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

MEMORANDUM FOR RECORD **April 19, 2019**

SUBJECT: CHARACTERIZATION OF SEDIMENT IMPOUNDED BY CHAMBERS CREEK DAM IN STEILACOOM, WASHINGTON TO ASSESS CONTAMINANT-RELATED RISKS ASSOCIATED WITH POTENTIAL DAM REMOVAL

1. **Introduction**. This memorandum documents the results of sediment characterization conducted for the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington Departments of Ecology and Natural Resources, and the Environmental Protection Agency) to assess contaminant-related risks associated with potential removal of the Chambers Creek Dam. The sediment samples that were tested represented fine-grained material that could erode following removal of the dam and be transported downstream into an estuarine/marine environment. As such, the results were compared to the State of Washington's marine sediment quality standards (SQS) and cleanup screening levels (CSLs) (Ecology, 2013). Because there are no marine standards for pesticides, which are potential chemicals of concern (COCs) at this site, pesticide results were compared to the DMMP screening levels (SLs). Testing results were also compared to the DMMP bioaccumulation triggers (BTs).

2. **Background**. Chambers Creek Dam is located on Chambers Creek, 4,900 feet upstream of the mouth of Chambers Bay, in Steilacoom, Washington (Figure 1). The dam impounds a 3.8-acre reservoir, trapping sediments and impeding estuarine processes that would otherwise benefit salmon, forage fish, and marine obligate birds (Anchor, 2018a). Forterra, the South Puget Sound Salmon Enhancement Group, and other stakeholders are conducting a feasibility study for removal of the dam and restoration of estuarine habitat. The sediment characterization documented in this memorandum was conducted as part of that study.

   Gravel mining began on the site in the 1890s, accompanied by the manufacture of asphalt and concrete. The site was once one of the largest gravel mines in the United States. Lone Star Northwest (now Glacier Northwest) purchased the mine in the 1980s. Commercial gravel mining on the site ceased in 2003. Chambers Bay has also been home to a number of mills – grain, lumber, pulp and paper (PCPR, 2017). The pulp and paper mill operated downstream of the dam site between 1919 and 2000 (Anchor, 2018a).

   The dam was originally constructed in 1933 in the lower reach of Chambers Creek as a joint venture between owners at the gravel mine and paper mill (PCPWU, 2013). The original purpose of the dam was to create a water impoundment to allow the withdrawal and beneficial use of Chambers Creek surface waters for gravel mining and paper manufacturing (Anchor, 2018a).

   The paper mill became a cleanup site under the Model Toxics Control Act (MTCA) in 2006. Contaminants included petroleum hydrocarbons, benzene and arsenic (Ecology, 2006). Cleanup has been completed and the site status is listed as "no further action" (Ecology, 2019). This former mill has not impacted adjacent sediment and is downstream of the dam; therefore, it is not considered a source of contaminants to upstream sediments (Anchor, 2018a).

   There are no known sources of dioxins/furans in the vicinity. The paper mill did not use Bleach Kraft processes that would generate chlorinated wastes such as dioxins and furans. During the remedial

investigation at the mill site, dioxins/furans were tested in soil samples from the aeration stabilization basin, with results less than 1 nanogram/kilogram toxicity equivalency (Anchor, 2018a). Therefore, analysis of dioxins/furans was not required for the DMMP evaluation. There are also no historical sources of tributyltin (e.g. boatyards) in the vicinity, so analysis of this chemical was not required.

Other historical sources of contaminants include the Asarco smelter in Tacoma (arsenic and lead) and algae control operations upstream in Lake Steilacoom (copper). Sediment testing conducted by the University of Puget Sound in 2011 north of the Chambers Creek Road bridge resulted in maximum concentrations of arsenic, copper and lead of 25, 53 and 70 milligrams per kilogram (mg/kg) in three cores analyzed at multiple depths down to 30 centimeters below mudline. These concentrations are all below their respective SQS for marine sediment (Anchor, 2018a).

Other upstream land uses included agriculture and golf courses, which are potential sources of pesticides. Therefore, the standard DMMP pesticides for marine projects were added to the list of COCs for analysis. The DMMP guidelines were used to interpret the results (DMMP, 2018).

The River Design Group identified areas of erosion if the dam were to be removed. Initially, soft silts and clays impounded behind the dam would migrate downstream. With tidal inundation and increased water velocity, additional erosion would occur from upstream of the bridge, with as much as 8 feet of erosion just north of the bridge. Figure 2 provides the existing surface elevations, in mean lower low water (MLLW), based on a bathymetric survey conducted in June 2018 by Gravity Marine Services. For characterization purposes, a conservative estimate of 56,000 cubic yards (cy) of erosion from a depth down to 8 feet below surface is predicted to occur in the area within 1,000 feet upstream of the dam (Anchor, 2018a).

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

Table 1. Project Summary

Project ranking	Low-Moderate (heterogeneous)
Characterized volume	56,000 cy
Characterized depth	Between dam and bridge: 4 ft Upstream of bridge: 8 ft
Draft SAP received	August 2, 2018
Draft SAP returned for revisions	August 15, 2018
Revised SAP received	August 23, 2018
Revised SAP returned for revisions	August 28, 2018
Final SAP received	September 4, 2018
Final SAP approved	September 5, 2018
Sampling dates	September 10, 2018
Draft data report received	March 1, 2019
Draft report returned for revisions	March 19, 2019
Final data report received	April 4, 2019
DMMO Tracking number	CCDAM-1-B-F-403
EIM Study ID	CCDAM18

USACE Permit Application Number	TBD
Recency Determination	September 2024 (LM rank = 6 yrs)

4. **Project Ranking and Sampling Requirements**. The DMMP agencies ranked the potential erosional areas as 'low-moderate' for sediment characterization based on the Tier 1 evaluation conducted by Anchor QEA, which indicated that the risk of encountering levels of contamination above the SQS in the impounded sediment was low, but that insufficient data existed to confirm a low ranking. Under such circumstances, the DMMP guidelines call for a rank of low-moderate to be applied. Due to unknown lithology in the impounded sediment, the material was considered to be heterogeneous.

   The minimum numbers of field samples and dredged material management units (DMMUs) in the erosional areas were calculated using the following Puget Sound guidelines for heterogeneous material in a low-moderate-ranked area (DMMP, 2018):

   - Maximum volume of sediment represented by each field sample = 8,000 cubic yards
   - Maximum volume of sediment represented by each surface DMMU = 32,000 cubic yards
   - Maximum volume of sediment represented by each subsurface DMMU = 48,000 cubic yards

   The area characterized consists of two subareas that are subject to erosion upon removal of the dam. The first subarea is located between the dam and the Chambers Creek Road Bridge (Figure 2). The second subarea is located upstream of the bridge. One of the objectives of the characterization was to understand the vertical and horizontal profiles of potential contaminants within the areas that will initially erode if the dam were to be removed (Anchor, 2018a). Core locations were selected in areas with finer-grained material because the coarse-grained material areas were too shallow to access with the sampling vessel and vibracoring equipment. Based on the DMMP guidelines, the existence of two subareas, and the desire to understand the vertical distribution of contaminants, the project was divided into four DMMUs, with one surface and one subsurface DMMU in each subarea. In each subarea, two cores were to be collected, with the surface core segments composited to represent the surface DMMU and the subsurface core segments composited to represent the subsurface DMMU. The total target sampling depths (i.e. surface plus subsurface core segments) were four feet between the dam and bridge, and eight feet upstream of the bridge.

