CENWS-ODS-ND

MEMORANDUM FOR RECORD February 8, 2018

SUBJECT: DETERMINATION REGARDING THE SUITABILITY OF DREDGED MATERIAL FROM THE SNOHOMISH RIVER, SNOHOMISH COUNTY, EVERETT, WA, EVALUATED UNDER SECTION 404 OF THE CLEAN WATER ACT, FOR UNCONFINED OPEN-WATER DISPOSAL AT THE PORT GARDNER NONDISPERSIVE SITE.

1. Introduction. This memorandum reflects the consensus determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers (USACE), Washington Departments of Ecology and Natural Resources, and the Environmental Protection Agency) regarding the suitability of 778,221 cubic yards (cy) of dredged material from the Snohomish River federal navigation channel and settling basins for disposal at the Port Gardner nondispersive open-water disposal site.

2. Background. The Everett Harbor and Snohomish River Project ("project") consists of deep and shallow-draft navigation channels and two settling basins to serve navigation in Everett Harbor and the Snohomish River. The authorized design depth varies from -8 feet (ft) Mean Lower Low Water (MLLW) in the shallow draft channel up to -40 ft MLLW in the upstream settling basin. Table 2 summarizes the project feature dimensions. The USACE Seattle District is responsible for dredging portions of the authorized project as needed to maintain navigation.

   Sedimentation in the navigation channel is due to input from the Snohomish River watershed. Sediment in the waterway has been characterized previously by the USACE under the Puget Sound Dredged Disposal Analysis (PSDDA) program or DMMP six times, including four full characterizations and a dedicated characterization for dioxins. Table 3 provides a summary of the previous characterization and survey results. A complete description can be found in Attachment A – Description of Previous Sediment Characterizations.

   A bathymetric survey of the waterway conducted by the USACE in June 2016 showed that significant sedimentation had occurred. The USACE contracted with Herrera Environmental and subcontractor NewFields to characterize the waterway to authorized depths plus 2 ft of overdepth for all areas except the upper settling basin. Characterization of the upper settling basin, which is rarely, if ever, dredged to its full authorized depth of -40 ft MLLW, was restricted to -22 ft MLLW (-20 ft plus 2 ft of overdepth).

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

Table 1. Project Summary and Tracking Information

Project ranking	Low-moderate[1]
Characterized volume (CY)	778,221
Characterized depth (plus 2 ft overdepth)	Varies; see Table 2
Draft SAP received	August 11, 2017
Draft SAP returned for revisions	August 25, 2017
2nd draft SAP received	August 28, 2017
Final SAP received	September 6, 2017
Sampling dates	September 13, 2017
Draft data report received	December 15, 2017
Comments provided on draft report	January 26, 2018
Final data report received	February 6, 2018
DMMO tracking number	EVEOM-1A-F-386
EIM Study ID	EVEOM17
Recency Determination (6 years for low-moderate)	September 2023

Notes: 1 – Although the Snohomish is technically ranked low-moderate, the DMMP agencies agreed to a special one-time "confirmatory" ranking status for this project to define the number of DMMUs and sampling density for this sediment characterization.

4. Project Ranking and Sampling Requirements. Sediments in the Snohomish River navigation channel are ranked low-moderate following the 1992 partial characterization and down-ranking. For the 2011 characterization, the DMMP agreed to a temporary ranking of "Very Low, Low and Confirmatory" based on data collected since the 1992 characterization. Results from the 2011 characterization enabled the DMMP to assign a special one-time "confirmatory" ranking for the entire navigation channel for the purposes of the 2017 sediment characterization. The confirmatory sampling volume requirements were thus uniquely defined for the 2017 sediment characterization as follows:

Maximum volume per DMMU = 100,000 CY
Maximum volume per grab sample = 20,000 CY

Based on past sampling findings, material in the navigation channel is considered homogeneous in nature. Thus, no distinction between surface and subsurface material was required, and grab samples were approved by the DMMP agencies as a representative sampling technique.

Using bathymetric survey data from March-April 2017and the characterization depths specified in Table 2, ten (10) Dredged Material Management Units (DMMUs) were defined to characterize 778,221 CY of proposed dredged material (Table 4).

In addition, a tiered approach to sampling was approved for the composite representing the most upstream DMMU (DMMU 10). Full chemical analysis would not be required if the grain size was <20% fines and total organic carbon (TOC) was <0.5%.

5. Sampling and Analysis. Sampling occurred on September 13, 2017 in accordance with the approved Sampling and Analysis Plan at the locations shown in Figures 2 through 4. All samples were collected using a stainless steel 0.2 m^2 power grab sampler attached to a winch and cable and deployed from the sampling vessel. A total of 41 sediment surface grab locations were collected and composited into 10 DMMUs (Tables 4 and 5).

   Wet sieving for grain size was conducted in the field for DMMU 10 (sample D10-C from the shallow draft channel upstream of the upper settling basin) to determine if additional chemistry analyses would be necessary. The field wet sieve results for composite DMMU 10 indicated 13 percent fines. This was under the threshold for 20 percent fines, and additional chemistry was not conducted on this sample beyond grain size and Total Organic Carbon (TOC). Conventional results later confirmed that full analysis of DMMU 10 was not required.

   The DMMU composites were submitted to ALS, located in Kelso, Washington for conventionals and chemical analyses. The Kelso laboratory performed all method analyses except for polybrominated diphenyl ether (PBDE) congeners, which were conducted by the ALS laboratory in Houston, Texas.

6. Results. The conventionals and chemistry results for the 10 DMMU composites are presented alongside the DMMP marine guidelines and Sediment Management Standards (SMS) benthic criteria in Tables 6 and 7, respectively.

   Grain Size and Sediment Conventionals. Percent fines varied from a high of 43.3% in the deep draft channel (DMMU 1) and decreased rapidly in the downstream settling basin (8.7 to 40.4% fines). The shallow draft channel and upstream settling basin contained less than 3.7% fines. TOC and sulfides followed a similar pattern, with decreasing percent/concentration upstream. DMMUs 5 through 10 had TOC concentrations less than 0.5%; thus, comparisons to OC-normalized benthic Sediment Management Standards were not performed for these sample results.

   Standard Chemicals of Concern. No chemistry results (detects and non-detects) exceeded the DMMP Screening Level (SL), Bioaccumulation Trigger (BT), or Maximum Level (ML) for the chemicals of concern (COCs). In general, concentrations were low for all chemicals of concern (COC) and correlated to percent fines and percent TOC. The downstream COC concentrations were slightly higher than those in the shallow draft channel and upstream settling basin. PCBs were non-detect in all DMMU composites.

   Dioxins/furans. Dioxin analyses were not required for this project due to existing data. Snohomish River sediments were most recently tested for dioxins in 2009; the maximum concentration measured at that time was 1.06 pptr TEQ (ND = ½ RL), which is well below the dispersive dioxin criteria of 4 pptr TEQ (DMMP, 2009).

TBT. Tributyltin (TBT) analyses were not required for this project based on results from previous monitoring.

PBDEs. Analyses for polybrominated diphenyl ethers (PBDEs) were performed on 3 of the 10 DMMU composites to fulfill the Essential Fish Habitat conservation recommendations that accompanied the National Marine Fisheries Service's biological opinion on the effects of dredged material disposal on listed rockfish species (DMMO, 2016). The three DMMU composites analyzed for PBDEs (DMMUs 1, 3, and 8) were selected to provide spatial coverage over the project area. Results from these analyses are included in Table 8. PBDE-209 was the most frequently detected congener with the highest concentration (2,660 ng/kg in D03-C). No sediment guidelines (DMMP, state, or federal) exist for PBDE congeners.

Comparison to SMS Benthic Criteria. Ecology does not recommend carbon-normalization when TOC is below 0.5 percent; therefore, only OC-normalized chemistry results from DMMUs 1 through 4 (TOC > 0.5%) were compared to Ecology's benthic criteria (Table 7). No detects or non-detects exceeded Ecology's benthic criteria.

Data Validation. All chemistry data were validated to a minimum of EPA Stage 2b; in addition, PBDE data underwent 10% Stage 4 data validation. Only minor issues were encountered during the data validation, and all data were considered usable by the data validator for the study purpose.

