Prepared by:
Dredged Material Management Office
Seattle District, US Army Corps of Engineers

Memorandum for Record **August 28, 2024**

Subject: Suitability Determination Memorandum for the Duwamish Yacht Club project in Seattle, Washington (NWS-2024-639).

Introduction

This suitability determination memorandum (SDM) documents the consensus regarding the suitability of the proposed dredged material for unconfined aquatic disposal and compliance of the post-dredge leave surface as determined by the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington Departments of Ecology and Natural Resources, and the U.S. Environmental Protection Agency).

Project Description

The Duwamish Yacht Club (DYC) is a 112-slip nonprofit yacht club that maintains facilities for the slip owner members along the west bank of the Duwamish River between River Mile 4.0 and 4.2, see Figure 1. There are four floating docks that make up the Yacht Club moorage basin. Routine maintenance dredging around the docks is necessary for the structural integrity of the floating docks and the navigability of the docks at low tide due to substantial deposition in the basin since the last maintenance dredging event in 1998-1999.

The need for maintenance dredging within the DYC was identified in 2011 and a sediment characterization was performed, resulting in a suitability determination by the DMMP agencies in 2013 (DMMP, 2013). The results indicated that a portion of the marina was unsuitable for open-water disposal due to SL exceedances and elevated dioxins/furan concentrations and that further testing would be required to pursue open-water disposal as an option. No maintenance dredging occurred at that time.

A bathymetric survey performed in April 2023 confirmed that additional material had accumulated since 2013 and that maintenance dredging was still needed. The sediment characterization documented in this memorandum was designed to evaluate the suitability of the dredged material that has accumulated within the Yacht Club basin since 2013, and to further evaluate the suitability of the material that required further testing based on the 2013 evaluation.

Project Summary

Waterbody	Duwamish River
Water classification	Marine
Initial Project rank	High
Final Project Rank	High
Total proposed dredging volume (cy)	45,750 cubic yards (CY)
Target proposed dredging depth	-8 ft MLLW
Max. proposed dredging depth (includes no overdepth allowance)	-8 ft MLLW
Proposed disposal location(s)	Elliott Bay non-dispersive disposal site
Dredged Material Management Units (DMMUs): No. of stations	13 DMMUs, 5-9 samples per DMMU. 49 vibracores in total.
DMMO tracking number	DUWYC-1-B-F-451

EIM Study ID	DUWYC23
USACE Regulatory Reference Number	NWS -2024-639
Draft Sampling and Analysis Plan (SAP) Submittal Date	July 10, 2023
Sampling and Analysis Plan (SAP) Approval Date	August 29, 2023
Sampling Date(s)	September 5 – 13, 2023
Testing Parameters	DMMP standard marine COCs plus Dioxins/Furans
Biological Testing	Marine bioassays triggered on 4 DMMUs
Suitability Outcome	28,300 CY from DMMUs 1-8 and 11 are suitable for open-water disposal at the Elliott Bay disposal site. 16,500 CY of material from DMMUs 7, 9, 10, 12 and 13 are unsuitable for open-water disposal.
Recency Expiration Date (high = 3 years)	September 2026

Sampling and Analysis Description

Sediment samples were collected by vibracore between September 5th and 11th, 2023, aboard the sampling vessel *R/V Cayuse* provided by Gravity Consulting. The DMMU design was developed to reduce testing costs by focusing on testing the newly deposited material and the material in the areas closest to the Hamm Creek outfall that required further testing to determine suitability.

The 2013 characterization included testing sediment to a depth of -8 ft MLLW throughout the marina. For the 2023 characterization, several special considerations were made in the DMMU design:

- The target proposed dredge elevation in the DMMUs on the south side of the yacht basin was increased by a foot to –9 ft MLLW to accommodate a 1-ft layer of sand placement.
- An additional subsurface DMMU on the southern side of the yacht basin was characterized to a depth of -13 ft MLLW. The purpose of this DMMU was to provide additional material for dioxin volume-weighted averaging, if needed, and to provide DYC with additional depth in the area with highest shoaling to lengthen the time between dredging events.
- Only confirmational sampling of DMMUs 2 and 3 was required, based on the 2013 sampling results. These DMMUs have been buried by sedimentation since then.
- More than the minimum required number of samples per DMMU were collected in some areas in order to collect sufficient volume of sediment for all potential biological testing scenarios.

Figure 2 shows the proposed and actual sediment sampling locations and Figures 3-5 show the surface, subsurface and second subsurface DMMUs, respectively. Table 1 lists the sampling station details and Table 2 shows the compositing scheme. The most notable deviations from the sampling and analysis plan are noted below:

- Multiple attempts were made at core locations C34 and C38, but full depth samples were not collected due to refusal on a dense sandy layer. The subsurface DMMU intervals were short and no z-layers were collected for these cores.
- Core interval of C48-B was short, resulting in the subsurface DMMU portion of this core only including material from -6 to -8 ft MLLW, instead of -6 to -9 ft MLLW.
- The z-sample interval from C46 was inadvertently collected from -9 to -12 ft MLLW, one foot deeper than planned.
- Three cores were added to the sampling plan in the field in order to ensure sufficient material was collected from DMMUs 8, 10, and 12.

- Several cores were moved more than 2 m from the target location in order to collect acceptable cores. C2 was moved to avoid riprap, C34 and C38 were moved to avoid the dense sandy clay subsurface layer.
- Due to a processing error, C4-B subsurface and z-sample intervals were shifted 0.5 ft deeper than planned.
- Photographs of core segments C1-B, C1-Z, C23-A and C39-A were inadvertently not collected.

When possible, deviations from the approved Sampling and Analysis Plan (Integral, 2023) were coordinated with the DMMP agencies. After reviewing the information provided, the DMMP agencies determined that the samples collected were representative of the proposed dredged material and are considered sufficient for decision-making. Samples were submitted to Analytical Resources in Tukwila, Washington for analysis. Analyses were performed by Analytical Resources, Pacific Rim Labs, located in Surrey, British Columbia, and AmTest Laboratories in Kirkland, Washington. Biological testing was performed by EcoAnalysts in Port Gamble, Washington.

Data Validation

An EPA Stage 2b data validation was performed by EcoChem of Seattle, WA on all data. In addition, Stage IV validation was conducted on 10% of the dioxin/furan data. The validation process resulted in some additional J and UJ qualified data beyond those assigned by the laboratory, based on specified protocol or technical advisory. Completeness was 100% and all data were considered usable, as qualified, by the data validator.

Additional validation details:

- Pesticide results from SDG PR232591 were received at the analytical laboratory with a cooler temperature of 15C, more than twice the upper control limit. Associated field results were J-flagged.
- Antimony results from SDGs 23I0277, 23I0178 and 23I0276 were rejected due to percent recovery less than 10% and no post-spike sample analysis. Samples were re-analyzed with an acceptable post-spike recovery and re-analyzed results are reported here.

Analytical Testing Results

Results of the sediment characterization are reported in the sediment characterization report (Integral, 2024). Sediment conventional results show that the material was classified as silts and sandy silts with total fines content ranging from 40.9 to 86.2%, see Table 3. Total organic carbon ranged from 1.05 to 3.66%. Total sulfides were elevated in many of the samples, ranging from 853 to 7550 mg/kg and averaging at 3710 mg/kg total sulfides.

Table 4 summarizes the analytical results for all 13 DMMUs and z-samples alongside the DMMP marine guidelines. There were detected SL exceedances in six DMMUs. Benzoic acid was above the SL in DMMU 4, benzyl alcohol was above the SL in DMMUs 7 and 9, butyl benzyl phthalate was above the SL in DMMU 10, and dimethyl phthalate was above the SL in DMMU 10, 12, and 13. All other COCs were below SLs except for dioxins/furans, which are discussed below.

Exceedances of benzoic acid in DMMU 4 and benzyl alcohol in DMMU 7 were not discovered until final validated data was received, which occurred well past expiration of the bioassay holding time. Therefore, the DMMP agencies allowed analysis of individual composite samples for benzoic acid in DMMU 4 and benzyl alcohol in DMMU 7, results are shown in Table 5.

All individual archive analyses of benzoic acid in DMMU 4 were below the SL and comparable to benzoic acid results for the rest of the marina. Based on the similarity to other results, uniformity of results seen the individual archive analyses and the often transient nature of benzoic acid, the DMMP agencies determined that the individual archive results were appropriate for decision-making on DMMU 4.

The individual archive results of benzyl alcohol in DMMU 7 were mixed, with half of the results above the SL and half below. The DMMP agencies reviewed the results and determined that the majority of the DMMU was unsuitable for open-water and that only a small portion on the eastern side could be separated and considered suitable, see Figure 7.

TBT. Tributyltin analysis was not required by the DMMP for this project based on the site history and location of the project.

Dioxins/furans. Dioxin analysis was required by the DMMP for this project based on previous results. Complete dioxin/furan results are shown in Table 4 and a summary of dioxin results is in Table 6. Four DMMUs had dioxin concentrations less than the DMMP disposal site management objective of 4 pptr TEQ. Six DMMUs had dioxin concentrations above the disposal site management objective, but less than the bioaccumulation trigger of 10 pptr TEQ, and three DMMUs had dioxin concentrations above the bioaccumulation trigger.

Table 7. Dioxin volume-weighted averaging for Duwamish Yacht Club (dredging to -8 ft MLLW)

DMMU	DMMU Volume[a] (cubic yards)	Dioxin/Furan TEQ (ND=1/2 DL) (pptr)	In-Water Disposal Volume × TEQ (cy-pptr)	
1	3,000	5.18	15540	
2	2,850	4.15	11828	
3	3,450	4.23	14594	
4	4,350	4.52	19662	
5	4,050	3.33	13487	
6	4,350	2.77	12050	
7	900	8.47	7623	
8	3,200	2.67	8544	
11	2,150	6.46	13889	
	28,300		**4.1**	**pptr TEQ VWA dioxin concentration**

Notes:

DL = detection limit

DMMU = dredged material management unit

ND = non-detect

pptr = parts per trillion

TEQ = toxicity equivalence

[a] Volume estimated based on the federal navigation channel boundaries, total dredge elevation, and a 1V:1.5H side slope.

Based on these results, DYC initially chose to pursue bioaccumulation testing for dioxins. However, once the bioassay results were received, DYC chose to suspend bioaccumulation testing and instead use volume-weighted averaging for dioxins.

Volume-weighted averaging for dioxins is allowed for DMMUs with dioxin concentrations between 4 and 10 pptr TEQ as long as the final VWA concentration meets the disposal site management objective of 4 pptr TEQ. Table 7 below shows the dioxin VWA for DMMUs 1 – 6, the suitable portion of DMMU 7 that passed the benzyl alcohol SL, and DMMUs 8 and 11. The VWA dioxin concentration is slightly above, 4.1 compared with the site management objective of 4 pptr TEQ. The DMMP agencies consider 4.1 pptr TEQ to be within the analytical uncertainty of 4 and less than Ecology's PQL for dioxins/furans of 5 pptr TEQ.

Biological Results

Due to SL exceedances based on preliminary data, bioassays were triggered in DMMUs 9, 10, 12 and 13. The standard suite of three marine bioassays were conducted by EcoAnalysts of Port Gamble, Washington using *Neanthes arenaceodentata* for the infaunal growth test, *Mytilus galloprovincialis* for the larval test, and either *Eohaustorius estuarius* or *Leptocheirus plumulosus* for the amphipod test. Two reference samples from Carr Inlet were collected in order to provide suitable grain size matches (see Figure 6 and Table 8).

The initial round of amphipod bioassays with *Ampelisca abdita* did not pass the control criterion. After coordination with the DMMP agencies, substitution with *Leptocheirus plumulosus* was allowed given limited commercial availability of *Ampelisca.*

Detailed results of the bioassay tests are shown in Table 9. All bioassays passed the negative control and reference sediment performance standards. There were no significant water quality deviations. The infaunal growth tests all passed with no hits. There was a minor hit (2-hit) in the amphipod test in DMMU 12 and a major hit (1-hit) in DMMU 13. All four DMMUs had major hits (1-hit) in the larval development bioassay.

	Amphipod mortality	**Juvenile infaunal growth**	**Larval development**	**Final determination**
DMMU 9	Pass	Pass	1-hit fail	FAIL
DMMU 10	Pass	Pass	1-hit fail	FAIL
DMMU 12	2-hit fail	Pass	1-hit fail	FAIL
DMMU 13	1-hit fail	Pass	1-hit fail	FAIL

If a test sediment has two minor (2-hit) hits or a single major (1-hit) hit then that material is unsuitable for open-water disposal. Therefore, all 4 DMMUs tested failed bioassays and are not suitable for open-water disposal. After receiving the bioassay results, the DYC chose to suspend bioaccumulation testing.

DMMP Determinations

Suitability Determination

Chemical concentrations in the dredge prism composite samples were below the DMMP marine SLs in DMMUs 1, 2, 3, 4, 5, 6, 8 and 11 and these DMMUs are suitable for open-water disposal. The eastern portion of DMMU 7 is suitable for open-water disposal based on individual core archive results and the remainder of DMMU 7 is unsuitable (See Figure 7). DMMUs 9, 10, 12 and 13 are unsuitable for open-water disposal due to failed bioassays.

A horizontal buffer between suitable DMMUs 8/11 and unsuitable DMMUs 9/10/12 must be added so that none of the suitable material sloughs into the suitable DMMUs during dredging. A similar buffer between suitable DMMU 7 and unsuitable DMMUs 9/10/12 must also be added.

An additional vertical buffer between unsuitable DMMU 7 and suitable DMMU 3 beneath is not required because the surface DMMU 7 includes an additional approximately 0.25 ft of material compared with the 2011 bathymetry. This additional 0.25 ft of material is considered an adequate vertical buffer given the nature of the unsuitable material (benzyl alcohol exceedance, no bioassays).

