7**
PCB Aroclors (µg/kg)											
Aroclor 1016	SW8082A	--	--	--	--	--	---	--	4 U	19.3 U	39.7 U
Aroclor 1221	SW8082A	--	--	--	--	--	---	--	4 U	19.3 U	39.7 U
Aroclor 1232	SW8082A	--	--	--	--	--	---	--	4 U	19.3 U	39.7 U
Aroclor 1242	SW8082A	--	--	--	--	--	---	--	4 U	19.3 U	39.7 U
Aroclor 1248	SW8082A	--	--	--	--	--	---	--	**80.7**	**172**	**1020**
Aroclor 1254	SW8082A	--	--	--	--	--	---	--	**122**	**343**	**1160**
Aroclor 1260	SW8082A	--	--	--	--	--	---	--	**58.9**	**210**	**654**
Aroclor 1262	SW8082A	--	--	--	--	--	---	--	4 U	19.3 U	39.7 U
Aroclor 1268	SW8082A	--	--	--	--	--	---	--	4 U	19.3 U	39.7 U
Total PCB Aroclors (U = 0)	Calculated	130	--	3100	--	--	---	--	**261.6**	**725**	**2834**

Source: Table 2 of Sediment Characterization Data Report (Anchor, 2019)

Table 3. Sample Results Summary

								Sample ID	C-1-A-180827	C-1-Z-180827	C-2-Z-180827
								Sample Date	8/27/2018	8/27/2018	8/27/2018
	Method	**DMMP SL**	**DMMP BT**	**DMMP ML**	**SMS Marine SCO**	**SMS Marine CSL**	**LDW Superfund RALs Category 1 Areas**	**Dioxin Furans TEF**			

Notes:

Italicized = Non-detected concentration is above one or more identified screening levels

Bold = Detected result

ected concentration exceeds one or more screening levels

ected concentration exceeds LDW Category 1 RAL (and DMMP criteria, if applicable)

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. Total LPAH consists of the sum of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene

Total HPAH consists of the sum of fluoranthene, pyrene, benz(a)anthracene, chrysene, benzo(b,j,k)fluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene. Total cPAH TEQ (7 minimum CAEPA 2005) calculation includes benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene and indeno(1,2,3-c,d)pyrene. Total DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.

Total Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane. Total PCB does not include Aroclor 1262 and 1268.

µg/kg: microgram per kilogram BT: bioaccumulation trigger

CSL: cleanup screening level

DMMP: Dredged Material Management Program ft: feet

HPAH: high-molecular-weight polycyclic aromatic hydrocarbon J: Estimated value

LDW Superfund RALs: Lower Duwamish Waterway Human Health Remedial Action Levels LPAH: low-molecular-weight polycyclic aromatic hydrocarbon

mg/kg: milligram per kilogram

mg/kg-OC: milligram per kilogram total organic carbon normalized ML: Maximum Level