7. Biological Testing. Biological testing was not required; concentrations of all detected and non-detected chemicals of concern were below the DMMP screening level criteria.

8. Sediment Exposed by Dredging. Sediment exposed by dredging must either meet the State of Washington Sediment Quality Standards (SQS) (Ecology, 2013) or the State's anti-degradation standard (DMMP, 2008). Concentrations of all DMMP chemicals of concern were below the DMMP SLs; therefore, this project is in compliance with the State of Washington anti-degradation standard.

9. Debris Management. The DMMP agencies implemented a debris management requirement following the 2015 SMARM in order to prevent the disposal of debris (wood or otherwise) greater than 12 inches in any dimension at open-water disposal sites in Puget Sound (DMMP, 2015). The Snohomish River federal navigation channel is dredged almost annually to maintain navigation; little to no reported debris has been encountered during recent dredging events. However, as in past characterizations, some small woody and leafy debris was observed in the lower settling basin and deep draft channel grab samples during this characterization. The DMMP agencies concur that the dredge project area is of low concern for debris, and a 12" X 12" screening grid or grizzly is not required for this project. However, if any debris larger than 12 inches in any dimension is encountered, or man-made debris of any size, it must be segregated and disposed of in an upland landfill or other appropriate use. At no time may any debris greater than 12 inches in any dimension or man-made debris of any size, be disposed at an open-water disposal site.

10. Suitability Determination. This memorandum documents the evaluation of the suitability of sediment from the federal navigation project in the Snohomish River for unconfined open-water disposal. The data gathered were determined to be sufficient and acceptable for regulatory decision-making under the DMMP program.

    In summary, based on the results of the testing, the DMMP agencies have concluded that all 778,221 CY of dredged material are suitable for unconfined open-water disposal at the Port Gardner non-dispersive site.

    The USACE Navigation dredging program also places dredged material suitable for open-water disposal at the Site O upland rehandling site and Jetty Island beneficial use site; USACE Navigation maintains the appropriate environmental documentation to cover this activity.

11. References.

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.

DMMP, 2009. *Memorandum for Record. Supplemental Determination Regarding the Suitability, with Respect to Dioxin, of Federal Operation and Maintenance Dredged Material from the Snohomish River, Everett, Snohomish County, Washington (Public Notice CENWS-OD-TS-NS-30) Evaluated under Section 404 of the Clean Water Act for Beneficial Use or Unconfined Open-Water Disposal at the Port Gardner Nondispersive Site*. Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, October 3, 2009.

DMMP, 2012. *Memorandum for Record. DMMP Suitability Determination for Proposed Maintenance Dredged Material from the Snohomish River, Everett (CENWS-OD-TS-NS-35, dated July 20, 2011) for Unconfined Open-Water Disposal at the Port Gardner Non-Dispersive Site or at an Approved Beneficial Use Upland Site.* Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, January 20. 2012.

DMMO, 2016. *Statutory Response to EFH Conservation Recommendations for the Continued Use of Multi-User Dredged Material Disposal Sites in Puget Sound and Grays Harbor (Fourth Field HUCs 17110020 Dungeness-Elwha, 17110002 Strait of Georgia, 1711019 Puget Sound, and 17100105 Grays Harbor) Washington. NMFS Consultation Number: WCR-2015-2975.* Prepared by the Seattle District Dredged Material Management Office, January 2016.

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.

Ecology, 2013. *Sediment Management Standards – Chapter 173-204 WAC*. Washington

State Department of Ecology, Revised February 2013.

Herrera, 2017. *Snohomish River Federal Navigation Channel and Settling Basins Dredged Material Characterization, Everett, Washington – Sampling and Analysis Plan*. Prepared by Herrera and NewFields for the U.S. Army Corps of Engineers, Seattle District, September 5, 2017.

Herrera, 2018. *Snohomish River Federal Navigation Channel and Settling Basins Dredged Material Characterization, Everett, Washington – Data Report*. Prepared by Herrera and NewFields for the U.S. Army Corps of Engineers, Seattle District, February 2018.

PSDDA, 1994. *Memorandum for Record. Supplemental Determination on the Suitability of Additional Maintenance Dredged Material under PSDDA Guidelines for US Army Corps of Engineers Everett Snohomish River Channel Maintenance Dredging Project (Reference: CENPS-OP-NP-77 dated April 9 1993) for Disposed at the PSDDA Port Gardner Open-Water Nondispersive Site*. Prepared by the Seattle District Dredged Material Management Office for the Puget Sound Dredged Disposal Analysis Program, March 11, 1994.

PSDDA, 1996. *Memorandum for Record: Suitability Determination for Dredged Material from the Everett Downstream Settling Basin and River Channel for Disposal at the PSDDA Port Gardner Open-Water Nondispersive Site (Public Notice CENPS-OP-TS-NS-99).* Prepared by the Seattle District Dredged Material Management Office for the Puget Sound Dredged Disposal Analysis Program, November 14, 1996.

10. Agency Signatures.

signed copy on file in DMMO - Seattle District office

Concur:

_____ _____
Date Heather Whitney Fourie - Seattle District Corps of Engineers

_____ _____
Date Justine Barton - Environmental Protection Agency

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

_____ _____
Date Celia Barton - Washington Department of Natural Resources

Copies furnished:

DMMP signatories
John Hicks, CENWS-ODS-NS
Elizabeth Chien, CENWS-ODS-NS
John Pell, CENWS-ODS-NS

Table 2. Project Features, Characterization Depths, and Characterization Volumes from March/April 2017 Condition Survey

Feature	Stations	Authorized Depth (ft MLLW)	Characterization Depth (ft MLLW)	Characterization Depth + 2 ft Overdepth (ft MLLW)	Characterization Depth + 2 ft Allowable Overdepth Volume (cy)
Deep-draft channel	0+00 to 78+00	-15	-15	-17	79,322
Downstream Settling Basin	78+00 to 90+00	-20	-20	-22	246,645
Shallow-draft channel	90+00 to 335+50	-8	-8	-10	159,125
Upstream Settling basin	335+50 to 355+79	-40	-20	-22	261,924
Shallow-draft channel	355+79 to 381+79	-8	-8	-10	31,205
				Total:	778,221

Table 3. Summary of Past Sediment Characterizations of Snohomish River Federal Navigation Channel (NewFields, 2017)

Characterization Event	Dredge Material Volume	Results	Suitability Determination
1992 Partial Characterization	NA	No SLs exceeded	Supported a down-ranking from moderate to low-moderate
1993 Full Characterization	462,243 cy	Two SL exceedances for anthracene and one SL exceedance for 4-methylphenol in a total of 3 DMMUs; SL exceedances passed biological testing	All material suitable for open-water disposal
1996 Full Characterization	300,347 cy	Diethyl phthalate exceeded SL in one DMMU; no biological testing was conducted	All material suitable for open-water disposal
2003-2004 Full Characterization	271,210 cy	No SLs exceeded	All material suitable for open-water disposal
2009 Dioxin Evaluation	801,849 cy	Dioxin concentrations ranged from 0.16 to 1.06 ng/kg TEQ	Sediment characterization was for planning purposes only; no dredging was performed
2011 Full Characterization	651,571 cy	Benzyl alcohol exceeded SL in 3 DMMUs of the downstream turning basin	DMMP agencies determined material suitable for open-water disposal without requiring bioassays

CY = cubic yards
SL = Screening Level
NA = not applicable
DMMP = Dredged Material Management Program
DMMU = dredged material management unit
TEQ = toxic equivalents

Table 4. Approximate Dredged Material Volumes and Field Sample Counts by DMMU (NewFields, 2017)

Feature	DMMU	Design Depth + 2 ft Allowable Overdepth Volume (cy)	Number of Field Samples
Deep-draft channel	1	79,322	4
Downstream Settling Basin	2	79,836	4
Downstream Settling Basin	3	79,094	4
Downstream Settling Basin	4	87,716	5
Shallow-draft channel	5	79,439	4
Shallow-draft channel	6	79,686	4
Upstream Settling basin	7	76,565	4
Upstream Settling basin	8	97,173	5
Upstream Settling basin	9	88,186	5
Shallow-draft channel	10	31,205	2
	Total:	778,221	41

Table 5. Sampling Locations, DMMU Composites, water depths, and mudline elevations