In summary, 28,300 CY of proposed dredged material from DMMUs 1-8 and 11 are suitable for open-water disposal at the Elliott Bay disposal site. 11,350 CY of material from DMMUs 7, 9, 10 and 12 are unsuitable for open-water disposal. All 5,150 CY of DMMU 13 are also unsuitable for open-water disposal, however, at this time DYC does not intend to pursue dredging of DMMU 13.

Antidegradation Determination

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).

An antidegradation determination was made in the 2013 for the leave surface below DMMUs 1-3. The DMMP agencies have evaluated that determination and decided that there are no changed conditions at depth and the determination is still valid. Therefore, the leave surface below DMMUs 1-3 meet anti-degradation.

The leave surface in the southern portion (beneath DMMUs 8, 9, and 10) of the marina requires further evaluation. A second subsurface DMMU, DMMU 13, was evaluated as part of this characterization and is the best representation of the quality of the leave surface. DMMU 13 triggered bioassay due to a dimethyl phthalate exceedance and the bioassays failed. In addition to the bioassay failure, Dioxin/furan concentrations in DMMU 13 was 11.5 pptr TEQ. This is less than the surface concentration in DMMU 10, but above the surface concentrations in DMMU 8 and 9 and above the bioaccumulation trigger for dioxins/furans. Therefore, due to both bioassay fails and dioxin concentrations in DMMU 13, the leave surface beneath DMMUs 8, 9 and 10 does not pass antidegradation. In these areas, since dredging deeper is not an option being considered by Duwamish Yacht Club, the following approaches will be used:

- A 1-ft buffer of material between suitable DMMU 11 and failed DMMU 13 at depths of -9 and -8 ft MLLW will be left in place.
- DMMU 12 will be dredged to a depth of -9 ft MLLW and a 1 foot layer of approved clean material will be placed.

Debris Management

The DMMP agencies implemented a debris screening requirement following the 2015 SMARM to prevent the disposal of solid waste and debris at open-water disposal sites in Puget Sound (DMMP, 2015). Marinas are known sources of debris. Per these guidelines, a 1-ft x 1-ft screening grid should be used during dredging of suitable material to remove potential debris not allowed at any DMMP disposal site. Alternate debris management plans may be submitted to the DMMP prior to dredging if it can be demonstrated that debris is unlikely to be present or that other removal options are sufficient.

Notes and Clarifications

The decisions documented in this memorandum do ***not*** constitute final agency approval of the project. During the public comment period that follows a public notice, 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 DNR, Ecology and the USACE Seattle District's Regulatory Branch and DMMO. Refer to the USACE permit and Ecology 401 certification for project-specific submittal requirements and timelines.

The DMMP does not make specific beneficial use determinations. However, these data are available for the assessment of project-specific beneficial use by the project proponent, permitting agencies, local health jurisdictions and/or the owner of a receiving property.

References

DMMP, 2013. *Determination Regarding the Suitability of Proposed Dredged Material from the Duwamish Yacht Club, Seattle, WA Evaluated Under Section 404 of the Clean Water Act for Unconfined Open-Water Disposal at the Elliott Bay Non-Dispersive Disposal Site.* Prepared by the DMMP agencies. 19 September 2013.

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, 2015. *Debris Screening Requirements for Dredged Material Disposed at Open-Water Sites.* Final DMMP Clarification Paper. October 02, 2015.

DMMP, 2021. *Dredged Material Evaluation and Disposal Procedures (User Manual)*. Dredged Material Management Program, updated July 2021.

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

Integral, 2023. *Sampling and Analysis Plan; Sediment Characterization, Duwamish Yacht Club, Seattle, Washington.* Prepared for Duwamish Yacht Club. Prepared by Integral Consulting, Inc., August 25, 2023.

Integral, 2024. *Data Report, Duwamish Yacht Club Dredged Material Characterization, Seattle, Washington.* Prepared for Duwamish Yacht Club, 1801 S 93rd St. Seattle, WA. Prepared by Integral Consulting Inc., August 2, 2024.

Agency Signatures

The signed version is on file in the Dredged Material Management Office, Seattle District U.S. Army Corps of Engineers

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Date Kelsey van der Elst – U.S. Army Corps of Engineers, Seattle District

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Date Whitney Conard, Ph.D. – U.S. Environmental Protection Agency, Region 10

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Date Laura Inouye, PhD. – Washington State Department of Ecology

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Date Shannon Soto – Washington State Department of Natural Resources

Copies Furnished:
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Update: October 14, 2025

The DMMP received the "Suitability Determination Addendum/Revision for the Duwamish Yacht Club project in Seattle, Washington (NWS-2024-639)" from Integral on April 21, 2025 proposing two additional options for dredging plans (see attachment). The three original options were included in the SCR. All five options were reviewed and approved by the DMMP. Option 3 is being pursued with no changes.

Table 1. Core Locations, Elevations, Penetration, Acquisition, and Percent Recovery

Station	Date	Latitude (NAD 83 HARN)	Longitude (NAD 83 HARN)	Lead-line Water Depth (ft)	Corrected Mudline Elevation (ft MLLW)	Penetration (ft)	Acquisition (ft)	Recovery (%)	Acquisition Elevation[a] (ft MLLW)
C-1	9/6/2023	47.52025658	122.30868003	11.6	-1.9	8.5	7.5	88	-9.4
C-2	9/7/2023	47.52025914	122.30843300	9.1	-2.9	7.5	7.3	97	-10.2
C-3	9/7/2023	47.52034650	122.30828006	5	-2.7	8	9.1	114	-11.8
C-4	9/7/2023	47.52037122	122.30783586	8.1	-4.0	8	8.2	103	-12.2
C-5	9/7/2023	47.52021892	122.30762097	15.5	-5.5	5	5.0	100	-10.5
C-6	9/6/2023	47.52002308	122.30748269	14.6	-6.7	4	4.5	113	-11.2
C-7	9/6/2023	47.51991325	122.30747997	14.4	-5.6	4	4.1	102	-9.7
C-8	9/6/2023	47.52004844	122.30763556	11.5	-4.0	8	7.9	99	-11.9
C-9	9/6/2023	47.51994953	122.30790514	8.8	-2.9	8	8.0	100	-10.9
C-10	9/6/2023	47.51994975	122.30829197	8.3	-3.5	8	8.2	102	-11.7
C-11	9/5/2023	47.51970217	122.30736975	14	-5.7	4	3.8	96	-9.5
C-12	9/5/2023	47.51941406	122.30726247	13	-4.9	4	4.2	104	-9.1
C-13	9/5/2023	47.51980764	122.30743822	13.7	-5.1	4	3.8	96	-8.9
C-14	9/5/2023	47.51962069	122.30756156	9	-2.2	8.5	8.8	104	-11.0
C-15	9/5/2023	47.51921067	122.30743078	9	-1.2	4	4.5	113	-5.7
C-16	9/5/2023	47.51959789	122.30788997	11	-2.4	4	3.7	93	-6.1
C-17	9/5/2023	47.51957142	122.30805556	11.3	-2.0	4	3.4	85	-5.4
C-18	9/5/2023	47.51950047	122.30831769	13.3	-3.7	4	4.3	108	-8.0
C-19	9/5/2023	47.51945822	122.30803356	13	-3.1	8.7	8.7	100	-11.8
C-20	9/5/2023	47.51940486	122.30834072	13.6	-3.5	5.5	5.7	104	-9.2
C-21	9/10/2023	47.51909453	122.30752725	10.6	-1.4	10.5	10.5	100	-11.9
C-22	9/10/2023	47.51912089	122.30745228	10	-1.7	10.5	10.5	100	-12.2
C-23	9/10/2023	47.51914278	122.30735772	9.1	-2.6	12.5	12.0	96	-14.6
C-24	9/10/2023	47.51908728	122.30706547	5.7	-3.8	7.5	7.8	103	-11.5
C-25	9/10/2023	47.51891539	122.30699314	9.6	-5.4	10.5	8.5	81	-13.9
C-26	9/10/2023	47.51886761	122.30721175	3.0	-1.4	9.4	8.0	85	-9.4
C-27	9/10/2023	47.51883544	122.30731906	7.0	-1.6	9.2	8.0	87	-9.6
C-28	9/10/2023	47.51874450	122.30736158	7.9	-1.9	9.2	7.7	83	-9.6
C-29	9/13/2023	47.51916325	122.30769367	9.9	-1.7	10	10.0	100	-11.7

Table 1. Core Locations, Elevations, Penetration, Acquisition, and Percent Recovery

Station	Date	Latitude (NAD 83 HARN)	Longitude (NAD 83 HARN)	Lead-line Water Depth (ft)	Corrected Mudline Elevation (ft MLLW)	Penetration (ft)	Acquisition (ft)	Recovery (%)	Acquisition Elevation[a] (ft MLLW)
C-30	9/11/2023	47.51913950	122.30785700	9	-2.3	5	4.1	82	-6.3
C-31	9/11/2023	47.519118	122.3079643	13.9	-2.3	10	7.5	75	-9.8
C-32	9/13/2023	47.5190896	122.3076302	11	-1.9	10.5	9.8	94	-11.7
C-33	9/13/2023	47.5190629	122.3077625	8.4	-2.2	12.5	12.2	97	-14.3
C-34	9/11/2023	47.5190291	122.3079029	14	-2.6	11.5	7.8	68	-10.4
C-35	9/10/2023	47.5187688	122.3075443	12.3	-1.7	12.5	12.8	103	-14.5
C-36	9/12/2023	47.5187728	122.3077369	8.3	-2.6	10	9.6	96	-12.1
C-37	9/11/2023	47.518732	122.3075954	7.8	-1.7	6	5.9	99	-7.6
C-38	9/13/2023	47.5187184	122.3077016	11.4	-0.2	12	6.8	57	-7.0
C-39	9/10/2023	47.5187511	122.3079987	11.2	0.2	10	6.5	65	-6.3
C-48[c]	9/12/2023	47.5187514	122.3078085	12.8	-1.4	8	7.9	99	-9.3
C-40	9/7/2023	47.5203231	122.3080833	6.7	-3.5	7.5	7.7	103	-11.2
C-41	9/6/2023	47.5200566	122.3078291	10	-3.5	4	3.8	96	-7.4
C-42	9/5/2023	47.5196226	122.3077894	9.3	-2.2	4	4.4	110	-6.7
C-43	9/5/2023	47.5194876	122.3081728	13.4	-3.4	4	4.2	105	-7.6
C-44	9/11/2023	47.5189522	122.3081828	10.9	-3.5	5.5	4.6	83	-8.1
C-45	9/11/2023	47.5188	122.3077	7.4	-2.5	5.5	5.8	106	-8.3
C46	9/10/2023	47.5190082	122.3069974	6.2	-4.6	7.5	7.3	97	-11.9
C-47	9/7/2023	47.5199772	122.3081251	13.0	-3.2	6	5.7	95	-8.9
C-49	9/13/2023	47.5189884	122.3077636	13.0	-2.5	13	9.8	75	-12.3

Notes:

DMMU = dredged material management unit

MLLW = mean lower low water

[a] Acquisition elevation = mudline elevation – length of acquired core

[b] Minimum percent recovery is 75% but 85% is the target.

[c] C48 refers to the fifth attempt of C39

Table 2. Sampling and Compositing Details for Duwamish Yacht Club

Station	DMMU 1	DMMU 1 Z	DMMU 2	DMMU 2 Z	DMMU 3	DMMU 3 Z	DMMU 4	DMMU 5	DMMU 6	DMMU 7	DMMU 8	DMMU 9	DMMU 10	DMMU 11	DMMU 11-Z	DMMU 12	DMMU 12-Z	DMMU 13	DMMU 13-Z	Total
SAP volume (CY):	3,000		2,850		3,450		4,350	4,050	4,350	4,050	3,200	2,400	2,200	3,100		3,600		5,150		45,750
C1	-4.9 to -8.0	-8 to -9.4					-1.9 to -4.9													
C2	-5.9 to -8.0	-8 to -10					-2.9 to -5.9													
C3	-5.7 to -8.0	-8 to -10					-2.7 to -5.7													
C4	-7 to -8.5	-8.5 to -10.5					-4.0 to -7.0													
C5							-5.5 to -8.0													
C6								-6.7 to -8.0												
C7								-5.6 to -8.0												
C8	-7 to -8.0	-8 to -10						-4.0 to -7.0												
C9	-5.9 to -8.0	-8 to -10						-2.9 to -5.9												
C10	-6.5 to -8.0	-8 to -10						-3.5 to -6.5												
C11									-5.7 to -8.7											
C12									-4.9 to -7.9											
C13									-5.1 to -8.1											
C14			-5.2 to -8.0	-8 to -10					-2.2 to -5.2											
C15									-1.2 to -4.2											
C16										-2.4 to -5.4										
C17										-2.0 to -5.0										
C18	---									-3.7 to -6.7										
C19	---				-6.1 to -8.0	-8 to -10				-3.1 to -6.1										
C20	---									-3.5 to -6.5										
C21	---										-1.4 to -6.0			-6.0 to -9.0	-9 to -11					
C22	---										-1.7 to -6.0			-6.0 to -9.0	-9 to -11					
C23											-2.6 to -6.0			-6.0 to -9.0				-9.0 to -12.0	-12 to -14	
C24											-3.8 to -6.0			-6.0 to -9.0	-9 to -11					
C25											-5.4 to -6.0			-6.0 to -9.0				-9.0 to -12.0	-12 to -14	
C26											-1.4 to -6.0			-6.0 to -9.0	-9.0 to -9.4					
C27											-1.6 to -6.0			-6.0 to -9.0	-9.0 to -9.6					
C28											-1.9 to -6.0			-6.0 to -9.0	-9.0 to -9.3					
C29												-1.7 to -6.0				-6.0 to -9.0	-9 to -11			
C30												-2.3 to -6.0								
C31												-2.3 to -6.0				-6.0 to -9.0	-9.0 to -9.6			
C32												-1.9 to -6.0				-6.0 to -9.0	-9 to -11			
C33												-2.2 to -6.0				-6.0 to -9.0		-9.0 to -12.0	-12 to -14	
C34												-2.6 to -6.0				-6.0 to -9.0		-9.0 to -10.1		
C35												-1.7 to -6.0				-6.0 to -9.0		-9.0 to -12.0	-12 to -14	
C36													-2.6 to -6.0			-6.0 to -9.0	-9 to -11			
C37													-1.7 to -6.0							
C38													-0.2 to -6.0				-6.0 to -6.8			
C39													0.2 to -6.0							
C40	-6.5 to -8.0	-8 to -10					-3.5 to -6.5													
C41								-3.5 to -6.5												
C42									-2.2 to -5.2											
C43										-3.4 to -6.4										
C44												-3.5 to -6.0								
C45													-2.5 to -6.0							
C46											-4.6 to -6.0			-6.0 to -9.0	-9 to -12					
C47	-6.2 to -8.0							-3.2 to -6.2												
C48													-1.4 to -6.0			-6.0 to -8.0				

Notes:

1) The design depth for DMMUs 1-31 is -8 feet MLLW

2) The design depth for DMMUs 11 and 12 is -9 feet MLLW; including 1 ft of overdredgd in case of need for 1ft sand cover for antidegradation

3) DMMU volumes have been adjusted with a 10% contingency factor for bulking and additional deposition.