   Flexibility was provided to the sampling team to adjust the depth of the surface core segments based on the lithology. If sample lithology indicated that material in the core was homogeneous, the cores would be divided into two equal segments (e.g. 0-2 ft for the surface DMMU and 2-4 feet for the subsurface DMMU between the dam and bridge). However, if the team encountered heterogeneous material, the upper two layers of sediment would be separated for analysis, using the break in lithology as the dividing line between surface and subsurface sediment units.

   Table 2 shows the sampling and compositing plan from Anchor (2018). A total of eight core segments and four DMMUs were planned. Each core segment was considered to be a separate field sample for the purposes of DMMP testing. Therefore, the number of planned field samples was one more than the minimum number required for DMMP characterization. The number of DMMUs was twice the minimum number required for DMMP characterization.

5. **Sampling**. Sampling took place September 10, 2018 using a vibracore deployed from research vessel Houma, a pontoon vessel operated by Gravity Marine Services that can operate in very low water levels. Sampling data can be found in Tables 3 and 4. Sediment samples were found to be relatively homogeneous, consisting predominantly of silt and fine sand (Anchor, 2019).

   Difficult coring conditions were encountered at station C-4 due to vegetation, coarse sand and low water levels. The station was moved 40 feet to the west to a somewhat better location, although sampling difficulties were still encountered there. Two coring attempts were made at C-4, both with core recovery below the target of 75%. The coring team suspected pile driving was occurring. This was confirmed by the presence of large woody debris at the bottom of the core (Anchor, 2019). The sampling team consulted with DMMO by telephone for guidance. While the sampling plan called for an 8-ft core to be collected at C-4, it was clear from the description of sampling conditions that collection of a core of this length was unlikely. DMMO instructed the sampling team to accept the core from the first attempt as representative of the upper four feet of sediment at C-4. To be consistent with the sampling procedure at C-4, only material from the upper four feet of the core from station C-3 was used. Sediment deeper than four feet from C-3 was archived for later possible analysis.

6. **Grain Size, Sediment Conventional and Chemical Analysis**. The grain-size, sediment conventional and chemistry results are presented in Table 5. The grain-size data show that the physical characteristics of the erosional material were similar in three of the DMMUs, with DMMUs 1, 2 and 4 all having a fines content greater than 60%. Only DMMU 3 was primarily coarse-grained, with a sand content greater than 60% and a fines content of 36%. The total organic carbon (TOC) and total volatile solids (TVS) content was high for all DMMUs, ranging from 4.7 to 7.9% for TOC and 9.5 to 16.1% for TVS. This reflected the plant debris and woody material noted in the core collection and processing logs. Ammonia levels were also elevated, again likely due to the decomposition of plant debris in the sediment. Sulfide concentrations were moderate.

   As indicated previously, the marine SQS and CSLs were used to assess COC concentrations in the sediment samples, with the exception of pesticides, for which the DMMP marine guidelines were used. The COC results in Table 5 include one exceedance of the SQS for mercury (DMMU 4), two exceedances of the SQS for benzyl alcohol (DMMUs 1 and 4), exceedances of the cleanup screening level (CSL) for benzoic acid in all four DMMUs, and exceedances of the DMMP screening level (SL) for total chlordane in DMMUs 1 and 4.

   Mercury and total chlordane are the only COCs with SQS or SL exceedances that have a DMMP bioaccumulation trigger (BT). The concentrations of these two chemicals did not exceed their respective BTs.

7. **Biological Testing**. Under the DMMP tiered testing procedures, the SQS/SL exceedances would normally have resulted in a requirement to run bioassays on all four of the DMMUs. However, for the Chambers Creek characterization, a smaller volume of sediment was collected from each DMMU than would typically be collected for a DMMP project, due to the shortness of the core segments. Following physical and chemical testing, a limited volume of sediment remained for bioassays. Anchor QEA suggested combining sediment from all four cores into a single composite and subjecting the composite to bioassays (Anchor, 2018b).

   A conference call was held October 26, 2018 with the DMMP agencies, Anchor QEA and the South Puget Sound Salmon Enhancement Group to discuss the chemistry results and options for biological testing.

The DMMP agencies recommended that at a minimum bioassays should be run on DMMU 4, which had the SQS exceedance for mercury, along with the highest concentration of benzoic acid and total chlordane. While DMMU 1 did have a slightly higher concentration of benzyl alcohol than DMMU 4, the agencies agreed that DMMU 4 constituted the "worst case" among the DMMUs. The DMMP agencies also recommended either running bioassays on DMMU 1 – due to the SL exceedance for chlordane – or reanalyzing it for chlordane using a more selective analytical method (see discussion below) to determine if chlordane was actually present in the sample. The DMMP agencies considered the CSL exceedances for benzoic acid in DMMUs 2 and 3 to be of lesser importance for biological testing, due to the ephemeral nature of this chemical and the likelihood that is was a natural byproduct of decomposition of plant material in the sediment (DMMP, 2016).

Due to limited funding and the fact that the sediment characterization was being done as part of a feasibility study and not for regulatory decision-making, the project proponent opted to run bioassays on DMMU 4 only and not conduct any additional chemical testing at this time.

The volume of sediment remaining from DMMU 4 was enough to run the larval development test and one of the bedded sediment tests (amphipod or Neanthes). Because of the high ammonia concentration in DMMU 4, the bioassay lab (EcoAnalysts) recommended running the Neanthes test over the amphipod test, because Neanthes is less sensitive to ammonia. Also, the Neanthes test would provide a chronic sublethal endpoint instead of a second acute endpoint. The lab also considered Neanthes to be equally sensitive to COCs compared to amphipod test species.

Because freshwater sediment was being subjected to marine bioassays, an acclimation period was necessary to adjust the salinity and allow a healthy microbial community to develop. In addition, the acclimation period provides time for ammonia to dissipate. Acclimation typically takes 7-14 days. The DMMP agencies were cognizant of the fact that the minimum acclimation period of 7 days would result in an exceedance of the 56-day holding time for bioassays, but the agencies preferred to exceed the holding time rather than cut short the acclimation period. After receiving the DMMU 4 sediment at their lab, EcoAnalysts recommended a 7-9 day acclimation period. A 7-day acclimation period ended up being used.

The bioassay results were mixed (Tables 6 through 10). Survival and growth in the Neanthes test met the SQS. However, the larval test failed at both the SQS and CSL level.

Although not required, EcoAnalysts conducted a side-by-side larval test using acclimated and unacclimated sediment to better understand the impact of acclimation. The test showed significant differences in larval development, with normal larval development in the unacclimated test being less than 5% of control and normal larval development in the acclimated sediment being 77% of control.