DMMU	Location Name	Date	State Plane WA-N, NAD83		Latitude (N) NAD83	Longitude (W) NAD 83	Water Depth (ft.)	Recorded Tidal Height (ft. MLLW)	Corrected Tidal Height (ft. MLLW)	Mudline (ft. MLLW)
			Northing	Easting						
SN17-D01-C	D01-1	9/13/17	366017.1	1299460.9	47.994963	122.225955	-16.3	2.9	3.0	-13.3
	D01-2	9/13/17	366651.5	1299618.3	47.996709	122.225358	-16.5	3.2	3.3	-13.2
	D01-3	9/13/17	367554.9	1299539.4	47.999182	122.225748	-18.5	3.5	3.6	-14.9
	D01-4	9/13/17	367639.1	1299849.7	47.999428	122.224486	-16.4	3.8	3.9	-12.5
SN17-D02-C	D02-1	9/13/17	368024.0	1299292.1	48.000455	122.226792	-14.0	4.5	4.6	-9.4
	D02-2	9/13/17	367912.6	1299539.7	48.000162	122.225773	-18.7	4.7	4.8	-13.9
	D02-3	9/13/17	368145.0	1299850.4	48.000814	122.224521	-15.1	4.8	4.9	-10.2
	D02-4	9/13/17	367874.1	1299890.8	48.000074	122.224336	-17.3	5.1	5.2	-12.1
SN17-D03-C	D03-1	9/13/17	368277.1	1299343.9	48.001151	122.226599	-17.5	5.8	5.9	-11.6
	D03-2	9/13/17	368484.3	1299525.3	48.001728	122.225874	-23.2	6.1	6.2	-17.0
	D03-3	9/13/17	368490.6	1299895.0	48.001764	122.224364	-15.4	6.4	6.5	-8.9
	D03-4	9/13/17	368259.3	1299756.4	48.001123	122.224913	-23.6	6.7	6.8	-16.8
SN17-D04-C	D04-1	9/13/17	368937.8	1299923.3	48.002991	122.224282	-14.4	7.2	7.3	-7.1
	D04-2	9/13/17	368656.7	1299867.4	48.002218	122.224489	-16.3	7.3	7.4	-8.9
	D04-3	9/13/17	368843.0	1299724.5	48.002721	122.225087	-22.5	7.6	7.7	-14.8
	D04-4	9/13/17	368956.0	1299365.1	48.003013	122.226563	-21.1	7.8	7.9	-13.2
	D04-5	9/13/17	368729.9	1299523.0	48.002401	122.225902	-24.2	8.1	8.2	-16.0
SN17-D05-C	D05-1	9/13/17	369906.1	1299743.5	48.005636	122.225088	-14.7	8.3	8.4	-6.3
	D05-2	9/13/17	370882.3	1299846.0	48.008317	122.224741	-14.7	8.5	8.6	-6.1
	D05-3	9/13/17	372300.5	1300003.8	48.012212	122.224201	-16.5	8.6	8.7	-7.8
	D05-4	9/13/17	373034.4	1300366.1	48.014242	122.222776	-17.4	9.0	9.1	-8.3
SN17-D06-C	D06-1	9/13/17	374795.2	1306774.8	48.019382	122.196723	-16.6	9.1	9.2	-7.4
	D06-2	9/13/17	371439.3	1310953.4	48.010385	122.179411	-16.8	9.2	9.3	-7.5
	D06-3	9/13/17	368896.3	1311430.7	48.003438	122.177280	-16.8	9.3	9.4	-7.4
	D06-4	9/13/17	364753.0	1310942.6	47.992058	122.178978	-16.9	9.4	9.5	-7.4
SN17-D07-C	D07-1	9/13/17	364490.2	1311102.6	47.991345	122.178305	-16.7	9.4	9.5	-7.2
	D07-2	9/13/17	364327.9	1311144.9	47.990902	122.178121	-16.6	9.4	9.5	-7.1
	D07-3	9/13/17	364294.8	1311324.5	47.990820	122.177385	-18.3	9.4	9.5	-8.8
	D07-4	9/13/17	364102.9	1311418.2	47.990298	122.176989	-15.1	9.5	9.6	-5.5
SN17-D08-C	D08-1	9/13/17	364112.9	1311547.7	47.990332	122.176461	-16.4	9.4	9.5	-6.9
	D08-2	9/13/17	363959.4	1311596.9	47.989914	122.176249	-14.6	9.3	9.4	-5.2
	D08-3	9/13/17	363947.9	1311769.3	47.989891	122.175544	-15.4	9.3	9.4	-6.0
	D08-4	9/13/17	363788.8	1311817.9	47.989457	122.175335	-14.6	9.2	9.3	-5.3
	D08-5	9/13/17	363772.7	1311975.7	47.989420	122.174689	-14.8	9.2	9.3	-5.5
SN17-D09-C	D09-1	9/13/17	363614.3	1312042.4	47.988989	122.174405	-14.8	9.0	9.1	-5.7
	D09-2	9/13/17	363609.3	1312183.0	47.988982	122.173831	-14.7	8.9	9.0	-5.7
	D09-3	9/13/17	363458.8	1312237.9	47.988572	122.173596	-14.9	8.4	8.5	-6.4
	D09-4	9/13/17	363451.1	1312399.2	47.988559	122.172937	-15.8	8.8	8.9	-6.9
	D09-5	9/13/17	363275.8	1312463.2	47.988082	122.172663	-14.8	8.7	8.8	-6.0
SN17-D10-C	D10-1	9/13/17	361797.8	1313354.4	47.984073	122.168919	-14.1	8.5	8.6	-5.5
	D10-2	9/13/17	361547.5	1313453.9	47.983391	122.168495	-16.3	8.4	8.5	-7.8