Table 3. Sediment Conventional Results for Duwamish Yacht Club

Analyte	Units	DMMU 1	DMMU 1Z	DMMU 2	DMMU 2Z	DMMU 3	DMMU 3Z
Conventionals							
Ammonia as N	mg/kg	78.7	82.7	127	131	127	164
Preserved total solids	%	49.3	51.6	53.2	52.65	46.0	47.8
Total organic carbon	%	2.23	1.99	2.33	2.41	3.24	3.66
Total solids	%	49.7	53.0	52.8	52.3	45.1	46.8
Total sulfides	mg/kg	3670 J	4130 J	3920 J	4390 J	6890 J	7550 J
Total volatile solids	%	7.86	7.09	7.21 J	7.82 J	9.24 J	9.81 J
Grain Size							
Gravel	%	0.700	0.100	0.100			
Sand	%	25.9	34.4	20.8			
Silt	%	69.3	61.9	71.6			
Clay	%	4.10	3.70	7.50			
Total Fines	%	73.40	65.60	79.10			

Analyte	Units	DMMU 4	DMMU 5	DMMU 6	DMMU 7	DMMU 8	DMMU 9
Conventionals							
Ammonia as N	mg/kg	36.6	44.8	45.9	57.3	70.9 J	81.4
Preserved total solids	%	46.1	46.4	51.1	42.2	52.1	44.4
Total organic carbon	%	2.22	2.31	2.03	2.72	2.06	2.71
Total solids	%	46.0	47.5	51.4	43.2	54.5	45.4
Total sulfides	mg/kg	2650 J	2070 J	3700 J	5960 J	3480 J	2650 J
Total volatile solids	%	8.12	8.67	7.17 J	9.09 J	6.72	8.77
Grain Size							
Gravel	%		0.100	0.100	0.100	7.00	0.100 U
Sand	%		22.3	37.3	13.6	40.7	22.4
Silt	%		69.7	55.0	79.4	48.0	72.3
Clay	%		7.90	7.60	6.80	4.40	5.20
Total Fines	%		77.60	62.60	86.20	52.40	77.50

Table 3. Sediment Conventional Res

Analyte	DMMU 10	DMMU 11	DMMU 11 - Dup1	DMMU 11 - Dup2	DMMU 11Z	DMMU 12
Conventionals						
Ammonia as N	50.7	128 J	119 J	116 J	139 J	133
Preserved total solids	55.2	51.1	51.0	52.0	55.3	51.5
Total organic carbon	2.10	2.22	2.21	2.15	2.07	3.26
Total solids	55.9	52.7	54.9	54.0	56.2	48.0
Total sulfides	2310 J	2990 J	3160 J	4740 J	4500 J	3300 J
Total volatile solids	6.71	7.22	7.31	7.27	7.30	9.05
Grain Size						
Gravel	0.900	0.100 U	0.100 U	0.200		0.100
Sand	58.3	35.2	36.1	35.4		23.3
Silt	37.5	60.3	59.4	59.8		72.6
Clay	3.40	4.60	4.50	4.70		4.00
Total Fines	40.90	64.90	63.90	64.50		76.60

Analyte	DMMU 12-Z	DMMU 13	DMMU 13Z
Conventionals			
Ammonia as N	119	117	69.0
Preserved total solids	55.3	58.3	70.8
Total organic carbon	2.53	1.96	1.05 J
Total solids	54.5	56.6	70.0
Total sulfides	3110 J	1880 J	853 J
Total volatile solids	7.86	7.30	3.88
Grain Size			
Gravel		0.300	
Sand		38.2	
Silt		56.2	
Clay		5.30	
Total Fines		61.50	

Notes:

DMMP = Dredged Material Management Program

DMMU = Dredged Material Management Unit

Data Qualifiers:

J = the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

U = the analyte was analyzed for, but was not detected above the reported sample quantitation limit.

Table 4. Analytical Results Compared to DMMP Guideline Values, Grain Size and Non-conventionals

		DMMP[a]			DYC_SL001	DYC_SL010	DYC_SL026	DYC_SL033	DYC_SL040	DYC_SL047	DYC_SL054	DYC_SL125	DYC_SL062
Analyte	Units	SL	BT	ML	DMMU 1	DMMU 1Z	DMMU 4	DMMU 5	DMMU 6	DMMU 7	DMMU 8	DMMU 8 - Replicate	DMMU 9
Grain Size													
Gravel	percent	--	--	--	0.700	0.100	0.100	0.100	0.100	0.100	7.00	--	0.100 U
Very coarse sand	percent	--	--	--	0.700	0.300	0.100	0.100 U	0.100	0.100	0.200	--	0.100
Coarse sand	percent	--	--	--	4.40	1.60	0.300	0.300	0.300	0.700	0.300	--	1.00
Medium sand	percent	--	--	--	9.40	6.70	1.40	1.00	1.40	1.20	1.60	--	2.60
Sand	percent	--	--	--	25.9	34.4	20.8	22.3	37.3	13.6	40.7	--	22.4
Fine sand	percent	--	--	--	3.40	9.20	3.00	5.80	13.6 J	2.10	15.8	--	3.60
Very fine sand	percent	--	--	--	8.00	16.6	16.0	15.2	21.9	9.50	22.8	--	15.1
Silt	percent	--	--	--	69.3	61.9	71.6	69.7	55.0	79.4	48.0	--	72.3
Clay	percent	--	--	--	4.10	3.70	7.50	7.90	7.60	6.80	4.40	--	5.20
Phi < -2.25	percent	--	--	--	0.400	0.100 U	0.100 U	0.100 U	0.100 U	0.100 U	6.90	--	0.100 U
Phi -2 to -2.25	percent	--	--	--	0.100 U	0.100 U	0.100	0.100 U	0.100	0.100 U	0.100 U	--	0.100 U
Phi -1 to -2	percent	--	--	--	0.300	0.100	0.100 U	0.100	0.100 U	0.100	0.100	--	0.100 U
Phi 4 to 5	percent	--	--	--	8.60	7.80	3.90	4.20	3.00	11.2	6.60	--	2.30
Phi 5 to 6	percent	--	--	--	44.1	38.3	56.5	50.5	41.6	52.9	29.0	--	50.8
Phi 6 to 7	percent	--	--	--	15.4	14.6	9.90	13.7	9.20	13.0	11.1	--	17.7
Phi 7 to 8	percent	--	--	--	1.20	1.20	1.30	1.30	1.20	2.30	1.30	--	1.50
Phi 8 to 9	percent	--	--	--	0.900	0.100 U	0.100 U	0.100 U	1.50	1.00	1.20	--	0.700
Phi 9 to 10	percent	--	--	--	0.500	0.100 U	0.100 U	0.100 U	0.900	0.500	0.900	--	0.500
Phi > 10	percent	--	--	--	2.70	3.70	7.50	7.90	5.20	5.30	2.30	--	4.00
Conventionals													
Ammonia as N	mg/kg	--	--	--	78.7	82.7	36.6	44.8	45.9	57.3	70.9 J	--	81.4
Preserved total solids	percent	--	--	--	49.3	51.6	46.1	46.4	51.1	42.2	52.1	--	44.4
Total organic carbon	percent	--	--	--	2.23	1.99	2.22	2.31	2.03	2.72	2.06	--	2.71
Total solids	percent	--	--	--	49.7	53.0	46.0	47.5	51.4	43.2	54.5	--	45.4
Total sulfides	mg/kg	--	--	--	3670 J	4130 J	2650 J	2070 J	3700 J	5960 J	3480 J	--	2650 J
Total volatile solids	percent	--	--	--	7.86	7.09	8.12	8.67	7.17 J	9.09 J	6.72	--	8.77
Metals													
Antimony	mg/kg	150	---	200	--	--	0.230 UJ	0.210 UJ	0.200 UJ	0.230 UJ	0.200 UJ	0.190 UJ	0.230 UJ
Arsenic	mg/kg	57	507.1	700	--	--	9.12	9.79	9.43	10.9	8.10	7.13	11.7
Cadmium	mg/kg	5.1	--	14	--	--	0.200 J	0.210	0.190 J	0.270	0.180	0.180 J	0.200 J
Chromium	mg/kg	260	--	---	--	--	23.3	27.5	22.3	25.3	21.2	20.9	31.7
Copper	mg/kg	390	--	1,300	--	--	41.3	43.4	36.1	51.1	32.7	28.9	51.1
Lead	mg/kg	450	975	1,200	--	--	13.1	14.0	11.8	17.0	11.4	10.1	18.5
Mercury	mg/kg	0.41	1.5	2.3	--	--	0.108 J	0.107 J	0.125 J	0.142 J	0.0759 J	0.0755 J	0.117
Selenium	mg/kg	---	3	---	--	--	1.67	1.48	1.80	1.78	1.21	1.52	2.97
Silver	mg/kg	6.1	--	8.4	--	--	0.150 J	0.170 J	0.140 J	0.180 J	0.130 J	0.120 J	0.180 J
Zinc	mg/kg	410	--	3,800	--	--	94.9	95.1	83.7	113	81.2	74.4	123
Polycyclic Aromatic Hydrocarbons													
Naphthalene	µg/kg	2,100	---	2,400	--	--	134	5.90 J	7.00 J	10.1 J	6.40 J	--	5.60 J
Acenaphthylene	µg/kg	560	---	1,300	--	--	6.20 U	6.20 U	6.20 U	6.20 U	6.20 U	--	6.20 U
Acenaphthene	µg/kg	500	---	2,000	--	--	5.20 U	5.20 U	5.20 U	5.20 U	5.20 U	--	5.20 U
Fluorene	µg/kg	540	---	3,600	--	--	14.5 U	14.6 U	14.6 U	14.6 U	14.6 U	--	14.5 U
Phenanthrene	µg/kg	1,500	---	21,000	--	--	69	32.3	44.2	55.5	41.1	--	35.3
Anthracene	µg/kg	960	---	13,000	--	--	20.7	8.90 J	10.5 J	19.3 J	8.20 J	--	8.30 J
2-Methylnaphthalene	µg/kg	670	---	1,900	--	--	13.7 J	5.50 J	6.70 J	9.10 J	7.40 J	--	5.50 J
Total LPAH[b]	µg/kg	5,200	---	29,000	--	--	224	47.1 J	61.7 J	84.9 J	55.7 J	--	49.2 J
Fluoranthene	µg/kg	1,700	4,600	30,000	--	--	117	82.4	101	146	101	--	103
Pyrene	µg/kg	2,600	11,980	16,000	--	--	143	91.2	117	187	99.2	--	107

Table 4. Analytical Results Compared to DMMP Guideline Values, Grain Size and Non-conventionals