8. **Discussion**. The purpose of this study was to assess the potential environmental risk from contaminants in fine-grained sediment that will likely erode once the dam is removed. Taken at face value, the bioassay results for DMMU 4 suggest that this sediment could be toxic to some benthic invertebrates when eroded or exposed. However, this conclusion is tempered by the dramatic difference in larval development results from the side-by-side testing of acclimated and unacclimated sediment samples. Had the acclimation period been extended from 7 to 14 days, it is possible that DMMU 4 would have passed the larval bioassay. A second factor that tempers a conclusion of toxicity is the performance of the Sequim Bay reference sediment in the larval test. The mean number of normal larvae in the reference chambers at the end of the test (398.6) was higher than both the stocking density (306) and the mean number of normal

larvae in the control at the end of the test (250.6). Had the reference performance been similar to the control (a more typical outcome) DMMU 4 would have exceeded the SQS for the larval test, but not the CSL. Another consideration is the possible role of pH in the toxicity expressed in the larval test. A recent paper (Kapsenberg, 2018) showed that depressed pH levels can have a significant effect on development of *Mytilus galloprovincialis*. The pH levels in test beakers with sediment from Chambers Creek were within the range shown to affect larval development. However, the relationship between ammonia, pH and toxicity is complex. The biodegradation of nitrogenous organic material results in the formation of ammonia, in both its ionized and unionized forms. The ionized form (ammonium ion) is relatively non-toxic, but mildly acidic, resulting in a lower pH. Unionized ammonia (NH_3) is the most toxic form of ammonia, but is present at lower concentrations when the pH is low. Therefore, a depressed pH theoretically reduces toxicity due to ammonia, but increases toxicity due to pH. During the acclimation period, the level of ammonia rises at first as nitrogenous organic material is biodegraded, but as nitrifying bacteria and archaea become established, ammonia is converted to nitrite and then to nitrate, both of which are relatively non-toxic. The length of time allowed for acclimation needs to be weighed against the laboratory costs involved and the potential loss of contaminants from the sediment due to volatilization.

With regard to chemistry, the DMMP agencies have several observations to make. First, as stated previously, benzoic acid is ephemeral in the aquatic environment and is associated with the decomposition of plant material (DMMP, 2016). The same is true for benzyl alcohol. The environmental risk posed by these chemicals is thought to be low. Second, it is possible that the SL exceedances for total chlordane were an artifact of the analytical method used. EPA method 8081 is typically used for DMMP pesticide analysis, as was the case for this project. This method uses gas chromatography (GC) with an electron capture detector (ECD). ECDs are highly sensitive for compounds containing electronegative atoms or functional groups. However, ECDs are also non-specific, relying solely on chromatographic peak retention time for compound identification. This method performs well if sample extracts are relatively free of interferences. However, environmental samples, especially those with the high TOC content seen in the Chambers Creek samples, rarely meet this criterion. Other methods, such as GC with tandem mass spectrometry, are much more selective and less susceptible to matrix interferences.

Anchor QEA (2018b) provided another key consideration for this project. The sediment that was collected for this study was that which could be practically sampled, consisting of softer, siltier material than the medium and coarse sand that comprises much of the upstream areas that are expected to erode. While true that this softer material is likely to erode faster and more easily that coarser material, both sands and silt will eventually be eroded, mixed and settle out in Chambers Bay and Puget Sound. The sandier areas in the reservoir could not be sampled due to the very shallow water depths. Therefore, the testing results were biased toward the content of the finer-grained sediment, which are more likely to have higher concentrations of hydrophobic chemicals.

9. **Recommendations.** The DMMP agencies have three recommendations for the project proponent. First, it is recommended that future testing for pesticides use a more selective analytical method, such as gas chromatography with tandem mass spectrometry. Second, future biological testing should include a longer acclimation period, taking both ammonia and pH levels into consideration in determining the duration of acclimation. Third, future sediment characterization should include samples that are more representative of the larger erosional area.

10. References.

Anchor, 2018a. *Chambers Creek Dam Impounded Sediments Characterization; Sampling and Analysis Plan.* Prepared by Anchor QEA for Forterra, September 2018.

Anchor, 2018b. *Memorandum from Joy Dunay to David Fox regarding Chambers Creek Dam Removal DMMP Advisory Determination.* Prepared by Anchor QEA, October 24, 2018.

Anchor, 2019. *Sediment Characterization Data Report - Chambers Creek Dam Removal and Estuary Restoration.* Prepared by Anchor QEA for Forterra, April 2019.

DMMP, 2016. *Revised Evaluation Guidelines for Benzyl Alcohol in Marine Sediment.* A DMMP clarification paper prepared by Heather Whitney Fourie (U.S. Army Corps of Engineers) and David Fox (U.S. Army Corps of Engineers) for the DMMP agencies. June 2016.

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PCPR, 2017. *Chambers Creek Regional Park Master Plan Update.* Pierce County Parks and Recreation, May 2017.

PCPWU, 2013. *Chambers Creek Dam Study – Final Report.* Pierce County Public Works and Utilities, August 2013.

11. <u>DMMO Signature</u>. This memorandum was coordinated by the undersigned with Laura Inouye (Ecology), Erika Hoffman (EPA) and Celia Barton (DNR).

The signed copy is on file in the Dredged Material Managment Office.

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Date David Fox, P.E. - Seattle District Corps of Engineers

Copies furnished:

DMMP agencies
Joy Dunay, Anchor QEA
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Table 2
Sampling and Compositing Plan

Erosional Area	Dredge Material Mangement Unit	Erosion Volume (cubic yards)	Station ID	Northing	Easting	Target Core Length (feet)	Sampling Interval[a,b]	DMMU	Depth Interval Below Mudline (feet)[d]	Testing Parameters: Sample Composites
Upstream of Dam (up to bridge)	DMMU1 (Surface) & DMMU2 (Subsurface)	DMMU1=12,000 DMMU2=12,000	C-1	684411	1124747	4.0	A	1	0 to 2	A Composite and B Composite analyzed for SMS Marine SQS[c] & DMMP pesticides, bioassay archive
							B	2	2 to 4	
			C-2	684558	1124790	4.0	A	1	0 to 2	
							B	2	2 to 4	
Upstream of Bridge (within 1,000 feet of dam)	DMMU3 (Surface) & DMMU4 (Subsurface)	DMMU3=16,000 DMMU4=16,000	C-3	684789	1124904	8.0	A	3	0 to 4	A Composite and B Composite analyzed for SMS Marine SQS[c] & DMMP pesticides, bioassay archive
							B	4	4 to 8	
			C-4	684955	1124979	8.0	A	3	0 to 4	
							B	4	4 to 8	

Notes:

Coordinates are in NAD83 WA State Plane South, U.S. Feet.

a. Archives of individual intervals will be kept

b. The surface and subsurface intervals within each erosional area will be composited to create one surface and one subsurface sample composite per area.

c. Marine SQS testing parameters include SVOC, PAH, PCB, metals, sulfide, ammonia, TOC, grain size, TVS, and TS.

d. These depth intervals are applicable to homogenous sediment; if the cores are heterogeneous, sampling intervals will be based on lithology (as described in Section 4.3)