Table 6. Snohomish River Navigation Channel Chemistry and Conventionals Results

	SL	ML	BT	SN17-D01-C			SN17-D02-C			SN17-D03-C			SN17-D04-C			SN17-D05-C			SN17-D06-C			SN17-D07-C			SN17-D08-C			SN17-D09-C			SN17-D10-C		
				9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ
Conventionals																																	
Total Solids (%)	--	--	--	57.2			60.3			69.6			73.5			74.3			85.4			87.2			89.7			91.7			89.5		
Total Organic Carbon (%)	--	--	--	1.41			1.55			1.54			0.957			0.168			0.15			0.097			0.107			0.094			0.109		
Sulfides (mg/kg)	--	--	--	286			132			85			71			0.67	U		0.59	U		0.57	U		0.56	U		0.55	U		--		
Ammonia (mg/kg)	--	--	--	8.2		J	10.9			10.3			5.13			1.07			0.12	J		0.55	U		0.55	U		0.53	U		--		
Total Volatile Solids (%)	--	--	--	4.8			4.6			3.8			3.2			1.4			1.3			1.3			1.3			1.3			--		
Grain Size (%)																																	
Gravel (>2,000 µm)	--	--	--	0.51			0.16			0.22			1.25			1.36			0.24		J	0		J	0.92			0.46			4.52		
Very Coarse Sand	--	--	--	0.54			0.41			0.34			1.07			5.44			2.31		J	0.68		J	7.04			6.03			8.35		
Coarse Sand	--	--	--	0.65			0.67			1.18			8.8			39.34			14.26		J	29.03		J	40.32			46.68			31.04		
Medium Sand	--	--	--	2.44			4.32			22.76			22.36			53.21			32.09		J	60.89		J	43.02			40.97			47.78		
Fine Sand	--	--	--	28.24			24.88			30.36			40.27			8.03			34.72		J	5.76		J	4.5			3.12			5.18		
Very Fine Sand	--	--	--	27.5			26.99			25.92			15.45			0.29			3.57		J	0.08		J	0.1			0.06			0.21		
Sand (62.5 to 2,000 µm)	--	--	--	59.37			57.27			80.56			87.95			106.31			86.95			96.44			94.98			96.86			92.56		
Silt (3.9 to 62.5 µm)	--	--	--	36.01			32.74			13.23			6			2			0.62		J	0.01		J	0.09			0.05			0.33		
Clay (0 to 3.9 µm)	--	--	--	7.27			7.7			4.25			2.71			1.65			0.82		J	0.56		J	0.4			0.31			0.19		
Percent Fines[a]	--	--	--	43.28			40.44			17.48			8.71			3.65			1.44		J	0.57		J	0.49			0.36			0.52		
Metals (mg/kg)																																	
Antimony	150	200	--	3.3	J		4.1	U		3.9	U		3.4	U		3.8	U		3.5	U		3.8	U		3.6	U	UJ	3.7	U		--		
Arsenic	57	700	507.1	11.3			10.2			9.8			7.4			6			5.7			5.5			4.9			5.8			--		
Cadmium	5.1	14	--	0.28	U		0.21	U		0.19	U		0.17	U		0.19	U		0.18	U		0.19	U		0.18	U		0.19	U		--		
Chromium	260	--	--	41.1			38.1			31.8			29			23.6			23.1			21.6			18.5			19.9			--		
Copper	390	1300	--	38.5			36.6			27.5			21.9			17.1			16.9			18.4			29.5		J	18.8			--		
Lead	450	1200	975	7.6			6.4			5.8			5.1			4			3.6			3.5			3.5			3.5			--		
Mercury	0.41	2.3	1.5	0.047			0.049			0.034			0.022			0.019	J		0.014	J		0.014	J		0.017	J		0.013	J		--		
Selenium	--	--	3	0.17			0.14			0.118			0.054	J		0.086	U		0.031	J		0.095	U		0.088	U		0.09	U		--		
Silver	6.1	8.4	--	1.1	U		0.82	U		0.77	U		0.69	U		0.76	U		0.71	U		0.76	U		0.71	U		0.74	U		--		
Zinc	410	3800	--	62.2			58.4			50.9			45			40.6			40.4			40.7			37.6			40.5			--		
PAHs (ug/kg)																																	
Naphthalene	2100	2400	--	9.6			10			13			11			6.8	U		6	U		4.1	J		4.4	J		3.7	J		--		
Acenaphthylene	560	1300	--	8.7	U		8.3	U		7.2	U		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
Acenaphthene	500	2000	--	3.6	J		3.9	J		3.8	J		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
Fluorene	540	3600	--	5.7	J		8.3	U		4.6	J		3.3	J		6.8	U		6	U		6	U		6	U		6	U		--		
Phenanthrene	1500	21000	--	20			9.7			15			14			6.8	U		6	U		6	U		6	U		6	U		--		
Anthracene	960	13000	--	21			8.3	U		3.3	J		8.9			6.8	U		6	U		6	U		6	U		6	U		--		
2-Methylnaphthalene	670	1900	--	3.9	J		3.1	J		4.3	J		3.2	J		6.8	U		6	U		6	U		6	U		6	U		--		
Total LPAHs[b]	5200	29000	--	59.9			23.6			39.7			37.2			6.8	U		6	U		4.1	J		4.4	J		3.7	J		--		
Fluoranthene	1700	30000	4600	18			16			23			20			6.8	U		6	U		6	U		6	U		6	U		--		
Pyrene	2600	16000	11980	15			13			25			17			6.8	U		6	U		6	U		6	U		6	U		--		
Benzo(a)anthracene	1300	5100	--	7.8	J		5.3	J		11			4.7	J		6.8	U		6	U		6	U		6	U		6	U		--		
Chrysene	1400	21000	--	16			5.6	J		9.7			7.6			6.8	U		6	U		6	U		6	U		6	U		--		
Benzofluoranthenes	3200	9900	--	10			6.9			12			7			6.8	U		6	U		6	U		6	U		6	U		--		
Benzo(a)pyrene	1600	3600	--	5.2	J		4.4	J		7.4			4	J		6.8	U		6	U		6	U		6	U		6	U		--		
Indeno(1,2,3-cd)pyrene	600	4400	--	3.2	J		8.3	U		3.4	J		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
Dibenzo(a,h)anthracene	230	1900	--	8.7	U		8.3	U		7.2	U		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
Benzo(g,h,i)perylene	670	3200	--	8.7	U		8.3	U		7.2	U		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
Total HPAHs[c]	12000	69000	--	75.2			51.2			91.5			60.3			6.8	U		6	U		4.1	J		4.4	J		3.7	J		--		
Phenols (ug/kg)																																	
2,4-Dimethylphenol[g]	29	210	--	6.3	U		6.3	U		6.3	U		6.3	U		6.3	U		6.3	U		6.3	U		6.3	U		6.3	U		--		
2-Methylphenol	63	77	--	8.7	U		8.3	U		7.2	U		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
4-Methylphenol	670	3600	--	26			10			11			7			6.8	U		6	U		6	U		6	U		6	U		--		
Pentachlorophenol	400	690	504	87	U		83	U		72	U		68	U		68	U		36	U		58	U		56	U		55	U		--		
Phenol	420	1200	--	3.6	J		3.9	J		4.5	J		21	U		21	U		11	U		18	U		17	U		17	U		--		
Phthalates (ug/kg)																																	
Butyl benzyl phthalate	63	970	--	41			11			18			15			6.8	U		16			6	U		6	U		6	U		--		

	SL	ML	BT	SN17-D01-C			SN17-D02-C			SN17-D03-C			SN17-D04-C			SN17-D05-C			SN17-D06-C			SN17-D07-C			SN17-D08-C			SN17-D09-C			SN17-D10-C		
				9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ	9/13/2017	LQ	VQ
Dibutyl phthalate	1400	5100	--	18	U		17	U		15	U		14	U		14	U		7.2	U		12	U		12	U		11	U		--		
Di-n-Octyl phthalate	6200	6200	--	9.4			7.4	J		7.2	U		8.4			7.9			6	U		4.8	J		4.7	J		7.6			--		
Diethyl phthalate	200	1200	--	8.7	U		8.3	U		7.2	U		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
Dimethyl phthalate	71	1400	--	8.7	U		8.3	U		7.2	U		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
Bis(2-Ethylhexyl) Phthalate	1300	8300	--	16	J		13	J		11	J		11	J		68	U		36	U		9.8	J		9.2	J		55	U		--		
Other SVOCs (ug/kg)																																	
Dibenzofuran	540	1700	--	3.9	J		8.3	U		3.7	J		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
Benzoic Acid	650	760	--	350	U	UJ	330	U	UJ	290	U	UJ	270	U	UJ	270	U	UJ	200	U	UJ	230	U	UJ	230	U	UJ	220	U	UJ	--		
Benzyl Alcohol	57	870	--	15	J		6.4	J		6	J		5.8	J		14	U		7.2	U		12	U		12	U		11	U		--		
1,2-Dichlorobenzene	35	110	--	8.7	U		8.3	U		7.2	U		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
1,4-Dichlorobenzene	110	120	--	8.7	U		8.3	U		7.2	U		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
Hexachlorobenzene	22	230	168	8.7	U		8.3	U		7.2	U		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
Hexachlorobutadiene	11	270	--	8.7	U		8.3	U		7.2	U		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
N-Nitrosodiphenylamine	28	130	--	8.7	U		8.3	U		7.2	U		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
1,2,4-Trichlorobenzene	31	64	--	8.7	U		8.3	U		7.2	U		6.8	U		6.8	U		6	U		6	U		6	U		6	U		--		
PCB Aroclors (ug/kg)																																	
Aroclor 1016	--	--	--	16	U		14	U		13	U		14	U		12	U		12	U		11	U		11	U		10	U		--		
Aroclor 1221	--	--	--	31	U		27	U		25	U		27	U		23	U		23	U		22	U		21	U		19	U		--		
Aroclor 1232	--	--	--	16	U		14	U		13	U		14	U		12	U		12	U		11	U		11	U		10	U		--		
Aroclor 1242	--	--	--	16	U		14	U		13	U		14	U		12	U		12	U		11	U		11	U		10	U		--		
Aroclor 1248	--	--	--	16	U		14	U		13	U		14	U		12	U		12	U		11	U		11	U		10	U		--		
Aroclor 1254	--	--	--	16	U		14	U		13	U		14	U		12	U		12	U		11	U		11	U		10	U		--		
Aroclor 1260	--	--	--	16	U		14	U		13	U		14	U		12	U		12	U		11	U		11	U		10	U		--		
Total PCBs[d]	130	3100	--	31	U		27	U		25	U		27	U		23	U		23	U		22	U		21	U		19	U		--		
Total PCBs[d] (mg/kg carbon)			38	2.2	U		1.74	U		1.62	U		2.82	U		13.7	U		15.3	U		22.7	U		19.6	U		20.2	U		--		
Pesticides (ug/kg)																																	
Heptachlor[g]	1.5	270	--	0.6	U		0.53	U		0.48	U		0.51	U		0.44	U		0.44	U		0.43	U		0.4	U		0.39	U		--		
Aldrin	9.5	--	--	1.6	U		1.4	U		1.3	U		1.4	U		1.2	U		1.2	U		1.1	U		1.1	U		1	U		--		
Dieldrin	1.9	1700	--	1.6	U		1.4	U		1.3	U		1.4	U		1.2	U		1.2	U		1.1	U		1.1	U		1	U		--		
4,4'-DDE	9	--	--	1.6	U		1.4	U		1.3	U		1.4	U		1.2	U		1.2	U		1.1	U		1.1	U		1	U		--		
4,4'-DDD	16	--	--	1.6	U		1.4	U		1.3	U		1.4	U		1.2	U		1.2	U		1.1	U		1.1	U		1	U		--		
4,4'-DDT	12	--	--	1.6	U		1.4	U		1.3	U		1.4	U		1.2	U		1.2	U		1.1	U		1.1	U		1	U		--		
Total DDTs[e]	--	69	50	1.6	U		1.4	U		1.3	U		1.4	U		1.2	U		1.2	U		1.1	U		1.1	U		1	U		--		
Oxychlordane	--	--	--	1.7	U		0.39	J		1.4	Ui	U	1.2	U		1.1	U		1.2	U		1.2	U		1	U		1	U		--		
cis-Nonachlor	--	--	--	1.7	U		1.3	U		1.4	U		1.2	U		1.1	U		1.2	U		1.2	U		1	U		1	U		--		
trans-Nonachlor	--	--	--	1.7	U		1.3	U		1.4	U		1.2	U		1.1	U		1.2	U		1.2	U		1	U		1	U		--		
gamma-Chlordane	--	--	--	1.6	U		1.4	U		1.3	U		1.4	U		1.2	U		1.2	U		1.1	U		1.1	U		1	U		--		
cis-Chlordane	--	--	--	1.6	U		1.4	U		1.3	U		1.4	U		1.2	U		1.2	U		1.1	U		1.1	U		1	U		--		
Total chlordane[f]	2.8	--	37	1.6	U		1.4	U		1.3	U		1.4	U		1.2	U		1.2	U		1.1	U		1.1	U		1	U		--		