		DMMP[a]			DYC_SL001	DYC_SL010	DYC_SL026	DYC_SL033	DYC_SL040	DYC_SL047	DYC_SL054	DYC_SL125	DYC_SL062
Analyte	Units	SL	BT	ML	DMMU 1	DMMU 1Z	DMMU 4	DMMU 5	DMMU 6	DMMU 7	DMMU 8	DMMU 8 - Replicate	DMMU 9
Benz(a)anthracene	µg/kg	1,300	---	5,100	--	--	47.1	31.5	36.6	67.4	34.6	--	40.7
Chrysene	µg/kg	1,400	---	21,000	--	--	73.6	45.2	55.1	96.7	53.4	--	63.3
Benzofluoranthenes, total[c]	µg/kg	3,200	---	9,900	--	--	156	84.8	95.8	176	89.0	--	108
Benzo(a)pyrene	µg/kg	1,600	---	3,600	--	--	61.4	38.7	43.4	86.1	38.6	--	46.0
Indeno(1,2,3-c,d)pyrene	µg/kg	600	---	4,400	--	--	40.9	36.2	38.6	64.7	35.9	--	41.8
Dibenz(a,h)anthracene	µg/kg	230	---	1,900	--	--	17.2 U	17.2 U	17.2 U	21.2	17.2 U	--	17.2 U
Benzo(ghi)perylene	µg/kg	670	---	3,200	--	--	44.4	48.9	49.5	77.4	48.3	--	51.8
Total HPAH[d]	µg/kg	12,000	---	69,000	--	--	683	459	537	922	500	--	562
Total PAHs	µg/kg	---	---	---	--	--	921 J	511 J	605 J	1020 J	563 J	--	616 J
Chlorinated Hydrocarbons													
1,4-Dichlorobenzene	µg/kg	110	---	120	--	--	6.30 U	6.40 U	6.40 U	6.40 U	6.40 U	--	6.30 U
1,2-Dichlorobenzene	µg/kg	35	---	110	--	--	0.700 U	0.700 U	0.700 U	0.700 U	0.700 U	--	0.700 U
1,2,4-Trichlorobenzene	µg/kg	31	---	64	--	--	2.70 U	2.70 U	2.70 U	2.70 U	2.70 U	--	2.70 U
Hexachlorobenzene (HCB)	µg/kg	22	168	230	--	--	1.20 J	0.700 U	0.700 U	0.700 U	0.700 U	--	0.700 U
Phthalate esters													
Dimethyl phthalate	µg/kg	71	---	1,400	--	--	9.60	8.70	7.20	19.7	7.8	--	21.9
Diethyl phthalate	µg/kg	200	---	1,200	--	--	20.6 U	29.8 U	59.6 U	39.9 U	52.6 U	--	40.7 U
Di-n-butyl phthalate	µg/kg	1,400	---	5,100	--	--	5.60 U	5.60 U	5.60 U	7.20 J	5.60 U	--	11.7 J
Butyl benzyl phthalate	µg/kg	63	---	970	--	--	14.7	14.7	11.8	28.5	11.1	--	27.0
Bis(2-ethylhexyl) phthalate	µg/kg	1,300	---	8,300	--	--	188 J	44.8 J	45.4 J	96.4	80.8 J	--	201 J
Di-n-octyl phthalate	µg/kg	6,200	---	6,200	--	--	4.40 U	4.40 U	4.40 U	4.40 U	4.40 U	--	4.40 U
Phenols													
Phenol	µg/kg	420	---	1,200	--	--	89.3	10.6 J	11.2 J	39.3 J	22.0	--	17.9 U
2-Methylphenol	µg/kg	63	---	77	--	--	6.60 U	6.70 U	6.70 U	6.70 U	6.70 U	--	6.60 U
4-Methylphenol	µg/kg	670	---	3,600	--	--	23.0	7.40 UJ	7.40 UJ	93.9 J	7.40 U	--	7.40 U
2,4-Dimethylphenol	µg/kg	29	---	210	--	--	2.20 UJ	2.20 U	2.20 U	2.20 U	2.20 U	--	2.20 U
Pentachlorophenol	µg/kg	400	504	690	--	--	31.2 U	31.3 UJ	31.2 UJ	31.2 UJ	31.2 U	--	31.2 U
Miscellaneous extractables													
Benzyl alcohol	µg/kg	57	---	870	--	--	31.4 J	27.7	36.3	71.2	27.9	--	66.1
Benzoic acid	µg/kg	650	---	760	--	--	723 J	46.2 J	57.4 J	63.4 J	53.9 J	--	53.3 J
Dibenzofuran	µg/kg	540	---	1,700	--	--	20.7	14.1 U	14.1 U	14.1 U	14.1 U	--	14.1 U
Hexachlorobutadiene	µg/kg	11	---	270	--	--	0.700 U	0.700 U	0.700 U	0.700 U	0.700 U	--	0.700 U
N-Nitrosodiphenylamine	µg/kg	28	---	130	--	--	1.30 U	1.30 U	1.30 U	1.30 U	4.88 J	--	1.30 U
Pesticides													
4,4'-DDD	µg/kg	16	---	---	--	--	1.59 J	1.74 J	1.46 J	2.31 J	1.22 J	--	1.70 J
4,4'-DDE	µg/kg	9	---	---	--	--	0.937 J	0.934 J	0.786 J	1.26 J	0.699 J	--	0.900 J
4,4'-DDT	µg/kg	12	---	---	--	--	0.604 J	0.388 J	0.633 J	0.762 J	0.318 J	--	0.500 J
Total 4,4'-DDx	µg/kg	---	50	69	--	--	3.13 J	3.07 J	2.88 J	4.34 J	2.24 J	--	3.10 J
Aldrin	µg/kg	10	---	---	--	--	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	--	0.200 U
trans-Chlordane	µg/kg	---	---	---	--	--	0.331 J	0.200 UJ	0.353 J	0.200 UJ	0.292 J	--	0.300 J
cis-Chlordane	µg/kg	---	---	---	--	--	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	0.250 J	--	0.400
cis-Nonachlor	µg/kg	---	---	---	--	--	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	--	0.200 U
trans-Nonachlor	µg/kg	---	---	---	--	--	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	--	0.200 U
Oxychlordane	µg/kg	---	---	---	--	--	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	--	0.200 U
Total Chlordane[e]	µg/kg	2.8	37	---	--	--	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	0.542 J	--	0.400
Dieldrin	µg/kg	1.9	---	1,700	--	--	0.200 UJ	0.381 J	0.331 J	0.200 UJ	0.200 UJ	--	0.300 J
Heptachlor	µg/kg	1.5	---	270	--	--	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	--	0.200 U
Endrin	µg/kg	---	---	---	--	--	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	0.200 UJ	--	0.200 UJ

Table 4. Analytical Results Compared to DMMP Guideline Values, Grain Size and Non-conventionals

		DMMP[a]			DYC_SL001	DYC_SL010	DYC_SL026	DYC_SL033	DYC_SL040	DYC_SL047	DYC_SL054	DYC_SL125	DYC_SL062
Analyte	Units	SL	BT	ML	DMMU 1	DMMU 1Z	DMMU 4	DMMU 5	DMMU 6	DMMU 7	DMMU 8	DMMU 8 - Replicate	DMMU 9
Polychlorinated biphenyls													
Aroclor 1016	µg/kg	---	---	---	--	--	7.80 U	7.80 U	7.80 U	7.80 U	7.80 U	--	3.10 U
Aroclor 1221	µg/kg	---	---	---	--	--	7.80 U	7.80 U	7.80 U	7.80 U	7.80 U	--	3.10 U
Aroclor 1232	µg/kg	---	---	---	--	--	7.80 U	7.80 U	7.80 U	7.80 U	7.80 U	--	3.10 U
Aroclor 1242	µg/kg	---	---	---	--	--	7.80 U	7.80 U	7.80 U	7.80 U	7.80 U	--	3.10 U
Aroclor 1248	µg/kg	---	---	---	--	--	20.8 J	19.0 J	15.6 J	23.3	60.5 UJ	--	17.8
Aroclor 1254	µg/kg	---	---	---	--	--	35.3 J	35.9 J	25.0 J	38.6 J	24.4 J	--	15.9
Aroclor 1260	µg/kg	---	---	---	--	--	16.7 J	19.7 J	13.0 J	20.3	17.1 J	--	20.0
Aroclor 1262	µg/kg	---	---	---	--	--	2.90 U	2.90 U	2.90 U	2.90 U	2.90 U	--	1.20 UJ
Aroclor 1268	µg/kg	---	---	---	--	--	2.90 U	2.90 U	2.90 U	2.90 U	2.90 U	--	1.20 UJ
Total PCB Aroclors	µg/kg	130	---	3,100	--	--	72.8 J	74.6 J	53.6 J	82.2 J	41.5 J	--	53.7
Total PCB Aroclors	mg/kg TOCN		38[f]		--	--	3.28 J	3.23 J	2.64 J	3.02 J	2.01 J	--	1.98
Dioxins/Furans													
2,3,7,8-TCDD	ng/kg	--	--	--	0.48	0.471 U	0.42 U	0.396 U	0.369 U	0.549 U	0.398 U	0.530 U	0.511 U
1,2,3,7,8-PeCDD	ng/kg	--	--	--	1.52	1.5	1.1	0.958 U	0.844 U	1.53	0.968 U	1.13	1.28 J
1,2,3,4,7,8-HxCDD	ng/kg	--	--	--	1.31	1.09	1.15	1.11	0.855 J	1.5	0.841 U	0.878 J	1.03 J
1,2,3,6,7,8-HxCDD	ng/kg	--	--	--	4.2	4.15	3.93	4.03	3.04	7	2.94	3.33	3.83
1,2,3,7,8,9-HxCDD	ng/kg	--	--	--	3.77	3.52	3.52	3 J	2.54	4.52	2.85	2.53	3.71
1,2,3,4,6,7,8-HpCDD	ng/kg	--	--	--	96.4	99	94.4	83.7	66.3	207	62.9	74.6	82.6
OCDD	ng/kg	--	--	--	717	699	813 J	705 J	556 J	1530 J	524 J	588 J	721 J
2,3,7,8-TCDF	ng/kg	--	--	--	0.77	0.906 J	0.654 J	0.652 U	0.308 J	0.914 U	0.417 J	0.535 U	0.367 J
1,2,3,7,8-PeCDF	ng/kg	--	--	--	0.91	0.613 J	0.52 J	0.591 J	0.407 J	0.788 J	0.415 U	0.392 J	0.324 J
2,3,4,7,8-PeCDF	ng/kg	--	--	--	0.88	0.538 U	0.857 U	0.807 U	0.45 U	1.14	0.491 U	0.529 J	0.467 J
1,2,3,4,7,8-HxCDF	ng/kg	--	--	--	2.32	1.73 J	2.69	2	1.77	9.62	1.26	1.72	1.4
1,2,3,6,7,8-HxCDF	ng/kg	--	--	--	0.87	0.905 U	1.28	0.947 J	0.787 J	2.46	0.661 U	0.890 J	0.731 U
1,2,3,7,8,9-HxCDF	ng/kg	--	--	--	0.43 J	0.367 U	0.482 J	0.555 U	0.487 U	2.07	0.344 J	0.824 J	0.364 U
2,3,4,6,7,8-HxCDF	ng/kg	--	--	--	1.16	1.34	1.24	0.916 U	1.01	1.48 J	1.05	0.699 J	0.696 U
1,2,3,4,6,7,8-HpCDF	ng/kg	--	--	--	19.8	18.6	33 J	21.3	17	71.2	13.8	17.2	18
1,2,3,4,7,8,9-HpCDF	ng/kg	--	--	--	1.36	1.32	2.72	1.75 J	1.42	6.68	1.09	1.24	1.5 J
OCDF	ng/kg	--	--	--	50.7	41.5	98 J	52.3	41.8	283	38.6	33.6	57.8
Total TCDD	ng/kg	--	--	--	1.52	0.602 J	1.08	1.78	0.851 J	1.31	2.20	2.38	1.83
Total TCDF	ng/kg	--	--	--	5.11	4.21 J	3.19	3.4	1.26	5.13	1.75	3.73	2.11
Total PeCDD	ng/kg	--	--	--	2.55	3.94	3.45	2.94	2.06	4.32	2.29	4.00	1.16
Total PeCDF	ng/kg	--	--	--	9.15	5.31 J	7.21 J	7.71	5.2	16.1	2.87 J	6.64 J	5.32
Total HxCDD	ng/kg	--	--	--	38.9	37.2 J	30.4	29.2	25	50.6	26.2	25.0	36.6
Total HxCDF	ng/kg	--	--	--	12.6	23.2	36.3	28.6	22.3	95.4	18.0	26.9	22.2
Total HpCDD	ng/kg	--	--	--	238	234	202	183	145	407	129	154	180
Total HpCDF	ng/kg	--	--	--	60.3	58.3	101 J	65	54.9	313	43.0	53.2	67.9
TEQ (ND=DL)	ng/kg	--	--	--	5.18 J	4.96 J	4.86 J	4.23 J	3.47 J	8.79 J	3.51 J	4.09 J	4.41 J
TEQ (ND=1/2 DL)	ng/kg	4 -10[g]	10[g]	--	5.18 J	4.58 J	4.52 J	3.33 J	2.77 J	8.47 J	2.67 J	3.80 J	4.06 J
TEQ (ND=0)	ng/kg	--	--	--	5.18 J	4.2 J	4.18 J	2.42 J	2.07 J	8.15 J	1.83 J	3.50 J	3.72 J

Table 4. Analytical Results Compared to DMMP Guideline Values, Grain Size and Non-conventionals