DMMP: Dredged Material Management Program

NAD: North American Datum

PAH: polycyclic aromatic hydrocarbon

PCB: polychlorinated biphenyl

SMS: Sediment Management Standard

SQS: Sediment Quality Standard

SVOC: semivolatile organic compound

TOC: total organic carbon

TPH: total petroleum hydrocarbons

TS: total solid

TVS: total volatile solid

Table 3
Core Collection Data

DMMU	Station	Date	Location[1]		Measured Water Depth from Leadline (feet)	Water Level (feet NAVD88)[2]	Mudline Elevation (feet NAVD88)	Water Level (feet MLLW)[2]	Mudline Elevation (feet MLLW)	Drive Penetration (feet)	Recovery Measurement (feet)	Recovery (%)
			X Coordinate	Y Coordinate								
DMMU-1 DMMU-2	C-1	9/10/2018	1124746.7	684416.8	7.5	14.0	6.5	17.7	10.2	4.5	4.3	96%
	C-2	9/10/2018	1124801.6	684559.9	7	14.0	7.0	17.7	10.7	5.4	5.1	94%
DMMU-3 DMMU-4	C-3	9/10/2018	1124900.4	684791.8	4.1	14.0	9.9	17.7	13.6	8	7.2	90%
	C-4	9/10/2018	1124939.9	684963.3	2.3	14.0	11.7	17.7	15.4	8	4.4	55%

Notes:

1. Coordinates are in North American Datum of 1983 Washington State Plane South, US feet.
2. Water levels at time of sampling were measured using a survey package that included a real-time kinematic survey differential global positioning system connected to the Washington State Reference Network.

3. To convert NAVD88 to MLLW, add 3.7 feet.

DMMU: Dredge Material Management Unit

MLLW: mean lower low water

NAVD88: North American Vertical Datum of 1988

SMS: Sediment Management Standards

Source: Table 2 of Sediment Characterization Data Report

Table 4
Core Sampling Intervals and Analysis

DMMU	Station	Surface Sample A Interval (feet MLLW)	Subsurface Sample B Interval (feet MLLW)	Archive Elevation Interval (feet MLLW)	Archive Samples	Composite Samples and Analyses[1, 2]
DMMU-1 (surface A intervals)	C-1	2 feet (10.2 to 8.2)	2 feet (8.2 to 6.2)	--	C-1-A-180910 C-1-B-180910	DU-1-A-091810: Marine SMS and DMMP
DMMU-2 (subsurface B intervals	C-2	2 feet (10.7 to 8.7)	1.8 feet (8.7 to 6.9)	0.7 feet (6.9 to 6.2)	C-2-A-180910 C-2-B-180910 C-2-C-180910	DU-2-B-091810: Marine SMS and DMMP (pesticides only)
DMMU-3 (surface A intervals)	C-3	2 feet (13.6 to 11.6)	2 feet (11.6 to 9.6)	3.2 feet (9.6 to 6.4)	C-3-A-180910 C-3-B-180910 C-3-C-180910	DU-3-A-091810: Marine SMS and DMMP
DMMU-4 (subsurface B intervals)	C-4	2 feet (15.4 to 13.4)	2.4 feet (13.4 to 11.0)	--	C-4-A-180910 C-4-B-180910	DU-4-A-091810: Marine SMS and DMMP (pesticides only)

Notes:

1. Surface sample intervals (DU1-A and DU3-A) and subsurface sample intervals (DU2-B and DU4-B) were composited for analyses (C-1-A and C-2-A, C-1-B and C-2-B, C-3-A and C-4-A, C-3-B and C-4-B).
2. Marine SMS and 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.

DMMU: Dredge Material Management Unit

MLLW: mean lower low water

SMS: Sediment Management Standards

-- Not applicable

Source: Table 3 of Sediment Characterization Data Report

Table 5
Chambers Creek Sample Results

								Task	2018_DMMP	2018_DMMP	2018_DMMP	2018_DMMP
								Location ID	DU1-A	DU2-B	DU3-A	DU4-B
								Sample ID	DU1-A-180910	DU2-B-180910	DU3-A-180910	DU4-B-180910
								Sample Date	9/11/2018	9/11/2018	9/10/2018	9/10/2018
								Sample Type	N	N	N	N
								Matrix	SE	SE	SE	SE
	Method	DMMP SL	DMMP BT	DMMP ML	SMS Marine SQSSCUM II	SMS Marine CSL SCUM II	AET Marine SQS SCUMII	AET Marine CSL SCUMII				
Conventional Parameters (mg/kg)												
Ammonia as nitrogen	SM4500NH3H	--	--	--	--	--	--	--	**164**	**233**	**175**	**295**
Sulfide	SM4500S2D	--	--	--	--	--	--	--	**254**	**163**	**72.7**	**64.6**
Conventional Parameters (pct)												
Total organic carbon	SW9060A	--	--	--	--	--	--	--	**6.51 J**	**4.7 J**	**7.93 J**	**6.28 J**
Total Solids	SM2540G	--	--	--	--	--	--	--	**27.94**	**32.69**	**48.17**	**36.82**
Total volatile solids	PSEP-TVS	--	--	--	--	--	--	--	**16.14**	**14.15**	**9.49**	**15.82**
Grain Size (pct)												
Total Gravel	PSEP-PS	--	--	--	--	--	--	--	**0.9**	**2.6**	**1.4**	**0.3**
Sand, very coarse	PSEP-PS	--	--	--	--	--	--	--	**4.8**	**4.4**	**5.2**	**3.7**
Sand, coarse	PSEP-PS	--	--	--	--	--	--	--	**2.2**	**3.8**	**13**	**2.4**
Sand, medium	PSEP-PS	--	--	--	--	--	--	--	**1.8**	**6.4**	**17.6**	**2.4**
Sand, fine	PSEP-PS	--	--	--	--	--	--	--	**3.4**	**10.1**	**10.9**	**4.8**
Sand, very fine	PSEP-PS	--	--	--	--	--	--	--	**9.9**	**9.1**	**15.9**	**9.3**
Total Sand	PSEP-PS								**22.1**	**33.8**	**62.6**	**22.6**
Silt, coarse	PSEP-PS	--	--	--	--	--	--	--	**17.5**	**11.9**	**11**	**19.2**
Silt, medium	PSEP-PS	--	--	--	--	--	--	--	**19.2**	**14.4**	**8.9**	**16.8**
Silt, fine	PSEP-PS	--	--	--	--	--	--	--	**14.3**	**11.6**	**5.4**	**12**
Silt, very fine	PSEP-PS	--	--	--	--	--	--	--	**9.8**	**8.1**	**3.9**	**9.7**
Clay, coarse	PSEP-PS	--	--	--	--	--	--	--	**7.6**	**6.6**	**2.9**	**7.9**
Clay, medium	PSEP-PS	--	--	--	--	--	--	--	**6.2**	**5.5**	**2.7**	**6**
Clay, fine	PSEP-PS	--	--	--	--	--	--	--	**2.6**	**5.4**	**1.2**	**5.4**
Total fines (silt + clay)	PSEP-PS								**77.2**	**63.5**	**36**	**77**
Metals (mg/kg)												
Antimony	SW6020A	150	--	200	--	--	--	--	0.7 U	0.58 U	0.38 U	0.53 U
Arsenic	SW6020A	57	507.1	700	57	93	57	93	**11.9**	**13.3**	**6.1**	**17.7**
Cadmium	SW6020A	5.1	11.3	14	5.1	6.7	5.1	6.7	**0.65**	**0.84**	**0.34**	**0.91**
Chromium	SW6020A	260	260	--	260	270	260	270	**32.6**	**36.8**	**28.7**	**38**
Copper	SW6020A	390	1027	1300	390	390	390	390	**54.9**	**54.1**	**30**	**85.5**
Lead	SW6020A	450	975	1200	450	530	450	530	**55.7**	**59**	**26.7**	**102**
Mercury	SW7471B	0.41	1.5	2.3	0.41	0.59	0.41	0.59	**0.222**	**0.198**	**0.0952**	**0.518**
Silver	SW6020A	6.1	6.1	8.4	6.1	6.1	6.1	6.1	**0.18 J**	**0.28 J**	**0.1 J**	**0.25 J**
Zinc	SW6020A	410	2783	3800	410	960	410	960	**133**	**139**	**89.2**	**171**
Polycyclic Aromatic Hydrocarbons (µg/kg)												
2-Methylnaphthalene	SW8270D	670	--	1900	--	--	670	670	19.9 U	**19.2 J**	**6.3 J**	**32.7**
Acenaphthene	SW8270D	500	--	2000	--	--	500	500	**12.1 J**	**24.5**	**5.9 J**	**26.7 J**
Acenaphthylene	SW8270D	560	--	1300	--	--	1300	1300	19.9 U	19.6 U	19.9 U	30.7 U
Anthracene	SW8270D	960	--	13000	--	--	960	960	**24.5**	**41.6**	**13.8 J**	**70.3**
Benzo(a)anthracene	SW8270D	1300	--	5100	--	--	1300	1600	**81.8**	**112**	**43.9**	**260**
Benzo(a)pyrene	SW8270D	1600	--	3600	--	--	1600	1600	**99.2**	**190**	**84**	**416**
Benzo(b,j,k)fluoranthenes	SW8270D	--	--	--	--	--	3200	3600	**322**	**430**	**202**	**967**
Benzo(g,h,i)perylene	SW8270D	670	--	3200	--	--	670	720	**75.8**	**82**	**42.2**	**264**
Chrysene	SW8270D	1400	--	21000	--	--	1400	2800	**186**	**300**	**128**	**584**
Dibenzo(a,h)anthracene	SW8270DSIM	230	--	1900	--	--	230	230	**16.4**	**14.5**	**7.8**	**47.9**
Fluoranthene	SW8270D	1700	4600	30000	--	--	1700	2500	**232**	**412**	**159**	**741**