Notes: LQ: laboratory qualifier VQ: validation qualifier SL: screening level ML: maximum level BT: bioaccumulation trigger
U the analyte was analyzed for, but not detected
i the LOQ is elevated due to chromatographic interference
J the result is estimated
--not targeted for analysis
a. sum of silt and clay fractions
b. sum of detected values of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene
c. sum of detected values of fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(ghi)perylene
d. sum of detected PCB Aroclors
e. sum of 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT
f. sum of gamma-chlordane, cis-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane
g. non-detect results reported at the method detection limit

Table 7. Snohomish River Carbon-Normalized Chemistry Results Compared to SQS

	SQS	CSL	SN17-D01-C 9/13/2017	LQ	VQ	SN17-D02-C 9/13/2017	LQ	VQ	SN17-D03-C 9/13/2017	LQ	VQ	SN17-D04-C 9/13/2017	LQ	VQ
Conventionals														
Total Organic Carbon (%)	--	--	1.41			1.55			1.54			0.957		
PAHs (ug/kg)														
Naphthalene	99	170	0.681			0.645			0.844			1.15		
Acenaphthylene	66	66	0.617	U		0.535	U		0.468	U		0.711	U	
Acenaphthene	16	57	0.255	J		0.252	J		0.247	J		0.711	U	
Fluorene	220	1200	0.404	J		0.535	U		0.299	J		0.345	J	
Phenanthrene	23	79	1.42			0.626			0.974			1.46		
Anthracene	100	480	1.49			0.535	U		0.214	J		0.93		
2-Methylnaphthalene	38	64	0.277	J		0.2	J		0.279	J		0.334	J	
Total LPAHs	370	780	4.25			1.52			2.58			3.89		
Fluoranthene	160	1200	1.28			1.03			1.49			2.09		
Pyrene	1000	1400	1.06			0.839			1.62			1.78		
Benzo(a)anthracene	110	270	0.553	J		0.342	J		0.714			0.491	J	
Chrysene	110	460	1.13			0.361	J		0.63			0.794		
Benzo(b)fluoranthene	--	--	0.709			0.445	J		0.779			0.731		
Benzo(k)fluoranthene	--	--	0.617	U		0.535	U		0.468	U		0.711	U	
Benzofluoranthene	230	450	0.709			0.445			0.779			0.731		
Benzo(a)pyrene	99	210	0.369	J		0.284	J		0.481			0.418	J	
Indeno(1,2,3-cd)pyrene	34	88	0.227	J		0.535	U		0.221	J		0.711	U	
Dibenzo(a,h)anthracene	12	33	0.617	U		0.535	U		0.468	U		0.711	U	
Benzo(g,h,i)perylene	31	78	0.617	U		0.535	U		0.468	U		0.711	U	
Total HPAHs	960	5300	5.33			3.3			5.94			6.3		
Phthalates (ug/kg)														
Butyl benzyl phthalate	4.9	64	2.91			0.71			1.17			1.57		
Dibutyl phthalate	220	1700	1.28	U		1.1	U		0.974	U		1.46	U	
Di-n-Octyl phthalate	58	4500	0.667			0.477	J		0.468	U		0.878		
Diethyl phthalate	61	110	0.617	U		0.535	U		0.468	U		0.711	U	
Dimethyl phthalate	53	53	0.617	U		0.535	U		0.468	U		0.711	U	
Bis(2-Ethylhexyl) Phthalate	47	78	1.13	J		0.839	J		0.714	J		1.15	J	
Other SVOCs (ug/kg)														
Dibenzofuran	15	58	0.277	J		0.535	U		0.24	J		0.711	U	
1,2-Dichlorobenzene	2.3	2.3	0.617	U		0.535	U		0.468	U		0.711	U	
1,4-Dichlorobenzene	3.1	9	0.617	U		0.535	U		0.468	U		0.711	U	
Hexachlorobenzene	0.38	2.3	0.234	U		0.213	U		0.214	U		0.345	U	
Hexachlorobutadiene	3.9	6.2	0.617	U		0.535	U		0.468	U		0.711	U	
N-Nitrosodiphenylamine	11	11	0.617	U		0.535	U		0.468	U		0.711	U	
1,2,4-Trichlorobenzene	0.81	1.8	0.617	U		0.535	U		0.468	U		0.711	U	
PCB Aroclors (ug/kg)														
Total PCBs	12	65	2.2	U		1.74	U		1.62	U		2.82	U	

Notes:
Non-detect result exceeding either the SQS or CSL criteria
LQ: laboratory qualifier VQ: validation qualifier SQS: sediment quality standard CSL: cleanup screening level OC: organic carbon normalized
U the analyte was analyzed for, but not detected
J the result is estimated
a. sum of detected values of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene
b. sum of detected values of fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzofluoranthene, benzo(a)pyrene, indeno(1,2,3-cd) pyrene, dibenzo(a,h)anthracene, and benzo(ghi)perylene
c. sum of detected PCB Aroclors