		DMMP[a]			DYC_SL070	DYC_SL128	DYC_SL077	DYC_SL126	DYC_SL127	DYC_SL095	DYC_SL111
Analyte	Units	SL	BT	ML	DMMU 10	DMMU 10 - MS/MSD	DMMU 11	MMU 11 - Triplicate	MMU 11 - Triplicate	DMMU 12	DMMU 13
Grain Size											
Gravel	percent	--	--	--	0.900	--	0.100 U	0.100 U	0.200	0.100	0.300
Very coarse sand	percent	--	--	--	2.10	--	0.100 U	0.100	0.200	0.300	1.20
Coarse sand	percent	--	--	--	7.80	--	0.300	0.300	0.300	0.700	3.90
Medium sand	percent	--	--	--	30.8	--	3.40	3.60	2.10	5.90	8.50
Sand	percent	--	--	--	58.3	--	35.2	36.1	35.4	23.3	38.2
Fine sand	percent	--	--	--	10.5	--	16.1	16.2	14.8	7.00	11.5
Very fine sand	percent	--	--	--	7.10	--	15.4	15.9	18.0	9.40	13.1
Silt	percent	--	--	--	37.5	--	60.3	59.4	59.8	72.6	56.2
Clay	percent	--	--	--	3.40	--	4.60	4.50	4.70	4.00	5.30
Phi < -2.25	percent	--	--	--	0.100 U	--	0.100 U	0.100 U	0.100	0.100 U	0.100 U
Phi -2 to -2.25	percent	--	--	--	0.100 U	--	0.100 U	0.100 U	0.100 U	0.100 U	0.100 U
Phi -1 to -2	percent	--	--	--	0.900	--	0.100 U	0.100 U	0.100	0.100	0.300
Phi 4 to 5	percent	--	--	--	2.40	--	11.1	11.0	9.20	10.6	9.40
Phi 5 to 6	percent	--	--	--	23.5	--	34.2	33.4	34.8	42.6	25.6
Phi 6 to 7	percent	--	--	--	11.2	--	14.6	14.6	14.8	17.9	19.2
Phi 7 to 8	percent	--	--	--	0.400	--	0.400	0.400	1.00	1.50	2.00
Phi 8 to 9	percent	--	--	--	1.10	--	0.600	1.20	0.800	0.700	1.30
Phi 9 to 10	percent	--	--	--	0.900	--	0.500	0.900	0.600	0.500	0.900
Phi > 10	percent	--	--	--	1.40	--	3.50	2.40	3.30	2.80	3.10
Conventionals											
Ammonia as N	mg/kg	--	--	--	50.7	--	128 J	119 J	116 J	133	117
Preserved total solids	percent	--	--	--	55.2	--	51.1	51.0	52.0	51.5	58.3
Total organic carbon	percent	--	--	--	2.10	--	2.22	2.21	2.15	3.26	1.96
Total solids	percent	--	--	--	55.9	--	52.7	54.9	54.0	48.0	56.6
Total sulfides	mg/kg	--	--	--	2310 J	--	2990 J	3160 J	4740 J	3300 J	1880 J
Total volatile solids	percent	--	--	--	6.71	--	7.22	7.31	7.27	9.05	7.30
Metals											
Antimony	mg/kg	150	---	200	0.170 UJ	0.200 UJ	0.19 UJ	--	--	0.190 UJ	0.170 UJ
Arsenic	mg/kg	57	507.1	700	9.33	9.67	8.87	--	--	11.7	9.85
Cadmium	mg/kg	5.1	--	14	0.220	0.280	0.240	--	--	0.440	0.380
Chromium	mg/kg	260	--	---	49.5	51.6	21.8	--	--	37.7	27.0
Copper	mg/kg	390	--	1,300	55.1	53.2	36.0	--	--	61.3	49.9
Lead	mg/kg	450	975	1,200	36.9	33.4	13.7	--	--	28.4	29.9
Mercury	mg/kg	0.41	1.5	2.3	0.0929	0.0894	0.0855 J	--	--	0.172	0.0606
Selenium	mg/kg	---	3	---	1.87	1.44	1.38	--	--	2.71	2.76
Silver	mg/kg	6.1	--	8.4	0.240 J	0.140 J	0.160 J	--	--	0.610 J	0.700 J
Zinc	mg/kg	410	--	3,800	266	257	94.6	--	--	192	122
Polycyclic Aromatic Hydrocarbons											
Naphthalene	µg/kg	2,100	---	2,400	13.1 J	9.60 J	7.50 J	--	--	8.80 J	11.2 J
Acenaphthylene	µg/kg	560	---	1,300	6.20 U	6.20 U	6.20 U	--	--	6.20 U	6.20 U
Acenaphthene	µg/kg	500	---	2,000	24.3	11.2 J	8.40 J	--	--	11.7 J	11.6 J
Fluorene	µg/kg	540	---	3,600	26.1	14.8 J	14.5 U	--	--	14.6 U	14.5 U
Phenanthrene	µg/kg	1,500	---	21,000	289 J	128 J	91.5	--	--	130	98.5
Anthracene	µg/kg	960	---	13,000	51.2	33.2	20.6	--	--	33.1	26.8
2-Methylnaphthalene	µg/kg	670	---	1,900	9.10 J	7.80 J	7.40 J	--	--	7.90 J	10.2 J
Total LPAH[b]	µg/kg	5,200	---	29,000	404 J	197 J	128 J	--	--	184 J	148 J
Fluoranthene	µg/kg	1,700	4,600	30,000	503 J	283 J	228	--	--	307	265
Pyrene	µg/kg	2,600	11,980	16,000	475 J	276 J	220	--	--	334	305

Table 4. Analytical Results Compared to DMMP Guideline Values, Grain Size and Non-conventionals

Analyte	Units	DMMP[a] SL	BT	ML	DYC_SL070 DMMU 10	DYC_SL128 DMMU 10 - MS/MSD	DYC_SL077 DMMU 11	DYC_SL126 MMU 11 - Triplicate	DYC_SL127 MMU 11 - Triplicate	DYC_SL095 DMMU 12	DYC_SL111 DMMU 13
Benz(a)anthracene	µg/kg	1,300	---	5,100	209	126	89.1	--	--	121	97.6
Chrysene	µg/kg	1,400	---	21,000	295 J	175 J	136	--	--	185	138
Benzofluoranthenes, total[c]	µg/kg	3,200	---	9,900	458	324	205	--	--	328	266
Benzo(a)pyrene	µg/kg	1,600	---	3,600	236	155	95.3	--	--	160	132
Indeno(1,2,3-c,d)pyrene	µg/kg	600	---	4,400	109	67.4	83.4	--	--	96.7	83.0
Dibenz(a,h)anthracene	µg/kg	230	---	1,900	27.9	17.3 J	27.8	--	--	25.5	21.3
Benzo(ghi)perylene	µg/kg	670	---	3,200	110 J	64.7 J	96.2	--	--	102	83.4
Total HPAH[d]	µg/kg	12,000	---	69,000	2420 J	1490 J	1180	--	--	1660	1390
Total PAHs	µg/kg	---	---	---	2840 J	1690 J	1320 J	--	--	1850 J	1550 J
Chlorinated Hydrocarbons											
1,4-Dichlorobenzene	µg/kg	110	---	120	6.40 U	6.30 U	6.30 U	--	--	6.40 U	6.30 U
1,2-Dichlorobenzene	µg/kg	35	---	110	0.700 U	0.700 U	0.700 U	--	--	0.700 U	1.00 J
1,2,4-Trichlorobenzene	µg/kg	31	---	64	2.70 U	2.70 U	2.70 U	--	--	2.70 U	2.70 U
Hexachlorobenzene (HCB)	µg/kg	22	168	230	0.700 U	0.700 U	0.700 U	--	--	0.700 U	0.700 U
Phthalate esters											
Dimethyl phthalate	µg/kg	71	---	1,400	98.1 J	185 J	29.9	--	--	128	132
Diethyl phthalate	µg/kg	200	---	1,200	30.6 U	47.2 U	42.3 U	--	--	34.3 U	48.1 U
Di-n-butyl phthalate	µg/kg	1,400	---	5,100	19.1 J	106	6.60 J	--	--	15.8 J	7.90 J
Butyl benzyl phthalate	µg/kg	63	---	970	82.2	66.9	24.8	--	--	62.3	35.4
Bis(2-ethylhexyl) phthalate	µg/kg	1,300	---	8,300	661 J	736 J	235 J	--	--	380 J	365 J
Di-n-octyl phthalate	µg/kg	6,200	---	6,200	34.2	32.6	4.40 U	--	--	15.4 J	9.30 J
Phenols											
Phenol	µg/kg	420	---	1,200	20.3 U	19.3 U	115 J	--	--	140 J	54.8
2-Methylphenol	µg/kg	63	---	77	6.70 U	6.60 U	6.60 U	--	--	6.70 U	6.60 U
4-Methylphenol	µg/kg	670	---	3,600	7.40 U	7.40 U	7.40 U	--	--	7.40 U	7.40 U
2,4-Dimethylphenol	µg/kg	29	---	210	2.20 U	2.20 U	2.20 U	--	--	2.20 U	2.20 U
Pentachlorophenol	µg/kg	400	504	690	31.2 U	31.2 U	31.2 U	--	--	31.2 U	31.2 U
Miscellaneous extractables											
Benzyl alcohol	µg/kg	57	---	870	35.2	26.4	26.9	--	--	26.1	20.5
Benzoic acid	µg/kg	650	---	760	84.3 J	67.4 J	50.7 J	--	--	47.5 J	39.0 UJ
Dibenzofuran	µg/kg	540	---	1,700	14.6 J	14.1 U	14.1 U	--	--	14.1 U	14.1 U
Hexachlorobutadiene	µg/kg	11	---	270	0.700 U	0.700 U	0.700 U	--	--	0.700 U	0.700 U
N-Nitrosodiphenylamine	µg/kg	28	---	130	1.30 U	4.60 J	1.30 U	--	--	1.30 U	5.48 J
Pesticides											
4,4'-DDD	µg/kg	16	---	---	2.30 J	2.50 J	1.78 J	--	--	2.60 J	4.90 J
4,4'-DDE	µg/kg	9	---	---	1.10 J	1.20 J	0.808 J	--	--	1.50 J	1.60 J
4,4'-DDT	µg/kg	12	---	---	1.20 J	0.500 J	0.401 J	--	--	1.90 J	0.600 J
Total 4,4'-DDx	µg/kg	---	50	69	4.60 J	4.20 J	2.99 J	--	--	6.00 J	7.10 J
Aldrin	µg/kg	10	---	---	0.200 U	0.200 U	0.200 UJ	--	--	0.200 U	0.200 U
trans-Chlordane	µg/kg	---	---	---	1.10	1.30	0.314 J	--	--	0.800	0.900
cis-Chlordane	µg/kg	---	---	---	1.10	1.50	0.346 J	--	--	0.800	0.800
cis-Nonachlor	µg/kg	---	---	---	0.200 U	0.200 U	0.200 UJ	--	--	0.200 U	0.200 U
trans-Nonachlor	µg/kg	---	---	---	0.200 U	0.200 U	0.200 UJ	--	--	0.200 U	0.200 U
Oxychlordane	µg/kg	---	---	---	0.200 U	0.200 U	0.200 UJ	--	--	0.200 U	0.200 U
Total Chlordane[e]	µg/kg	2.8	37	---	2.20	2.80	0.660 J	--	--	1.60	1.80
Dieldrin	µg/kg	1.9	---	1,700	0.700	0.900	0.223 J	--	--	0.200 U	0.200 U
Heptachlor	µg/kg	1.5	---	270	0.200 U	0.200 U	0.200 UJ	--	--	0.200 U	0.200 U
Endrin	µg/kg	---	---	---	0.200 UJ	0.200 UJ	0.200 UJ	--	--	0.200 UJ	0.200 UJ

Table 4. Analytical Results Compared to DMMP Guideline Values, Grain Size and Non-conventionals

		DMMP[a]			DYC_SL070	DYC_SL128	DYC_SL077	DYC_SL126	DYC_SL127	DYC_SL095	DYC_SL111
Analyte	Units	SL	BT	ML	DMMU 10	DMMU 10 - MS/MSD	DMMU 11	MMU 11 - Triplicate	MMU 11 - Triplicate	DMMU 12	DMMU 13
Polychlorinated biphenyls											
Aroclor 1016	µg/kg	---	---	---	3.10 U	3.10 U	7.80 U	--	--	3.10 U	3.10 U
Aroclor 1221	µg/kg	---	---	---	3.10 U	3.10 U	7.80 U	--	--	3.10 U	3.10 U
Aroclor 1232	µg/kg	---	---	---	3.10 U	3.10 U	7.80 U	--	--	3.10 U	3.10 U
Aroclor 1242	µg/kg	---	---	---	3.10 U	3.10 U	7.80 U	--	--	3.10 U	3.10 U
Aroclor 1248	µg/kg	---	---	---	21.8	15.9	80.7 UJ	--	--	25.8	29.6
Aroclor 1254	µg/kg	---	---	---	25.7 J	22.3	41.0	--	--	23.6	32.7
Aroclor 1260	µg/kg	---	---	---	18.9	23.0	18.5 J	--	--	27.5	32.3
Aroclor 1262	µg/kg	---	---	---	1.20 UJ	1.20 UJ	2.90 U	--	--	1.20 UJ	1.20 UJ
Aroclor 1268	µg/kg	---	---	---	1.20 UJ	1.20 UJ	2.90 U	--	--	1.20 UJ	1.20 UJ
Total PCB Aroclors	µg/kg	130	---	3,100	66.4 J	61.2	59.5 J	--	--	76.9	94.6
Total PCB Aroclors	mg/kg TOCN		38[f]		3.16 J		2.71 J	--	--	2.36	4.83
Dioxins/Furans											
2,3,7,8-TCDD	ng/kg	--	--	--	3.31	--	0.775 U	--	--	3.69	1.86
1,2,3,7,8-PeCDD	ng/kg	--	--	--	9.12	--	1.99	--	--	8.36	4.77
1,2,3,4,7,8-HxCDD	ng/kg	--	--	--	3.07	--	1.59	--	--	2.73	1.55
1,2,3,6,7,8-HxCDD	ng/kg	--	--	--	12.7	--	5.79	--	--	11.9	8.17
1,2,3,7,8,9-HxCDD	ng/kg	--	--	--	16.6	--	6.65	--	--	14.3	10
1,2,3,4,6,7,8-HpCDD	ng/kg	--	--	--	187	--	125	--	--	186	134
OCDD	ng/kg	--	--	--	1360 J	--	1030 J	--	--	1480 J	1060 J
2,3,7,8-TCDF	ng/kg	--	--	--	0.797 J	--	0.656 J	--	--	0.777 U	0.493 U
1,2,3,7,8-PeCDF	ng/kg	--	--	--	0.961 U	--	0.609 J	--	--	0.837 U	0.55 J
2,3,4,7,8-PeCDF	ng/kg	--	--	--	1.04 J	--	0.817 J	--	--	1.12 J	0.696 U
1,2,3,4,7,8-HxCDF	ng/kg	--	--	--	2.96	--	2.45	--	--	3.32	4.61
1,2,3,6,7,8-HxCDF	ng/kg	--	--	--	1.65 J	--	1.3	--	--	1.69	1.27
1,2,3,7,8,9-HxCDF	ng/kg	--	--	--	1.08	--	0.588 J	--	--	1.02 J	0.789 J
2,3,4,6,7,8-HxCDF	ng/kg	--	--	--	1.22 J	--	1.05 J	--	--	1.1	0.942 J
1,2,3,4,6,7,8-HpCDF	ng/kg	--	--	--	26	--	21.7	--	--	29.3	30.5
1,2,3,4,7,8,9-HpCDF	ng/kg	--	--	--	2.03	--	1.78	--	--	2.21	4.7
OCDF	ng/kg	--	--	--	46.2	--	56.7	--	--	64.2	66.1
Total TCDD	ng/kg	--	--	--	11.8	--	1.81	--	--	16	5.81
Total TCDF	ng/kg	--	--	--	10.1	--	6.88	--	--	7.43	3.88
Total PeCDD	ng/kg	--	--	--	33.2	--	7.83	--	--	34.9	19.9
Total PeCDF	ng/kg	--	--	--	14	--	8.26	--	--	16.2	10.2
Total HxCDD	ng/kg	--	--	--	147	--	61.5	--	--	134	93.7
Total HxCDF	ng/kg	--	--	--	54.5	--	35	--	--	57.7	44.7
Total HpCDD	ng/kg	--	--	--	381	--	262	--	--	399	288
Total HpCDF	ng/kg	--	--	--	78.3	--	72.2	--	--	94	111
TEQ (ND=DL)	ng/kg	--	--	--	19.4 J	--	6.85 J	--	--	18.7 J	11.7 J
TEQ (ND=1/2 DL)	ng/kg	4 -10[g]	10[g]	--	19.3 J	--	6.46 J	--	--	18.7 J	11.5 J
TEQ (ND=0)	ng/kg	--	--	--	19.3 J	--	6.07 J	--	--	18.6 J	11.4 J

Table 4. Analytical Results Compared to DMMP Guideline Values, Grain Size and Non-conventionals

Notes:

Shaded values represent concentration that exceed one or more of the listed DMMP criterion.