Source: Table 3 of Sediment Characterization Data Report (Anchor, 2019)

Table 5
Chambers Creek Sample Results

								Task	2018_DMMP	2018_DMMP	2018_DMMP	2018_DMMP
								Location ID	DU1-A	DU2-B	DU3-A	DU4-B
								Sample ID	DU1-A-180910	DU2-B-180910	DU3-A-180910	DU4-B-180910
								Sample Date	9/11/2018	9/11/2018	9/10/2018	9/10/2018
								Sample Type	N	N	N	N
								Matrix	SE	SE	SE	SE
	Method	DMMP SL	DMMP BT	DMMP ML	SMS Marine SQSSCUM II	SMS Marine CSL SCUM II	AET Marine SQS SCUMII	AET Marine CSL SCUMII				
Fluorene	SW8270D	540	--	3600	--	--	540	540	**18.4 J**	**42.6**	19.9 U	**54**
Indeno(1,2,3-c,d)pyrene	SW8270D	600	--	4400	--	--	600	690	**80**	**73.3**	**35.2**	**337**
Naphthalene	SW8270D	2100	--	2400	--	--	2100	2100	**81 J**	**80.3 J**	**14.3 J**	**121 J**
Phenanthrene	SW8270D	1500	--	21000	--	--	1500	1500	**125**	**213**	**76.1**	**358**
Pyrene	SW8270D	2600	11980	16000	--	--	2600	3300	**227**	**373**	**165**	**722**
Total HPAH (SMS) (U = 0)	SW8270D	12000	--	69000	--	--	12000	17000	**1320.2**	**1986.8**	**867.1**	**4338.9**
Total LPAH (SMS) (U = 0)	SW8270D	5200	--	29000	--	--	5200	5200	**261 J**	**402 J**	**110.1 J**	**630 J**
Polycyclic Aromatic Hydrocarbons (mg/kg-OC)												
2-Methylnaphthalene	SW8270D	--	--	--	38	64	--	--	0.3057 U	**0.4085 J**	**0.0794 J**	**0.5207**
Acenaphthene	SW8270D	--	--	--	16	57	--	--	**0.1859 J**	**0.5213**	**0.0744 J**	**0.4252 J**
Acenaphthylene	SW8270D	--	--	--	66	66	--	--	0.3057 U	0.417 U	0.2509 U	0.4889 U
Anthracene	SW8270D	--	--	--	220	1200	--	--	**0.3763**	**0.8851**	**0.174 J**	**1.1194**
Benzo(a)anthracene	SW8270D	--	--	--	110	270	--	--	**1.2565**	**2.383**	**0.5536**	**4.14**
Benzo(a)pyrene	SW8270D	--	--	--	99	210	--	--	**1.5238**	**4.043**	**1.0593**	**6.624**
Benzo(b,j,k)fluoranthenes	SW8270D	--	--	--	230	450	--	--	**4.946**	**9.149**	**2.547**	**15.398**
Benzo(g,h,i)perylene	SW8270D	--	--	--	31	78	--	--	**1.1644**	**1.7447**	**0.5322**	**4.204**
Chrysene	SW8270D	--	--	--	110	460	--	--	**2.857**	**6.383**	**1.614**	**9.299**
Dibenzo(a,h)anthracene	SW8270DSIM	--	--	--	12	33	--	--	**0.2519**	**0.3085**	**0.0984**	**0.7627**
Fluoranthene	SW8270D	--	--	--	160	1200	--	--	**3.564**	**8.766**	**2.005**	**11.799**
Fluorene	SW8270D	--	--	--	23	79	--	--	**0.2826 J**	**0.9064**	0.2509 U	**0.8599**
Indeno(1,2,3-c,d)pyrene	SW8270D	--	--	--	34	88	--	--	**1.2289**	**1.5596**	**0.4439**	**5.366**
Naphthalene	SW8270D	--	--	--	99	170	--	--	**1.2442 J**	**1.7085 J**	**0.1803 J**	**1.927 J**
Phenanthrene	SW8270D	--	--	--	100	480	--	--	**1.92**	**4.532**	**0.9596**	**5.701**
Pyrene	SW8270D	--	--	--	1000	1400	--	--	**3.487**	**7.936**	**2.081**	**11.497**
Total HPAH (SMS) (U = 0)	SW8270D	--	--	--	960	5300	--	--	**20.2795**	**42.2723**	**10.9345**	**69.0907**
Total LPAH (SMS) (U = 0)	SW8270D	--	--	--	370	780	--	--	**4.0092 J**	**8.5532 J**	**1.3884 J**	**10.0318 J**
Semivolatile Organics (µg/kg)												
1,2,4-Trichlorobenzene	SW8270DSIM	31	--	64	--	--	31	51	5 U	4.9 U	5 U	7.7 U
1,2-Dichlorobenzene	SW8270DSIM	35	--	110	--	--	35	50	5 U	4.9 U	5 U	7.7 U
1,4-Dichlorobenzene	SW8270DSIM	110	--	120	--	--	110	110	**4.3 J**	**3.9 J**	5 UJ	**7.8 J**
2,4-Dimethylphenol	SW8270DSIM	29	--	210	29	29	29	29	24.9 UJ	24.5 UJ	24.8 UJ	*38.3 UJ*
2-Methylphenol (o-Cresol)	SW8270DSIM	63	--	77	63	63	63	63	**14.2**	**10.9**	**11.6**	**17.4**
4-Methylphenol (p-Cresol)	SW8270DSIM	670	--	3600	670	670	670	670	**108**	**174**	**73.8**	**190**
Benzoic acid	SW8270D	650	--	760	650	650	650	650	**1140 J**	**874 J**	**687 J**	**1390 J**
Benzyl alcohol	SW8270D	57	--	870	57	73	57	73	**69.7**	**39.2**	**56.2**	**59.2**
bis(2-Ethylhexyl)phthalate	SW8270D	1300	--	8300	--	--	1300	3100	**270**	**201**	**106**	**640**
Butylbenzyl phthalate	SW8270D	63	--	970	--	--	63	900	19.9 U	19.6 U	19.9 U	30.7 U
Dibenzofuran	SW8270D	540	--	1700	--	--	540	540	19.9 U	**23.7**	**10.4 J**	**34.5**
Diethyl phthalate	SW8270DSIM	200	--	1200	--	--	200	1200	19.9 U	19.6 U	19.9 U	30.7 U
Dimethyl phthalate	SW8270DSIM	71	--	1400	--	--	71	160	19.6 U	4.9 U	5 U	7.7 U
Di-n-butyl phthalate	SW8270D	1400	--	5100	--	--	1400	1400	**11.2 J**	19.6 U	19.9 U	30.7 U
Di-n-octyl phthalate	SW8270D	6200	--	6200	--	--	6200	6200	19.9 U	19.6 U	19.9 U	30.7 U
Hexachlorobenzene	SW8270DSIM	22	168	230	--	--	22	70	5 U	4.9 U	5 U	7.7 U
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	SW8270D	11	--	270	--	--	11	120	*19.9 U*	*19.6 U*	*19.9 U*	*30.7 U*
n-Nitrosodiphenylamine	SW8270D	28	--	130	--	--	28	40	19.9 U	19.6 UJ	19.9 U	*30.7 U*