Table 8. Polybrominated Diphenyl Ether Results

	SN17-D01-C	LQ	VQ	SN17-D03-C	LQ	VQ	SN17-D08-C	LQ	VQ
PBDEs (ng/kg)									
PBDE-008/011	1.58	J		1.36	J		0.037	U	
PBDE-015	2.13	J		1.47	J		0.416	J	
PBDE-017/025	16.4			9.55			0.361	J	
PBDE-028/033	5.1			2.85	J		0.605	J	
PBDE-032	0.21	MJR	U	2.78	J		0.067	U	
PBDE-035	0.33	JR	U	0.22	MJR	U	0.06	U	
PBDE-037	0.51	JR	U	0.3	JR	U	0.12	MJR	U
PBDE-047	79.9			44.4			8.92		J
PBDE-049	33.4			15.4			1.15	MJ	
PBDE-051	3.01	J		1.39	J		0.059	U	
PBDE-066	4.91			2.63	J		0.48	JR	U
PBDE-071	3.74			1.84	J		0.12	MJR	U
PBDE-075	0.22	MJR	U	0.16	U		0.08	U	
PBDE-077	0.17	U		0.13	U		0.069	U	
PBDE-079	0.17	U		0.13	U		0.067	U	
PBDE-085	2.32	J		0.95	J		0.35	MJ	J
PBDE-099	74.6			35.5			7.57		J
PBDE-100	20			9.83			1.55	J	
PBDE-105	0.41	U		0.25	U		0.18	U	
PBDE-118	0.41	U		0.25	U		0.18	U	
PBDE-119/120	0.38	U		0.24	U		0.17	U	
PBDE-126	0.3	MJ		0.15	U		0.11	U	
PBDE-128	0.92	U		0.68	U		0.69	U	
PBDE-138/166	2.2	MJ		0.52	U		0.53	U	
PBDE-140	0.97	JR	U	0.33	U		0.34	U	
PBDE-153	9.6			3.66	J		0.62	JR	UJ
PBDE-154	8.83	M		3.86	MJ		0.76	J	
PBDE-155	1.16	J		0.41	MJ		0.24	U	
PBDE-156	1	U		0.77	U		0.78	U	
PBDE-181	0.43	U		0.27	U		0.37	U	
PBDE-183	2.96	J		1.89	MJ		0.22	U	
PBDE-184	1.1	JR	U	0.46	MJ		0.19	U	
PBDE-190	0.6	U		0.37	U		0.51	U	
PBDE-191	1.36	MJ		0.3	U		0.42	U	
PBDE-196	2.7	JR	U	2.88	J		0.24	U	
PBDE-197	2.9	JR	U	2.96	J		0.19	U	
PBDE-203	4.33	J		6.09	J		0.26	U	
PBDE-206	19.1	J		60.7			1.51	J	
PBDE-207	21.3	J		54.5			0.78	JR	U
PBDE-208	18.7	J		39.2			0.39	MJR	U
PBDE-209	422			2660			57.6		J

Notes:
LQ: laboratory qualifier VQ: validation qualifier DW: dry weight BDE: brominated diphenyl ether
M a peak has been manually integrated
R the ion abundance ratio(s) did not meet the acceptance criteria. Value is an estimated maximum.
J the analyte was detected below the calibrated range but above the EDL
U the analyte was not detected above the EDL

Figure 1. Snohomish River Study Area

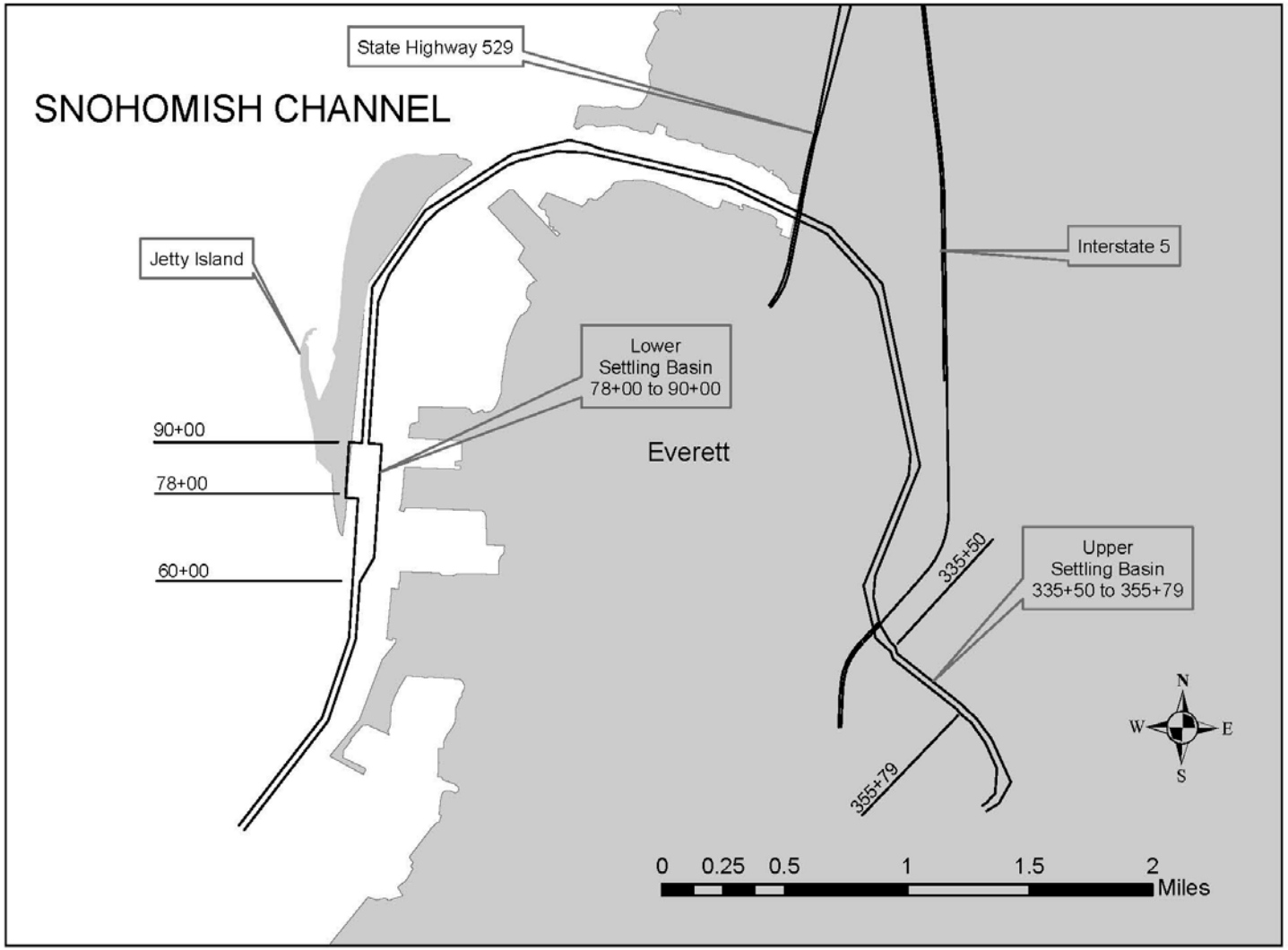


Figure 2. Deep-draft Channel and Downstream Settling Basin Sampling Locations (DMMUs 1, 2, 3, and 4) (NewFields, 2018)