BT = bioaccumulation trigger
DL = detection limit
DMMP = Dredged Material Management Program
DMMU = Dredged Material Management Unit
HPAH = high molecular weight polycyclic aromatic hydrocarbons
LPAH = low molecular weight polycyclic aromatic hydrocarbons
µg/kg = microgram per kilogram
mg/kg = milligram per kilogram
ML = maximum limit
ND = non-detect
ng/kg = nanogram per kilogram
PCB = polychlorinated biphenyl
SL = screening level
TEQ = toxicity equivalence
TOCN = total organic carbon normalized

Data Qualifiers:
J = the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
U = the analyte was analyzed for, but was not detected above the reported sample quantitation limit.
UJ = the analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

[a] Criteria from DMMP Table 8-3
[b] Total LPAH includes naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene.
[c] Total benzofluoranthenes represents the sum of the concentrations of the "B," "J," and "K" isomers.
[d] Total HPAH includes fluoranthene, pyrene, benz[a]anthracene, chrysene, total benzofluoranthenes, benzo[a]yrene, indeno[1,2,3-cd]pyrene, dibenz[a,h]anthracene, and benzo[ghi]perylene.
[e] Total chlordane includes cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane.
[f] This value is normalized to total organic carbon and is expressed in mg/kg carbon.
[g] Puget Sound only.

Table 5. DMMU 4 and DMMU 7 Archive Sample Analytical Results Compared to DMMP Guideline Values

		DMMP			DYC_SL027	DYC_SL028	DYC_SL029	DYC_SL030	DYC_SL031	DYC_SL032	DYC_SL048	DYC_SL049	DYC_SL050	DYC_SL051	DYC_SL052	DYC_SL053
Analyte	Units	SL	BT	ML	DYC04-C1-A	DYC04-C2-A	DYC04-C3-A	DYC04-C4-A	DYC04-C5-A	DYC04-C40-A	DYC04-C16-A	DYC04-C17-A	DYC04-C18-A	DYC04-C19-A	DYC04-C20-A	DYC04-C43-A
Miscellaneous extractables																
Benzyl alcohol	µg/kg	57	---	870	--	--	--	--	--	--	36.1	73.3	55.8	47.4	61.0	66.9
Benzoic acid	µg/kg	650	---	760	73.8 J	39.8 J	42.0 J	39.0 UJ	39.0 UJ	46.6 J	--	--	--	--	--	--

Notes:

BT = bioaccumulation trigger
DMMP = Dredged Material Management Program
DMMU = Dredged Material Management Unit
µg/kg = microgram per kilogram
ML = maximum limit
SL = screening level

Shaded values represent concentration that exceed one or more of the listed DMMP criterion.

Data Qualifiers:
J = the analyte was positiively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

U = the analyte was analyzed for, but was not detected above the reported sample quantitation limit.

Table 6. Bioassay Results for Control, Reference, and Onsite Sediments

Sample	Grain Size (% fines)	Amphipod Test: Mortality (%)	Larval Test: Mean Normal Survival	Juvenile Polychaete Test: Mean Growth Rate - AFDW (mg/ind/day)
Control	NA	3 (Eoh)	0.84	0.573
		2 (Lepto)		
CARR52-23-REF	52	4 (Eoh)	0.79	0.711
CARR70-23-REF	70	0 (Lepto)	0.72	0.764
DMMU 9	78	12 (Lepto)	0.41	0.589
DMMU 10	41	3 (Eoh)	0.11	0.521
DMMU 12	77	25 (Lepto)	0.24	0.475
DMMU 13	62	54 (Lepto)	0.29	0.485

Notes:

The reference samples were collected from Carr Inlet, Washington. CARR52-23-REF is the reference sample associated with DMMU-10. CARR70-23-REF is the reference sample associated with DMMU-09, 12, and 13.

AFDW = ash-free dry weight
mg/ind/day = milligrams per individual per day

Test species:
amphipod: *Eohaustorius estuarius (Eoh)* and *Leptocherius plumulosus (Lepto)*
larvae: *Mytilus galloprovincialis*
polychaete: *Neanthes arenaceodentata*

Table 8. Bioassay Results Relative to Performance Standards and Interpretive Criteria

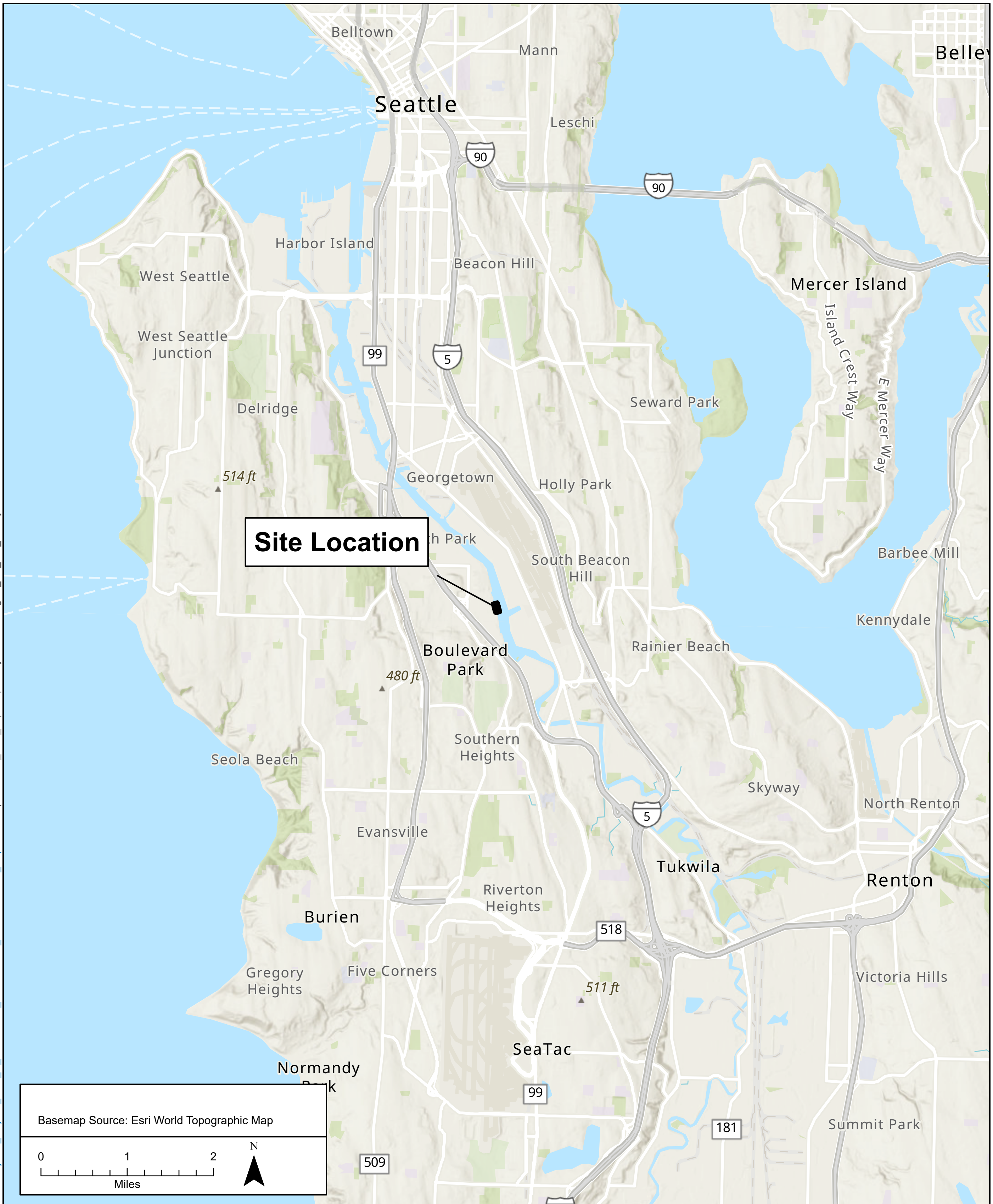
	Negative Control		Reference Sediment		Nondispersive Disposal Site Interpretation Guidelines									
Test	Performance Standard	Result	Performance Standard	Result	1-Hit Rule	2-Hit-Rule	DMMU-09 Result	Result Summary	DMMU-10 Result	Result Summary	DMMU-12 Result	Result Summary	DMMU-13 Result	Result Summary
Amphipod Mortality	$M_C \leq 10\%$	3% (Eoh) 2% (Lepto)	$\lvert M_R - M_C \rvert \leq 20\%$	1% (Eoh) 2% (Lepto)	$M_T - M_C > 20\%$ and M_T vs. M_R SS (p=.05) and		10% (Lepto) Yes	Pass	0% (Eoh) No	Pass	23% (Lepto) Yes	Fail (2-Hit)	52% (Lepto) Yes	Fail (1-Hit)
					$M_T - M_R > 30\%$	NOCN	12%		-1%		25%		54%	
Larval Development	$N_C/I \geq 0.70$	0.84	$N_R/N_C \geq 0.65$	0.79 (CARR52-23-REF) 0.72 (CARR70-23-REF)	$N_T/N_C < 0.80$ and N_T/N_C vs. N_R/N_C SS (p=.10) and		0.41 Yes	Fail (1-Hit)	0.11 Yes	Fail (1-Hit)	0.24 Yes	Fail (1-Hit)	0.29 Yes	Fail (1-Hit)
					$N_R/N_C - N_T/N_C > 0.30$	NOCN	0.31		0.68		0.48		0.43	
Juvenile Polychaete Growth (AFDW)	$M_C \leq 10\%$ and $MIG_C \geq 0.38$	0.0% 0.573	$M_R \leq 20\%$ and $MIG_R/MIG_C \geq 0.80$	0% 1.24 (CARR52-23-REF) 1.33 (CARR70-23-REF)	$MIG_T/MIG_C < 0.80$ and MIG_T vs. MIG_R SS (p=.05) and		1.03 No	Pass	0.91 No	Pass	0.83 Yes	Pass	0.85 Yes	Pass
					$MIG_T/MIG_R < 0.50$	$MIG_T/MIG_R < 0.70$	0.77		0.73		0.62		0.63	

Notes:

Source: DMMP User Manual Table 9-7 (DMMP 2021)

The reference samples were collected from Carr Inlet, Washington. CARR52-23-REF is the reference sample associated with DMMU-10. CARR70-23-REF is the reference sample associated with DMMU-09, 12, and 13.