Source: Table 3 of Sediment Characterization Data Report (Anchor, 2019)

Table 5
Chambers Creek Sample Results

								Task	2018_DMMP	2018_DMMP	2018_DMMP	2018_DMMP
								Location ID	DU1-A	DU2-B	DU3-A	DU4-B
								Sample ID	DU1-A-180910	DU2-B-180910	DU3-A-180910	DU4-B-180910
								Sample Date	9/11/2018	9/11/2018	9/10/2018	9/10/2018
								Sample Type	N	N	N	N
								Matrix	SE	SE	SE	SE
	Method	DMMP SL	DMMP BT	DMMP ML	SMS Marine SQSSCUM II	SMS Marine CSL SCUM II	AET Marine SQS SCUMII	AET Marine CSL SCUMII				
Pentachlorophenol	SW8270D	400	504	690	360	690	360	690	99.5 UJ	98.1 UJ	99.3 UJ	--
Pentachlorophenol	SW8270DSIM	400	504	690	360	690	360	690	--	--	--	**81.6 J**
Phenol	SW8270DSIM	420	--	1200	420	1200	420	1200	62.4 U	45.3 U	42.2 U	59.4 U
Semivolatile Organics (mg/kg-OC)												
1,2,4-Trichlorobenzene	SW8270DSIM	--	--	--	0.81	1.8	--	--	0.0768 U	0.1043 U	0.0631 U	0.1226 U
1,2-Dichlorobenzene	SW8270DSIM	--	--	--	2.3	2.3	--	--	0.0768 U	0.1043 U	0.0631 U	0.1226 U
1,4-Dichlorobenzene	SW8270DSIM	--	--	--	3.1	9	--	--	**0.0661 J**	**0.083 J**	0.0631 UJ	**0.1242 J**
2,4-Dimethylphenol	SW8270DSIM	--	--	--	--	--	--	--	0.3825 UJ	0.5213 UJ	0.3127 UJ	0.6099 UJ
2-Methylphenol (o-Cresol)	SW8270DSIM	--	--	--	--	--	--	--	**0.2181**	**0.2319**	**0.1463**	**0.2771**
4-Methylphenol (p-Cresol)	SW8270DSIM	--	--	--	--	--	--	--	**1.659**	**3.702**	**0.9306**	**3.025**
Benzoic acid	SW8270D	--	--	--	--	--	--	--	**17.512 J**	**18.596 J**	**8.663 J**	**22.134 J**
Benzyl alcohol	SW8270D	--	--	--	--	--	--	--	**1.0707**	**0.834**	**0.7087**	**0.9427**
bis(2-Ethylhexyl)phthalate	SW8270D	--	--	--	47	78	--	--	**4.147**	**4.277**	**1.337**	**10.191**
Butylbenzyl phthalate	SW8270D	--	--	--	4.9	64	--	--	0.3057 U	0.417 U	0.2509 U	0.4889 U
Dibenzofuran	SW8270D	--	--	--	15	58	--	--	0.3057 U	**0.5043**	**0.1311 J**	**0.5494**
Diethyl phthalate	SW8270DSIM	--	--	--	61	110	--	--	0.3057 U	0.417 U	0.2509 U	0.4889 U
Dimethyl phthalate	SW8270DSIM	--	--	--	53	53	--	--	0.3011 U	0.1043 U	0.0631 U	0.1226 U
Di-n-butyl phthalate	SW8270D	--	--	--	220	1700	--	--	**0.172 J**	0.417 U	0.2509 U	0.4889 U
Di-n-octyl phthalate	SW8270D	--	--	--	58	4500	--	--	0.3057 U	0.417 U	0.2509 U	0.4889 U
Hexachlorobenzene	SW8270DSIM	--	--	--	0.38	2.3	--	--	0.0768 U	0.1043 U	0.0631 U	0.1226 U
Hexachlorobutadiene (Hexachloro-1,3-butadiene)	SW8270D	--	--	--	3.9	6.2	--	--	0.3057 U	0.417 U	0.2509 U	0.4889 U
n-Nitrosodiphenylamine	SW8270D	--	--	--	11	11	--	--	0.3057 U	0.417 UJ	0.2509 U	0.4889 U
Pentachlorophenol	SW8270D	--	--	--	--	--	--	--	1.5284 UJ	2.0872 UJ	1.2522 UJ	--
Pentachlorophenol	SW8270DSIM	--	--	--	--	--	--	--	--	--	--	**1.2994 J**
Phenol	SW8270DSIM	--	--	--	--	--	--	--	0.9585 U	0.9638 U	0.5322 U	0.9459 U
Pesticides (µg/kg)												
4,4'-DDD (p,p'-DDD)	SW8081B	16	--	--	--	--	--	--	**2.02**	**1.45 J**	0.97 U	**2.6 J**
4,4'-DDE (p,p'-DDE)	SW8081B	9	--	--	--	--	--	--	**2**	**2.38 J**	0.97 U	**3.02**
4,4'-DDT (p,p'-DDT)	SW8081B	12	--	--	--	--	--	--	1 UJ	1 UJ	0.97 UJ	5.26 UJ
Aldrin	SW8081B	9.5	--	--	--	--	--	--	0.5 U	0.5 U	0.49 U	0.5 U
Chlordane, alpha- (Chlordane, cis-)	SW8081B	--	--	--	--	--	--	--	**1.51**	2.49 UJ	**1.05**	**4.74**
Chlordane, beta- (Chlordane, trans-)	SW8081B	--	--	--	--	--	--	--	**1.66**	2.19 UJ	**1.05**	**2.87**
Dieldrin	SW8081B	1.9	--	1700	--	--	--	--	1 U	1 UJ	0.97 U	0.99 U
Heptachlor	SW8081B	1.5	--	270	--	--	--	--	0.5 U	0.5 UJ	0.49 U	0.5 U
Nonachlor, cis-	SW8081B	--	--	--	--	--	--	--	**2.09**	**1.61**	0.97 U	0.99 U
Nonachlor, trans-	SW8081B	--	--	--	--	--	--	--	4.19 U	1 U	0.97 U	0.99 U
Oxychlordane	SW8081B	--	--	--	--	--	--	--	1 U	1 U	0.97 U	0.99 U
Sum 4,4 DDT, DDE, DDD (U = 0)		--	50	69	--	--	--	--	**4.02 J**	**3.83 J**	0.97 UJ	**5.62 J**
Total DMMP Chlordane (U = 0)		2.8	37	--	--	--	--	--	**5.26**	**1.61 J**	**2.1**	**7.61**
PCB Aroclors (µg/kg)												
Aroclor 1016	SW8082A	--	--	--	--	--	--	--	4 U	4 U	3.9 U	3.9 U
Aroclor 1221	SW8082A	--	--	--	--	--	--	--	4 U	4 U	3.9 U	3.9 U
Aroclor 1232	SW8082A	--	--	--	--	--	--	--	4 U	4 U	3.9 U	3.9 U
Aroclor 1242	SW8082A	--	--	--	--	--	--	--	4 U	4 U	3.9 U	3.9 U
Aroclor 1248	SW8082A	--	--	--	--	--	--	--	4 U	4 U	3.9 U	3.9 U