N: normal environmental sample PCB: polychlorinated biphenyl

pct: percent

SCO: sediment cleanup objective SL: screening level

SMS: Sediment Management Standards TEF: toxicity equivalency factor

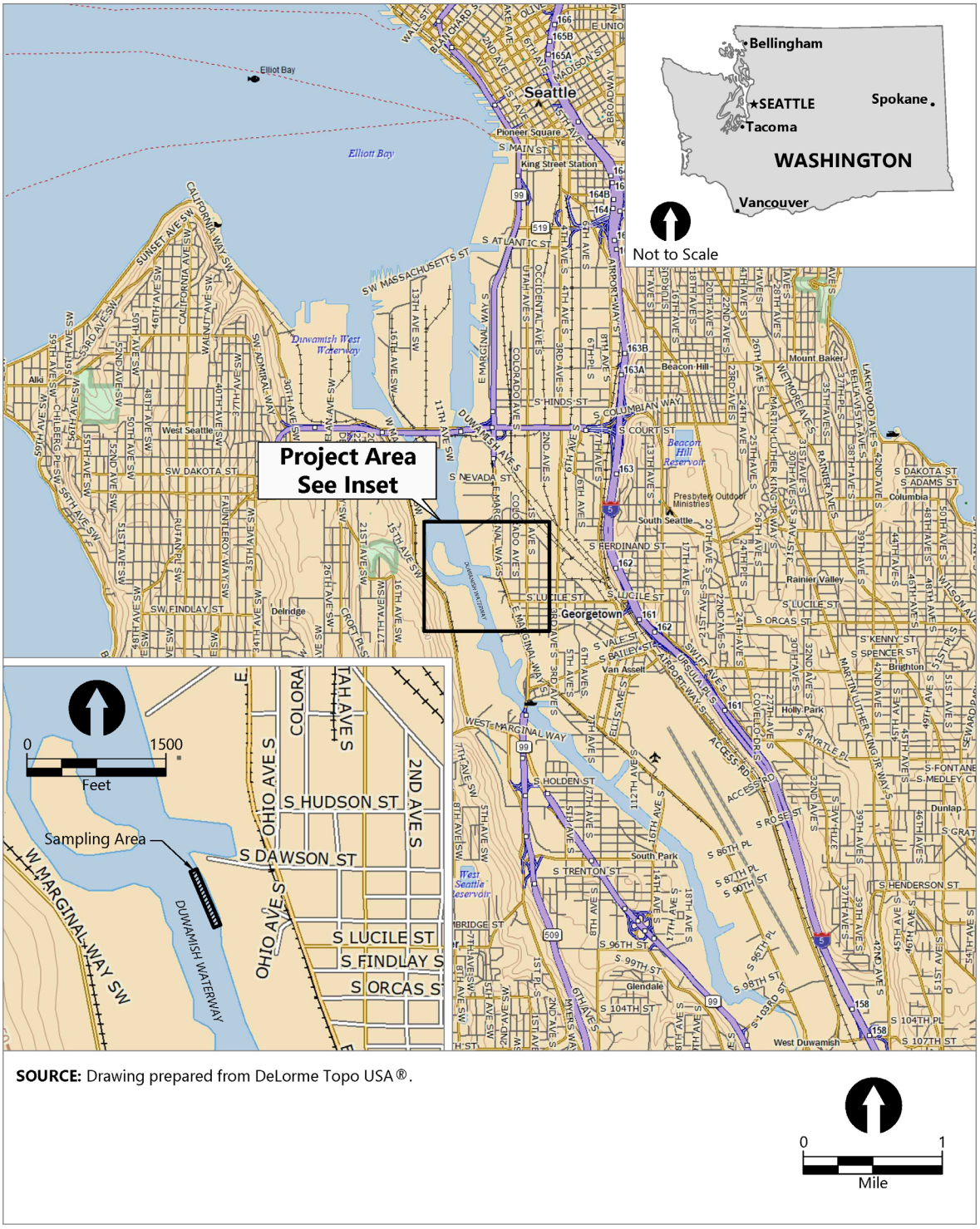
TEQ: toxic equivalent

U: Compound analyzed, but not detected above detection limit

UJ: Compound analyzed, but not detected above estimated detection limit

Source: Table 2 of Sediment Characterization Data Report (Anchor, 2019)
Lehigh Hanson - Duwamish River Facility Navigational Maintenance Dredging Sediment Characterization

Figure 1. Project Location Map



Source: Figure 1 of Sediment Characterization Data Report (Anchor, 2019)
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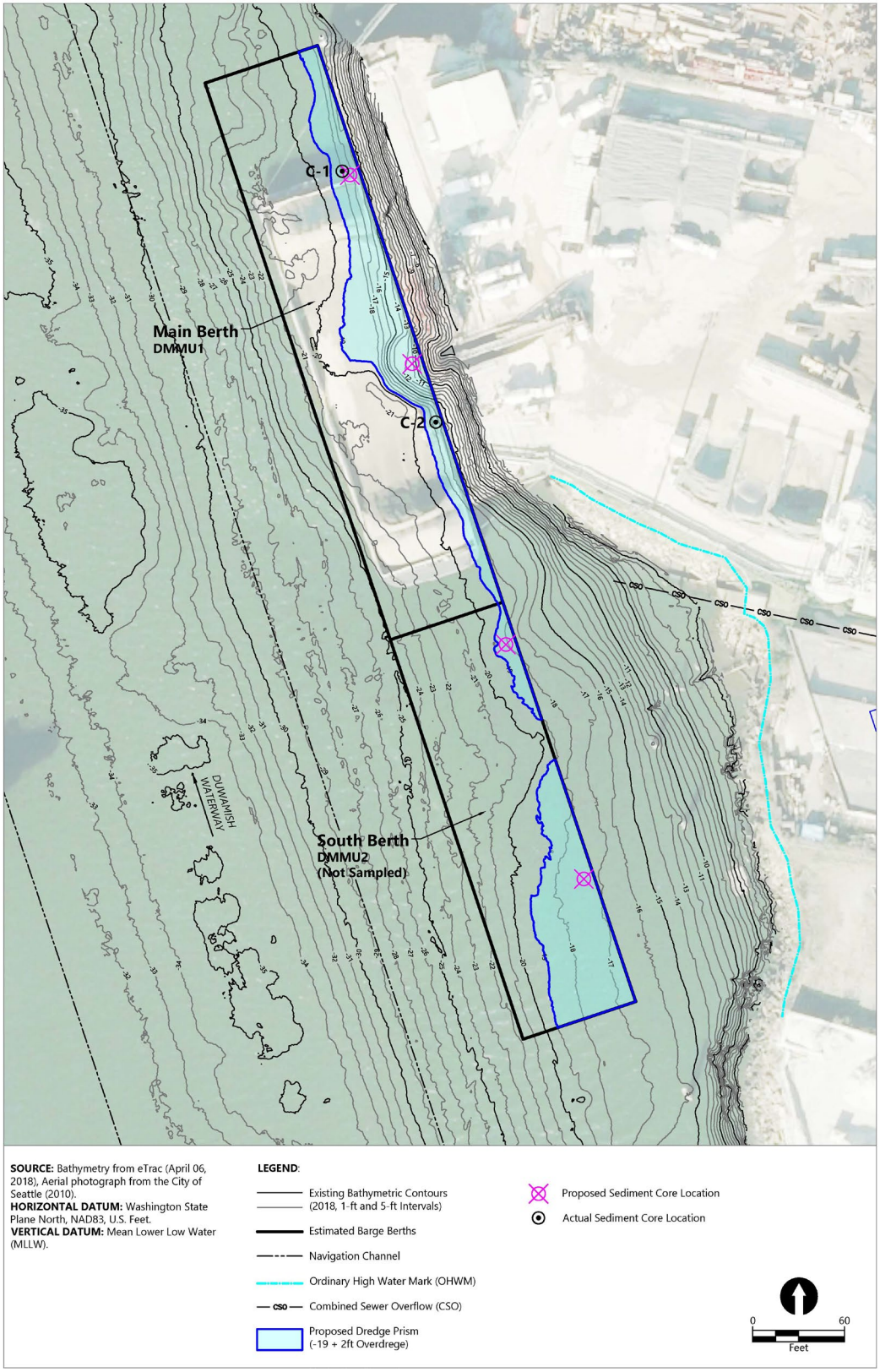
Figure 2. Proposed and Actual Sampling Locations



Source: Figure 2 of Sediment Characterization Data Report (Anchor, 2019)

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