AFDW = ash-free dry weight
DMMO = Dredged Material Management Office
I = initial count
M = mortality
MIG = mean individual growth rate (mg/individual/day)
N = number normal larvae
NA = not analyzed
NOCN = no other conditions necessary
SS = statistically significant
Subscripts:
C = negative control
R = reference sediment
T = test sample
Test species:
amphipod: *Eohaustorius estuarius (Eoh)* and *Leptocherius plumulosus (Lepto)*
larvae: *Mytilus galloprovincialis*
polychaete: *Neanthes arenaceodentata*



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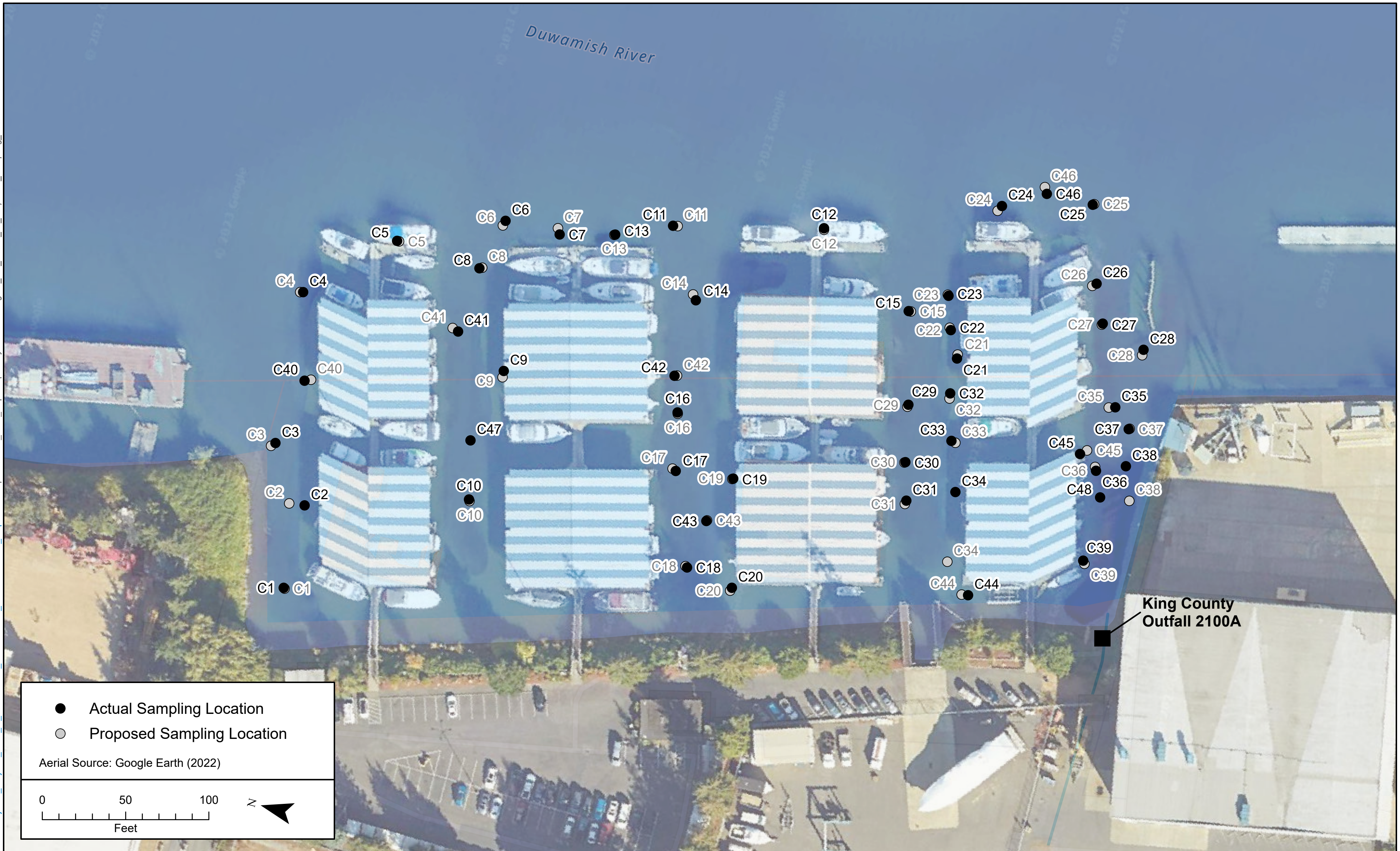
integral consulting inc.

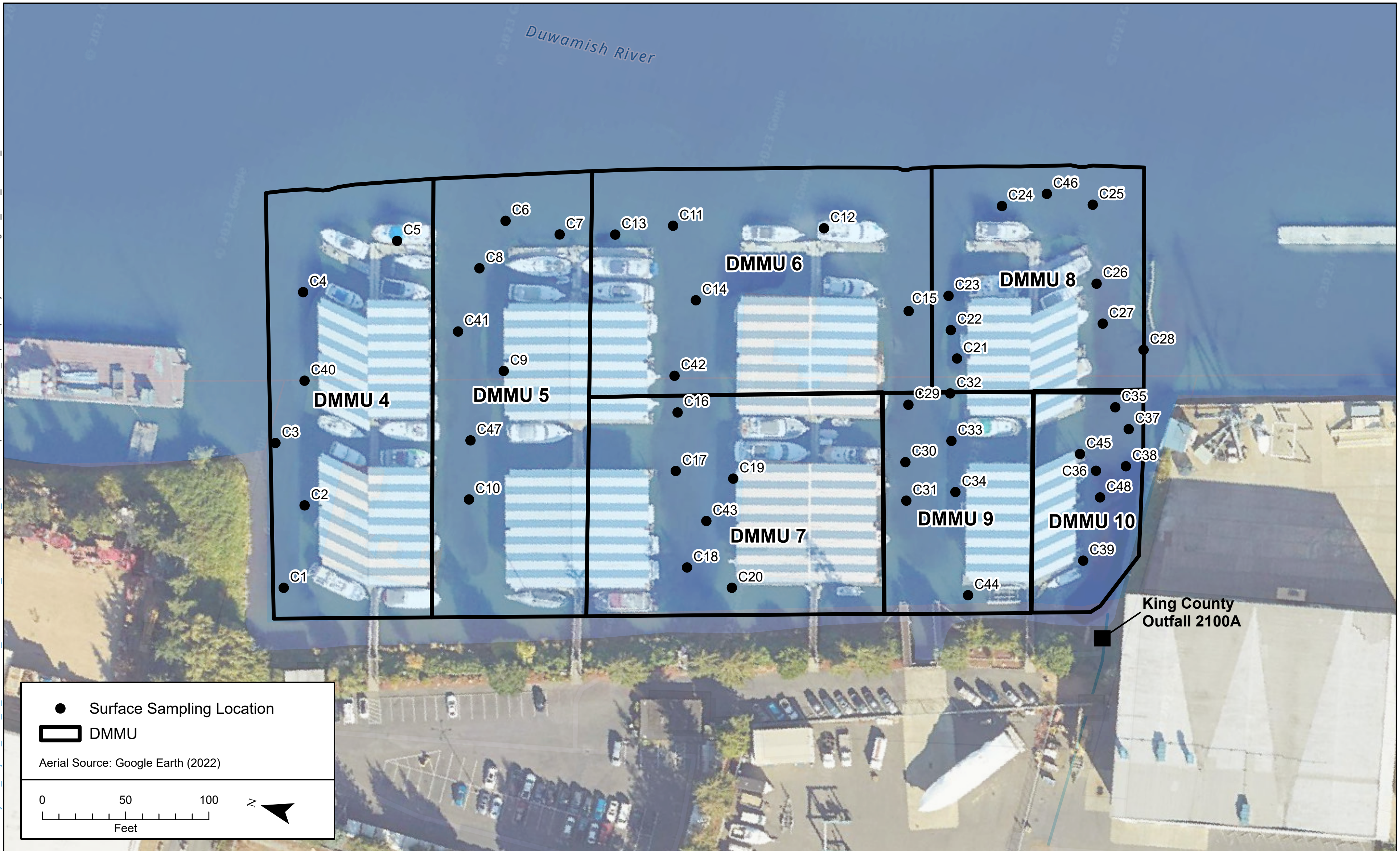
Figure 1.
Site Vicinity



integral consulting inc.

Note:
1. Location of processed and accepted sediment samples displayed

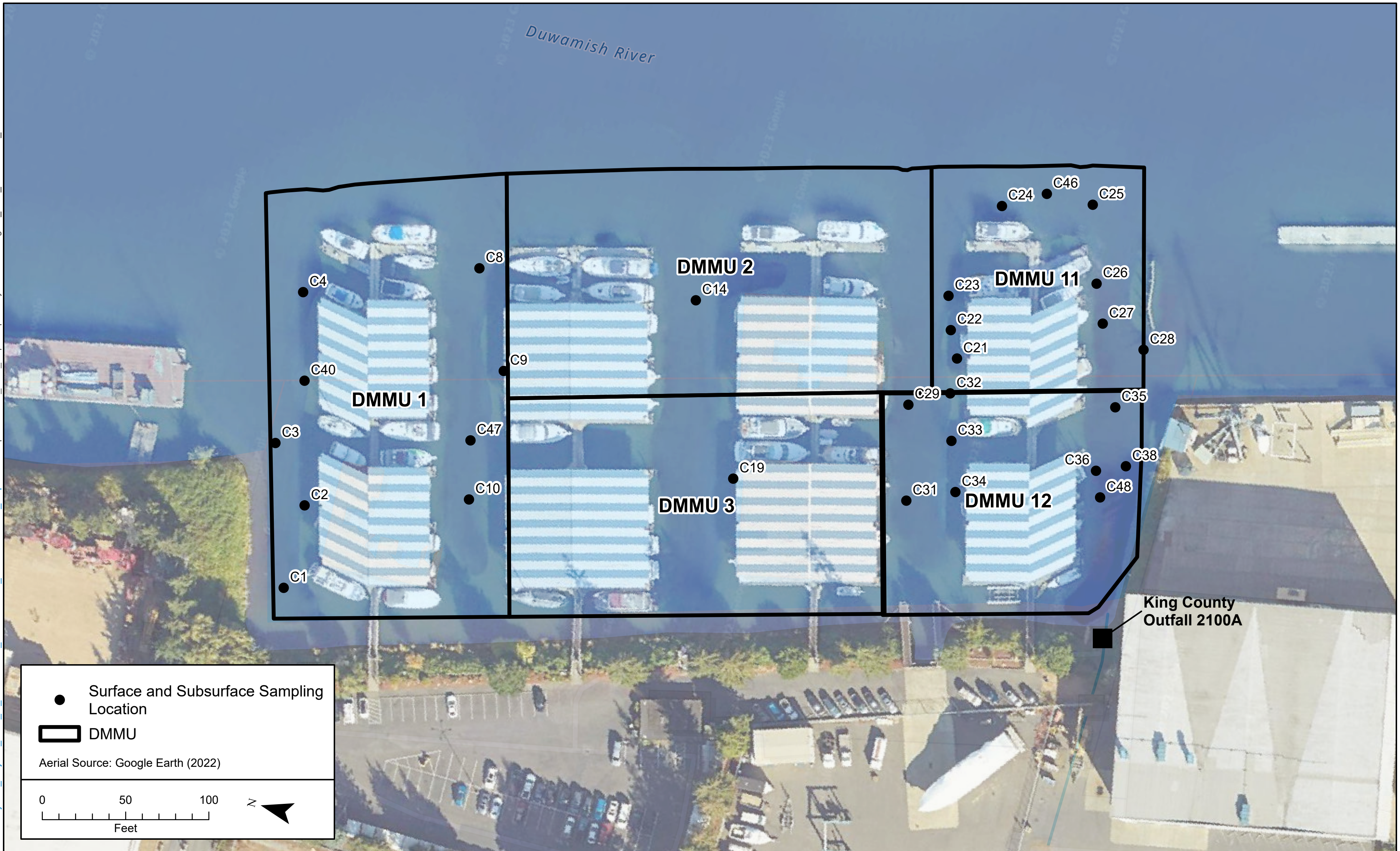
Figure 2.
Actual vs Proposed Sediment Sampling Locations
Duwamish Yacht Club 2023



integral consulting inc.

Note:
1. Location of processed and accepted sediment samples displayed

Figure 3.
Duwamish Yacht Club 2023 Surface Dredged Material Management Units and Sediment Sampling Locations



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Note:
1. Location of processed and accepted sediment samples displayed

Figure 4.
Duwamish Yacht Club 2023 Subsurface Dredged Material Management Units and Sediment Sampling Locations

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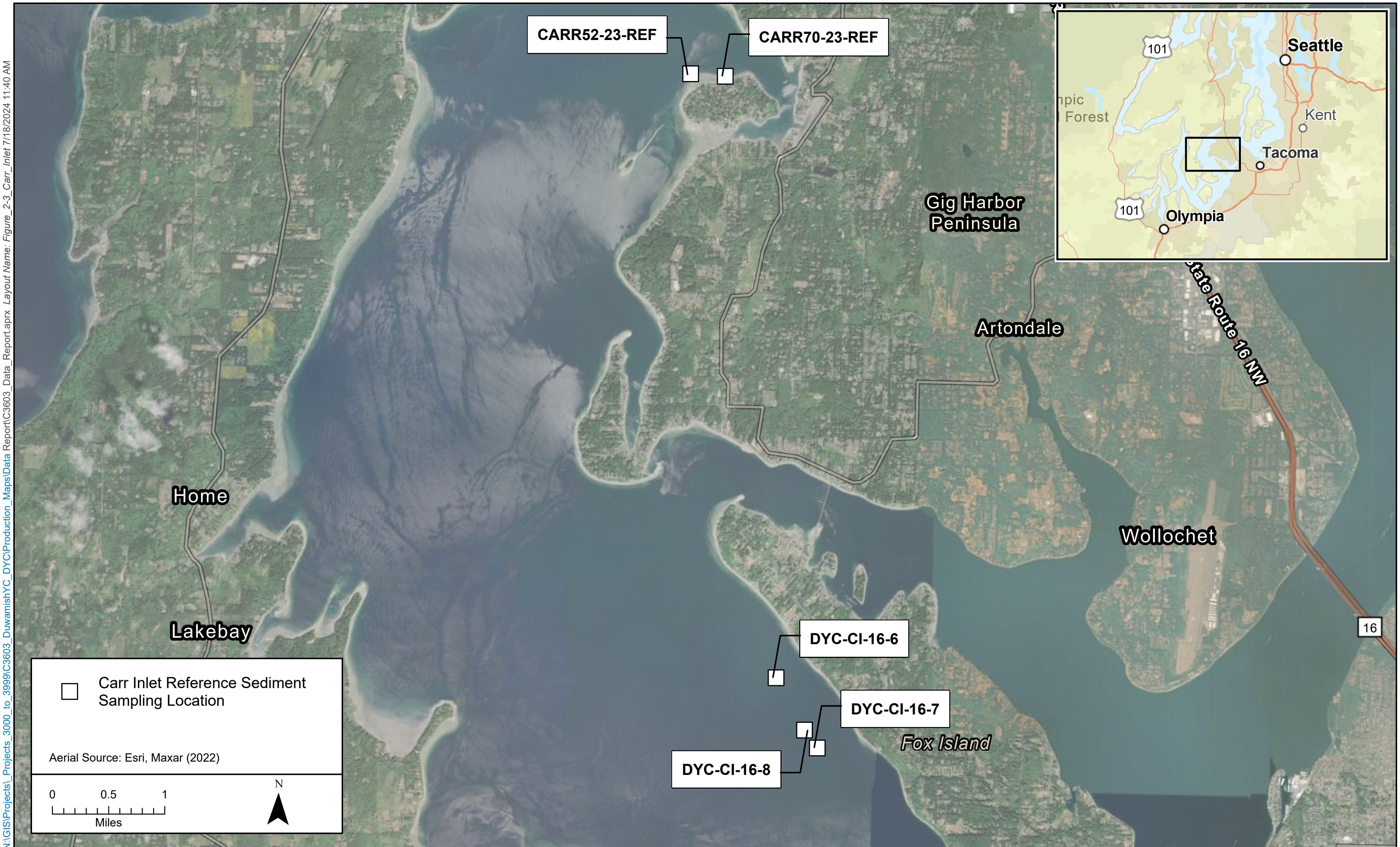
Note:
1. Location of processed and accepted sediment samples displayed