Source: Table 3 of Sediment Characterization Data Report (Anchor, 2019)

Table 5
Chambers Creek Sample Results

								Task	2018_DMMP	2018_DMMP	2018_DMMP	2018_DMMP
								Location ID	DU1-A	DU2-B	DU3-A	DU4-B
								Sample ID	DU1-A-180910	DU2-B-180910	DU3-A-180910	DU4-B-180910
								Sample Date	9/11/2018	9/11/2018	9/10/2018	9/10/2018
								Sample Type	N	N	N	N
								Matrix	SE	SE	SE	SE
	Method	DMMP SL	DMMP BT	DMMP ML	SMS Marine SQSSCUM II	SMS Marine CSL SCUM II	AET Marine SQS SCUMII	AET Marine CSL SCUMII				
Aroclor 1254	SW8082A	--	--	--	--	--	--	--	**19.9**	**17**	**8.3**	**26.6**
Aroclor 1260	SW8082A	--	--	--	--	--	--	--	**18.6**	**13**	**7.4 J**	**28 J**
Aroclor 1262	SW8082A	--	--	--	--	--	--	--	4 U	4 U	3.9 U	3.9 U
Aroclor 1268	SW8082A	--	--	--	--	--	--	--	4 U	4 U	3.9 U	3.9 U
Total DMMP PCB Aroclors (U = 0)		130	--	3100	--	--	130	1000	**38.5**	**30**	**15.7 J**	**54.6 J**
PCB Aroclors (mg/kg-OC)												
Total DMMP PCB Aroclors (U = 0)		--	38	--	12	65	--	--	**0.5914**	**0.6383**	**0.198 J**	**0.8694 J**

Notes:

Detected concentration is greater than DMMP SL
Detected concentration is greater than DMMP BT
Detected concentration is greater than DMMP ML
Detected concentration is greater than SMS Marine SQS SCUMII screening level
Detected concentration is greater than SMS Marine CSL SCUMII screening level
Detected concentration is greater than AET Marine SQS SCUMII screening level
Detected concentration is greater than AET Marine CSL SCUMII screening level

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

Bold = Detected result

J = Estimated value

U = Compound analyzed, but not detected above detection limit

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

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 DDT consists of the sum of 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT.

Chlordane includes cis-chlordane, trans-chlordane, cis-nonaclor, trans-nonaclor, and oxychlordane.

µg/kg: micrograms per kilogram

AET: Apparent Effects Threshold

BT: Bioaccumulation Trigger

CSL: Cleanup screening level

DMMP: Dredged Material Management Program

HPAH: high-density polycyclic aromatic hydrocarbons

LPAH: low-density polycyclic aromatic hydrocarbons

mg/kg: milligrams per kilogram

ML: Maximum Level

N: normal environmental sample

OC: organic carbon normalized

PCB: polychlorinated biphenyl

pct: percent

SCO: sediment cleanup objective

SCUM II: Sediment Cleanup Users Manual II

SE: sediment

SL: Screening Level

SMS: Sediment Management Standards

SQS: sediment quality standards

Source: Table 3 of Sediment Characterization Data Report (Anchor, 2019)

Table 6. Test Results for *Neanthes arenaceodentata*

Treatment	Rep	Number Initiated	Survivors	Mean Mortality (%)	Individual Growth (mg/ind/day)					
					Dry Weight	Mean	Std Dev	AFDW	Mean	Std Dev
Control	1	5	5	0	0.709	0.705	0.058	0.453	0.494	0.033
	2	5	5		0.648			0.508		
	3	5	5		0.757			0.526		
	4	5	5		0.767			0.519		
	5	5	5		0.645			0.465		
Sequim Bay Reference	1	5	5	0	0.847	0.780	0.063	0.609	0.610	0.032
	2	5	5		0.765			0.630		
	3	5	5		0.689			0.556		
	4	5	5		0.766			0.617		
	5	5	5		0.832			0.635		
DU4 (acclimated)	1	5	5	4	0.734	0.705	0.063	0.618	0.581	0.060
	2	5	5		0.653			0.519		
	3	5	4		0.802			0.665		
	4	5	5		0.678			0.562		
	5	5	5		0.659			0.537		

Source: Table 3-1 from EcoAnalysts (2019)