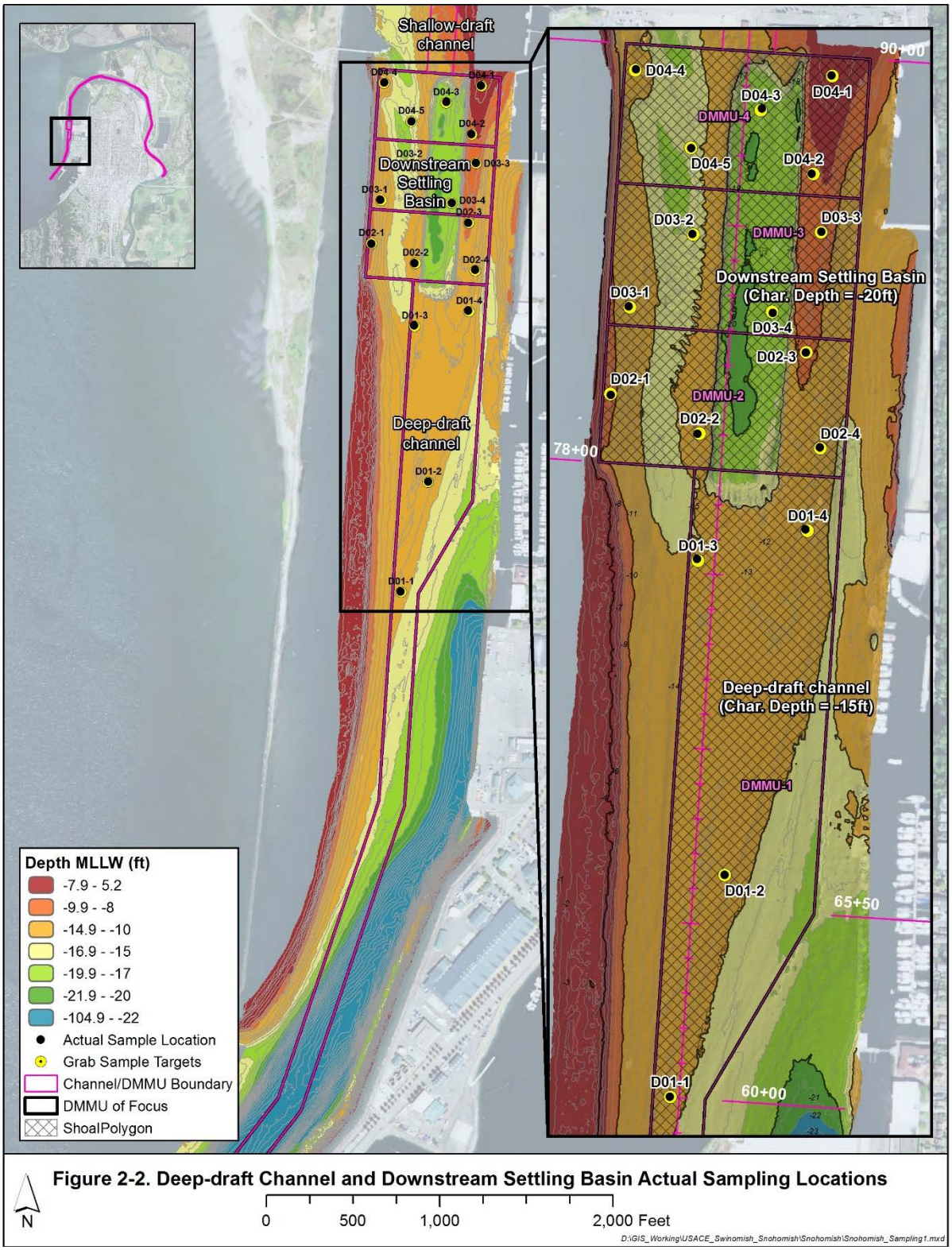


Figure 3. Shallow-draft Channel Sampling Locations (DMMU 5 and 6) (NewFields, 2018)

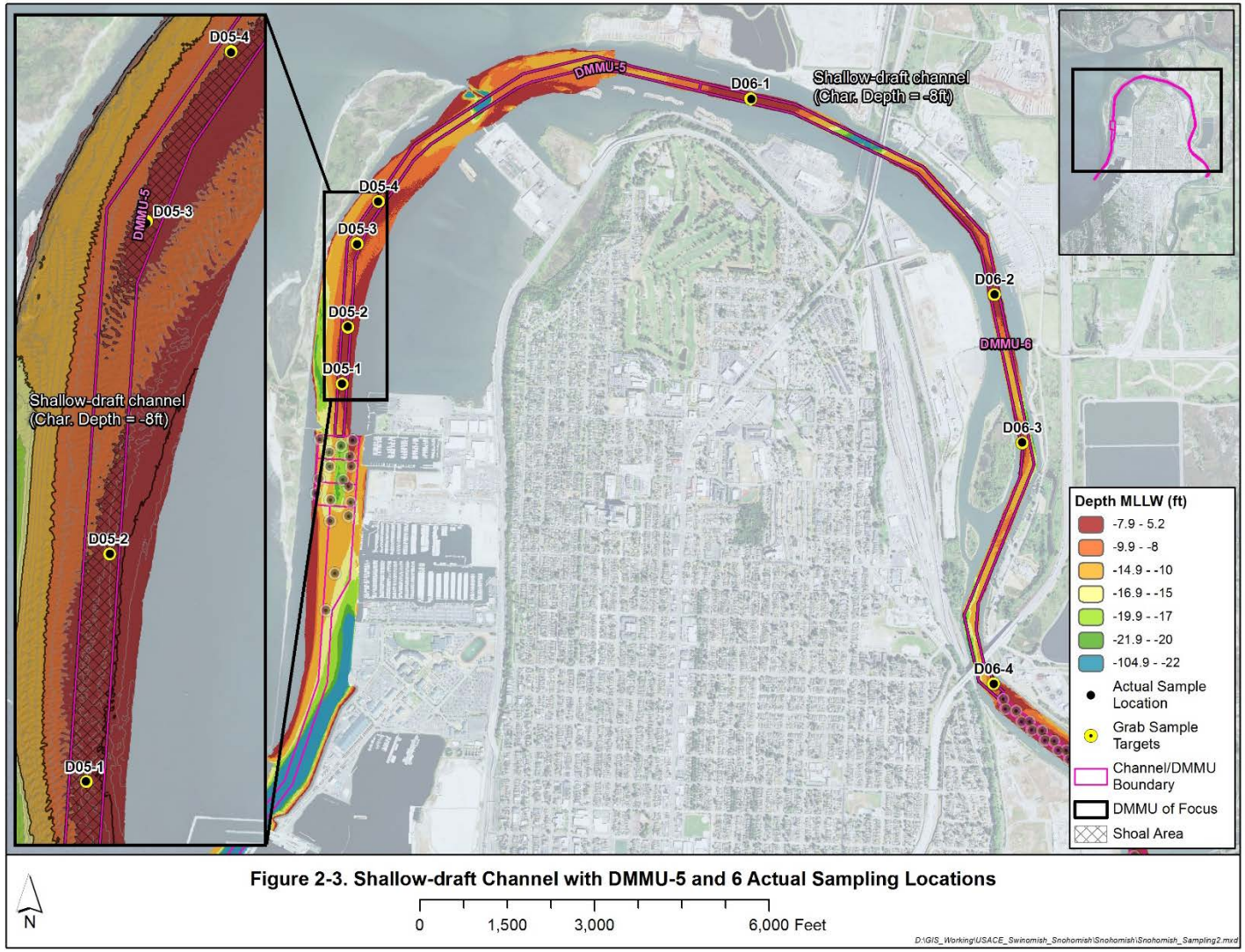
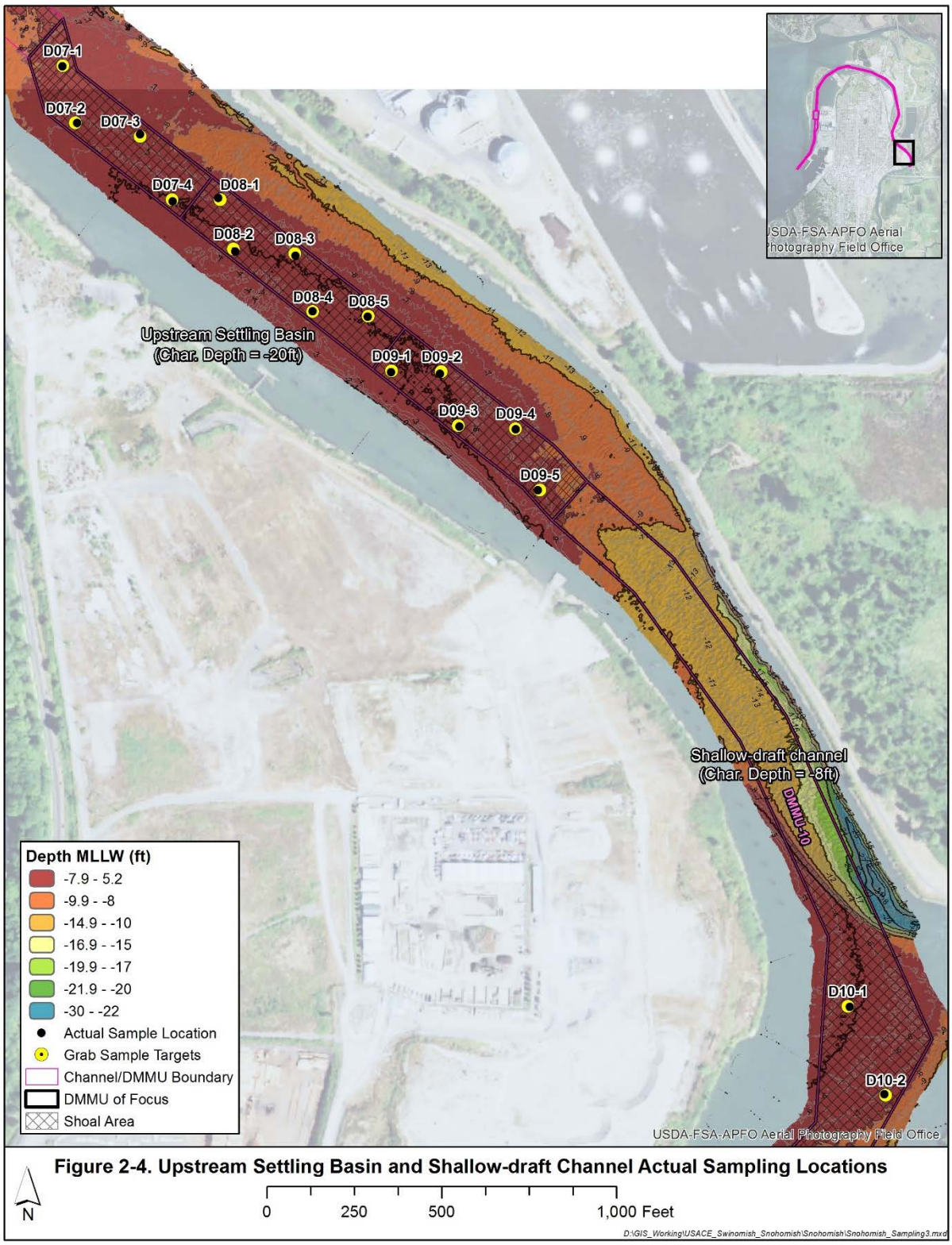


Figure 2-3. Shallow-draft Channel with DMMU-5 and 6 Actual Sampling Locations

D:\GIS_Working\USACE_Swinomish_Snohomish\Snohomish\Snohomish_Sampling2.mxd

Figure 4. Upstream Settling Basin and Shallow-draft Channel Sampling Locations (DMMUs, 7, 8, 9, and 10) (NewFields, 2018)



Attachment A
Description of Previous Sediment Characterizations
Snohomish River Federal Waterway and Navigation Channel

Note: The following information was compiled by Heather Fourie (USACE) during preparation of the scope of work for sediment characterization of the Snohomish River Federal Waterway in 2017. Sources of information included suitability determinations made under the Puget Sound Dredged Disposal Analysis (PSDDA) program and the Dredged Material Management Program (DMMP), as well as other project documentation available to the Dredged Material Management Office (DMMO). The available documentation did not always include enough detail to determine definitively what occurred. As a result, this compilation has limitations and the information included should not be considered definitive in nature.

The Everett Harbor and Snohomish River Project and maintenance dredging by the Department of the Army was adopted June 25, 1910 and modified by subsequent acts. The project consists of deep and shallow-draft navigation channels and two settling basins to serve navigation in Everett Harbor and the Snohomish River (Figure 1). Table 1 summarizes details regarding the dimensions of the project features. The USACE is responsible for dredging portions of the authorized project as needed to maintain navigation. Dredging of the lower settling basin most recently occurred in October 2016; additional planned dredging is unknown at this time. Advanced maintenance dredging is not planned.

Sedimentation in the Snohomish navigation channel and settling basins is due to input from the Snohomish River. Accreted sediment in the waterway has been characterized by USACE under the Puget Sound Dredged Disposal Analysis (PSDDA) program or Dredged Material Management Program (DMMP) six times, including four full characterizations and a dedicated characterization for dioxin. Descriptions of these characterization efforts follow.

1992 Characterization (downstream only)

Five surface (0-4 ft) sediment cores were collected from the lower Snohomish River in October 1992. Detected chemical concentrations were below the existing PSDDA screening levels (SL). The partial characterization supported a down-ranking of lower Snohomish sediment from moderate to low-moderate for the subsequent full characterization.

1993 Full Characterization (downstream only)

A total of 28 cores were collected comprising twelve composite samples (7 surface and 5 subsurface) in December 2012 in the area of the lower settling basin and lower navigation channel. Comparison to the 1993 PSDDA SLs revealed two exceedances for anthracene and one exceedance for 4-methylphenol in a total of 3 DMMUs. Anthracene was detected at 140 ug/kg d.w. (SL = 130 ug/kg) and 4=methylphenol at 150 ug/kg (SL = 120 ug/kg). (The SLs for both these chemicals were raised in 1998 to the current SLs of 906 ug/kg and 670 ug/kg for anthracene and 4-methylphenol, respectively).

Bioassays were conducted on three affected DMMUs. Although some performance problems occurred, no bioassays failed. All 462,243 CY of proposed dredged sediment were considered suitable for open-water disposal.

1996 Full Characterization (downstream only)

Full characterization of the lower settling basin and river channel occurred in 1996, resulting in 300,437 CY of sediment approved for open-water disposal. Following the previous low-moderate ranking, sediment was collected from 24 sampling locations and composited into six surface and three subsurface DMMU composite samples (total of

9 DMMUs). One PSDDA SL of diethyl phthalate (99 ug/kg; SL = 97 ug/kg) occurred in one DMMU. No other SL exceedances occurred in any DMMUs. Bioassays were not run based on the determination that phthalates are a common laboratory contaminant. Furthermore, archived sediment was analyzed and no phthalates were detected in the archive sample; therefore, all 300,437 CY were considered suitable for open-water disposal.

2003-2004 Full Characterization

In September 2003, sediment cores were collected via vibracore from the lower Snohomish Settling basin and the adjacent navigation channel. In accordance with a low-moderate rank for homogenous material, samples were composited into nine composites for analysis (9 DMMUs). No DMMP SL exceedances (detect or non-detect) occurred in any samples, and all 271,210 CY were determined to be suitable for open water disposal. TBT was included in the analyses, but was non-detect in all samples.

In March 2004, sediment cores were collected from the upper settling basin and adjacent upstream navigation channel. In accordance with a low-moderate rank for homogenous material, samples were composited into 12 composites for analysis (12 DMMUs). No DMMP SL exceedances (detect or non-detect) occurred in any samples, and all 430,000 CY of sediment were determined suitable for open water disposal. TBT analysis was not included.

2009 Dioxin Evaluation

In 2009, the Snohomish River federal navigation channel was tested for dioxin to determine the impact on maintenance dredging of the 2010 revised DMMP dioxin guidelines for open-water disposal in Puget Sound. A total of 36 sediment grab samples were collected from throughout the Snohomish River navigation channel and settling basins using a van Veen grab sampler. Composites were analyzed for conventionals and dioxins. Dioxin/furan concentrations ranged from 0.16 to 1.06 ng/kg TEQ (n = 16).

Total organic carbon (TOC) ranged from 0.14 to 1.84% with the lowest TOC concentrations in the upper settling basin and higher concentrations downstream. As expected, grain size data indicated that the percentage of fine-grained material increases downstream. DMMU1, the furthest upstream DMMU, consisted of sand and gravel. Material in the upper settling basin was greater than 90% sand, as were the shoals in the shallow navigation channel between the settling basins. The lower settling basin was approximately 70% sand with the remaining volume consisting of roughly equal parts silt and clay. The downstream deep-draft channel had the highest fines content of all the DMMUS.

2011 USACE Full Characterization

For the 2011 characterization, the DMMP agencies agreed to a one-time re-ranking of the Snohomish project. Under this agreement, 1) no testing was required of the most upstream shoal because it had been consistently shown to consist of gravel and cobble; 2) only a confirmatory level of sampling (one sample per 20,000 CY and one analysis per 100,000 CY) was required for the material in the upstream settling basin and shallow navigation channel between settling basins; and 3) the downstream settling basin was ranked low. A total of 43 grab samples were collected in 2012 for the most recent full characterization of the Snohomish River navigation channel and settling basins. The samples were composited into 9 DMMUs for analysis of all DMMP marine COCs (except TBT and dioxins; dioxins were evaluated separately in 2009). Sediment grain size results confirmed what was found previously, with all samples from the upstream settling basin and navigation channel averaging greater than 95% sand and gravel. Fines were more abundant (32-52%) in the downstream settling basin.

Only one COC, benzyl alcohol, was found at concentrations exceeding the SL in 3 DMMUs, all from the downstream settling basin. All other COCs (detect and non-detect) were below SL. Using several lines of evidence including the observed presence of woody material, the DMMP agencies determined that bioassays were unnecessary. All 651,571 CY of sediment were determined suitable for open-water disposal at the Port Gardner non-dispersive site.