Table 7. Test Results for *Mytilus galloprovincialis*

Treatment	Rep	Number Normal	Number Abnormal	Mean # Normal (N)	Std. Dev.	Control Normal Survival N_C/I	Reference Normal Survival Relative to Control N_R/N_C	Performance Standard
Control	1	266	2	250.6	35.0	0.819		≥0.70; Meets Criterion
	2	220	1					
	3	250	0					
	4	301	2					
	5	216	1					
Sequim Bay Reference	1	310	1	398.6	92.2		1.59	≥0.65; Meets Criterion
	2	389	2					
	3	316	1					
	4	527	5					
	5	451	2					
DU4 (acclimated)	1	199	134	193.0	28.3	See Section 4.2 for Larval Test Suitability Determination		
	2	226	152					
	3	178	137					
	4	209	132					
	5	153	146					
DU4 (unacclimated)	1	11	62	12.2	9.5			
	2	15	37					
	3	3	46					
	4	5	20					
	5	27	35					

I = Mean Initial count (Stocking density); 306

N_C = Mean Control Normal

N_R = Mean Reference Normal

Source: Table 3-6 from EcoAnalysts (2019)

Table 8. SMS Comparison for *Neanthes arenaceodentata*

Treatment	MIG (mg/ind/day)	Statistically Less than Reference? (p=0.05)	MIG Relative to Reference MIG_T/MIG_R	Fails SCO?[1] < 0.70	Fails CSL?[2] < 0.50
AFDW					
Control	0.494				
Sequim Bay Reference	0.610				
DU4 (acclimated)	0.581	No	0.95	No	No

[1]SCO: Statistical Significance and MIG_T/MIG_R <0.70
[2]CSL: Statistical Significance and MIG_T/MIG_R <0.50
MIG_T = Treatment Mean Individual Growth
MIG_R = Reference Mean Individual Growth

Table 9. SMS Comparison for *Mytilus galloprovincialis*

Treatment	Mean Normal Survival (%)[1]	Mean Number Normal	Statistically Less than Reference? (p=0.10)	Normal Survival to Reference N_T/N_R	Fails SCO?[2] <0.85	Fails CSL?[3] <0.70
Control	81.9	250.6				
Sequim Bay Reference	100.0	398.6				
DU4 (acclimated)	77.0	193.0	Yes	0.48	Yes	Yes
DU4 (unacclimated)	4.9	12.2	Yes	0.03	Yes	Yes

[1] Control data is normalized to the stocking density; reference and project treatments are normalized to the control
[2] SCO: Statistical Significance and (N_T/N_R) <0.85
[3] CSL: Statistical Significance and (N_T/N_R) <0.70
N_T =Treatment Mean Number Normal
N_R =Reference Mean Number Normal

Table 10. Summary of SMS Evaluation

Treatment	Sediment Cleanup Objectives		Cleanup Screening Levels	
	Polychaete	Larval	Polychaete	Larval
DU4 (acclimated)	Pass	Fail	Pass	Fail
DU4 (unacclimated)		Fail		Fail

*Shaded cells represent tests not conducted as part of the test design

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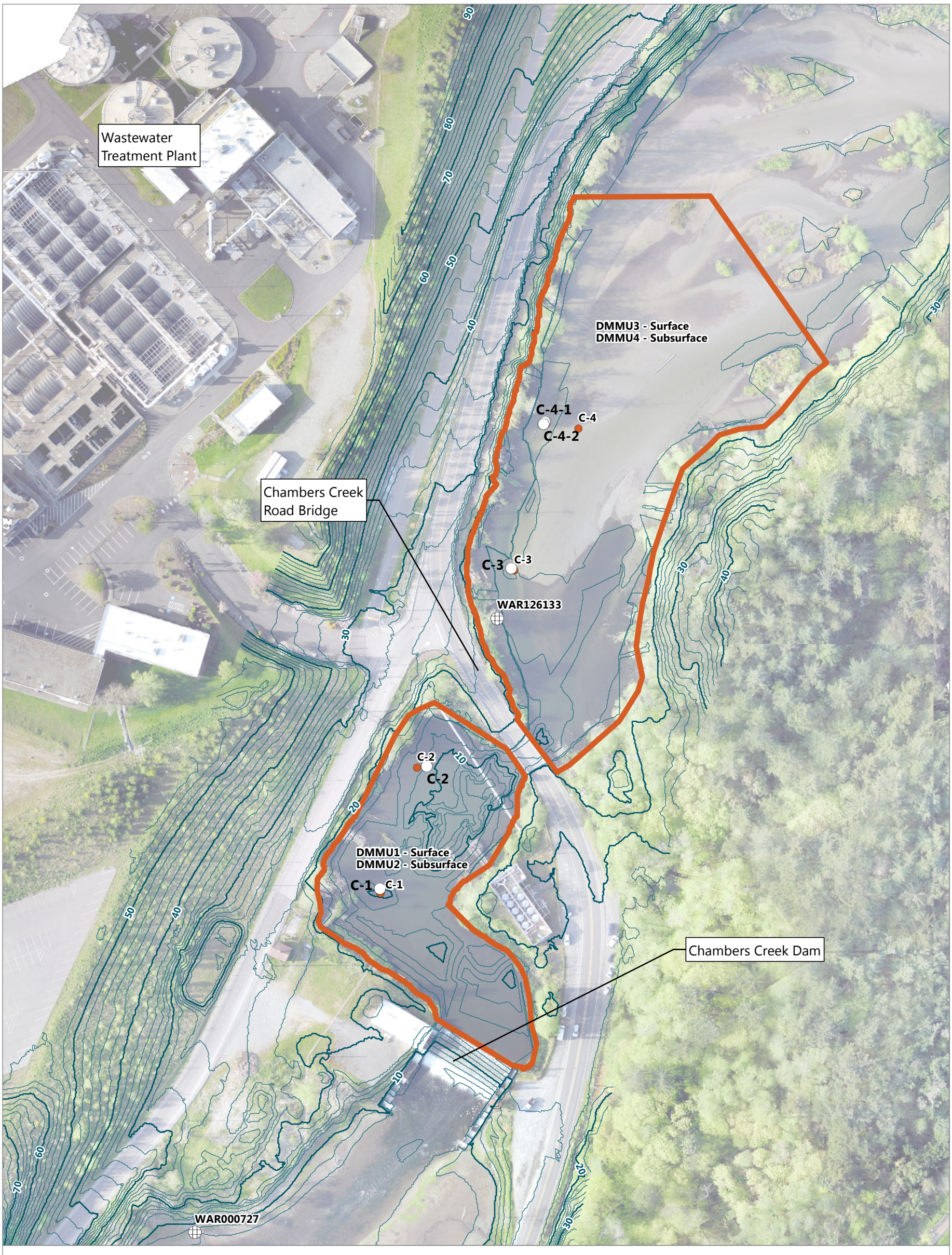
Figure 1
Site Vicinity
Sediment Characterization Data Report
Chambers Creek Dam Removal and Estuary Restoration



LEGEND:

- Actual Sample Location
- Proposed Sample Location
- Outfall
- DMMUs
- 2-Foot Contours (MLLW)

0 100
Feet

Publish Date: 2018/09/12, 6:36 PM | User: ckiblinger
Filepath: \\orcas\gis\Jobs\100379-01_WDFW_Strategic_Restoration\Maps\Chambers_Bay\SedCharRept_201809\AQ_Proposed_Actual_Sampling_and_ImpoundedSed_SedChrRept.mxd

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Figure 2
Sampling Locations
Sediment Characterization Data Report
Chambers Creek Dam Removal and Estuary Restoration