Figure 5.
Duwamish Yacht Club 2023 Additional Dredged Material Management Units and Sediment Sampling Locations



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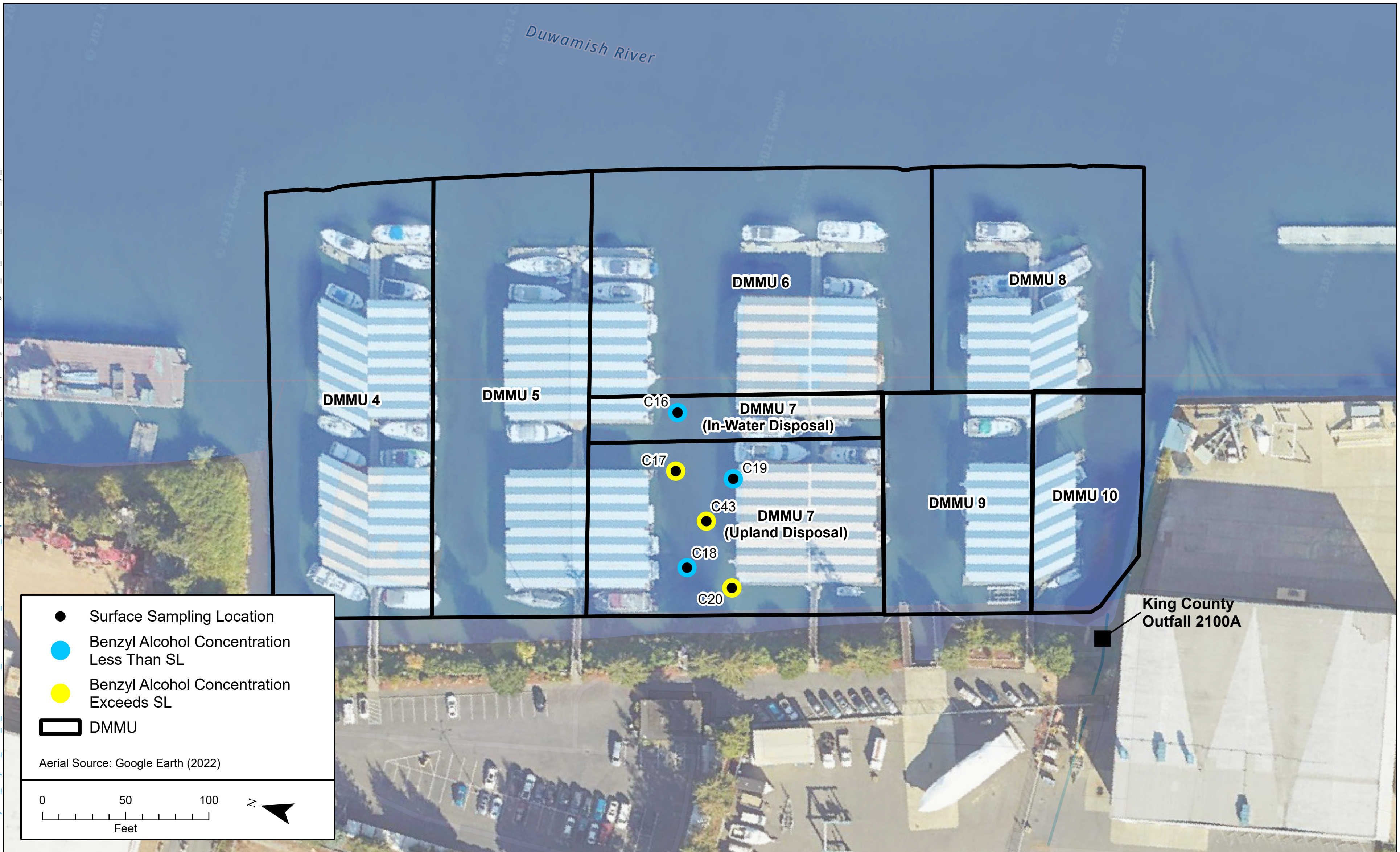
DYC-CI-16-6 Sample Location ID

Figure 6.
Actual Carr Inlet Reference Sediment Sampling Locations



integral consulting inc.

Note:
1. Location of processed and accepted sediment samples displayed

Figure 7.
DMMU 7 Individual Core Location Benzyl Alcohol Screening Results and Suitable Material Boundary

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MEMORANDUM

To:	Dredged Material Management Program
From:	Olivia Hargrave, Integral Consulting Inc., on behalf of the Duwamish Yacht Club
Date:	April 21, 2025
Subject:	Suitability Determination Addendum/Revision for the Duwamish Yacht Club project in Seattle, Washington (NWS-2024-639)
Project No.:	C3603

The Duwamish Yacht Club (DYC) proposes a maintenance dredging project around its docks to allow access to slips and prevent damage to the floating docks. Sediments were characterized by Integral Consulting Inc. (Integral) in 2023 and results were presented in the 2024 Data Report for Duwamish Yacht Club Dredged Material Characterization (Data Report; Integral 2024). A Suitability Determination was subsequently issued by the Dredged Material Management Office (DMMO) in 2024 (DMMO 2024).

Following the issuance of the suitability determination, the DYC had to reevaluate the project design due to feasibility constraints associated with high cost of unsuitable material handling and disposal. DYC found that financial limitations will likely prevent implementation of the full scope of the dredging described in the Suitability Determination. Based on guidance provided in a meeting on January 23, 2025, DYC continues to pursue additional funding and is also providing the DMMO with additional suitability information for options that are financially feasible. This memorandum describes the additional dredging options proposed by the DYC, including dredge volumes, dioxin/furan volume-weighted average concentrations, antidegradation leave surface (dioxin/furan surface area-weighted average concentrations), bioassay failures, buffers, and sequencing.

It is the DYC's intention that these additional evaluations be used to amend or revise the Suitability Determination to offer additional flexibility. The final option will be selected in Fall 2025 and will be presented in the final Dredge Plan and pre-dredge conference, both of which will be provided to the DMMO before dredging begins, allowing time for additional comments.

SUMMARY OF OPTIONS

The volumes and areas presented here (and in the 2024 Data Report) reflect the maximum dredge depths and are described in parentheses by their maximum dredge depths:

- Option 1 (–8 ft mean lower low water [MLLW]): Required minimum dredge depth of –7 ft MLLW; Maximum paid dredge depth of –8 ft MLLW. In the 0.7-acre southwest corner defined by dredged material management units (DMMUs) 9 and 10 (which sit atop subsurface DMMU 12), the minimum, target, paid and unpaid allowable overdredge depths shift 1 ft deeper, and a 1 ft sand cover will be placed over the same area.
- Option 2 (–7 ft MLLW): Required minimum dredge depth of –6 ft MLLW; Maximum paid dredge depth of –7 ft MLLW. In the 0.7-acre southwest corner, the minimum, target, paid and unpaid allowable overdredge depths shift 1 ft deeper, and a 1 ft sand cover will be placed over the same area.
- Option 3 (–6 ft MLLW): Target dredge depth of –5 ft MLLW with a ±6 in. paid allowable overdredge depth and additional 6 in. unpaid allowable overdredge depth, for a maximum dredge depth of –6 ft MLLW[1]. In the 0.7-acre southwest corner, the minimum, target, paid and unpaid allowable overdredge depths shift 1 ft deeper, and a 1 ft sand cover will be placed over the same area.
- Option 4 (5– ft MLLW): Target dredge depth of –4 ft MLLW with a ±6 in. paid allowable overdredge depth and additional 6 in. unpaid allowable overdredge depth, for a maximum dredge depth of –5 ft MLLW. In the 0.7-acre southwest corner, the minimum, target, paid and unpaid allowable overdredge depths shift 1 ft deeper, and a 1 ft sand cover will be placed over the same area.
- Option 5 (–4 ft MLLW): Target dredge depth of –3 ft MLLW with a ±6 in. paid allowable overdredge depth and additional 6 in. unpaid allowable overdredge depth, for a maximum dredge depth of –4 ft MLLW. In the 0.7-acre southwest corner, the minimum, target, paid and unpaid allowable overdredge depths shift 1 ft deeper, and a 1 ft sand cover will be placed over the same area.

[1] DMMO recommended that an additional 6 in. of dredge depth be added to the dredge tolerance in discussions of Options 3, 4, and 5. Options 1 and 2 do not include this and their descriptions remain unchanged from the original 2024 Data Report (Integral 2024).

DREDGE VOLUMES AND DIOXIN VOLUME-WEIGHTED AVERAGES

Dioxin volume weighted averages for Options 1, 2, and 3 are covered in Data Report Tables 6-2, 6-3, and 6-4, respectively (Integral 2024).

Two additional tables present the equivalent information for Options 4 and 5 (Tables 1 and 2, respectively).

DREDGING AREAS AND ANTIDEGRADATION LEAVE SURFACE AREA-WEIGHTED AVERAGE OF DIOXIN/FURAN

Table 3 presents the surface areas for pre- and post-dredging and the associated surface area-weighted average dioxin/furan concentrations. These concentrations are based on the concentrations of dioxins/furans measured in the DMMUs that would be exposed by the maximum dredge depth for each option. For DMMUs 1 through 7, the boundary between surface and subsurface DMMUs was set 3 ft below the 2023 mudline, rather than at a specific depth referenced to MLLW.

BIOASSAYS

DMMUs 9, 10, 12, and 13 failed bioassay tests. No other DMMUs has bioassay tests triggered. Sediment dredged from DMMUs 9, 10, 12, and 13 will be disposed of at an upland location.

Where the maintenance dredging would expose a leave surface of DMMUs 9, 10, 12, or 13, an additional 1 ft of dredge depth will be dredged, and a 1-ft-thick sand cover will be placed atop the dredged area. This condition is true for all options.

BUFFERS

Horizontal buffers will be applied around the unsuitable DMMUs where they are adjacent to suitable DMMUs, for all options:

- Horizontal buffer between suitable DMMUs 8 and 11 and unsuitable DMMUs 9, 10, and 12.
- Horizontal buffer between suitable DMMU 7 and unsuitable DMMUs 9, 10, and 12.

A vertical buffer between the unsuitable sediment in DMMU 7 overlying the suitable sediment in DMMU 3 is not required for any option, per the 2024 Suitability Determination: "An additional vertical buffer between unsuitable DMMU 7 and suitable DMMU 3 beneath is not required because the surface DMMU 7 includes an additional approximately 0.25 ft of material compared with the 2011 bathymetry. This additional 0.25 ft of material is considered an adequate vertical buffer given the nature of the unsuitable material (benzyl alcohol exceedance, no bioassays)." (DMMO 2024)

DREDGE SEQUENCING

For Option 1, the DYC and DMMO decided to use dredge sequencing for the in-water DMMUs. This decision was based on the fact that the volume-weighted average toxicity equivalent (TEQ) concentration for dioxin/furan was slightly above the DMMO disposal site management objective of 4 parts per trillion (pptr), and was less than the Washington State Department of Ecology's practical quantitation limit for dioxins/furans of 5 pptr (Integral 2024).The DMMUs with dioxin/furan concentrations above the DMMO disposal site management objective would be dredged first, to the extent practical.

For Options 2, 3, 4, and 5, the volume-weighted average TEQ for dioxins/furans is at or below the DMMO disposal site management objective, so sequencing of DMMUs will not be used within the in-water disposal DMMUs.

Generally, the Contractor's plan is to dredge suitable material first, and unsuitable material last.

REFERENCES

DMMO. 2024. Suitability determination memorandum for the Duwamish Yacht Club project in Seattle, WA (NWS-2024-639). Dredged Material Management Office, Seattle, WA. August 28.

Integral. 2024. Data Report, Duwamish Yacht Club Dredged Material Characterization. Prepared for Duwamish Yacht Club, Seattle, WA. Integral Consulting Inc., Seattle, WA. August 29.

Table 1. Dredged Material Disposal Volumes and Dioxin/Furan TEQ Volume Weighted Average (Option 4: Dredge Elevation of –5 ft MLLW)

	DMMU Volume (cy)								
DMMU	2023 Bathymetry Survey Estimated Volume [a]	Contingency Factor [b]	Final DMMU Volume [c]	In-Water Disposal Volume	Upland Disposal Volume	Volume Left in Place	Dioxin/Furan TEQ (ND=1/2 DL) (pptr)	In-Water Disposal Volume × TEQ (cy-pptr)	Upland Disposal Volume × TEQ (cy-pptr)
1	2,750	10%	3,000	50	0	2,950	5.18	259	0
2	2,595	10%	2,850	100	0	2,750	4.15	415	0
3 [d]	3,145	10%	3,450	0	150	3,300	4.23	0	635
4	3,950	10%	4,350	2,100	0	2,250	4.52	9492	0
5	3,700	10%	4,050	2,100	0	1,950	3.33	6993	0
6	3,970	10%	4,350	2,900	0	1,450	2.77	8033	0
7 (In-Water)	800	10%	900	550	0	350	8.47	4659	0
7 (Upland)	2,880	10%	3,150	0	2,050	1,100	8.47	0	17364
8	2,910	10%	3,200	2,300	0	900	2.67	6141	0
9	2,120	10%	2,300	0	2,300	0	4.06	0	9338
10	2,100	10%	2,300	0	2,300	0	19.3	0	44390
11	2,810	10%	3,100	0	0	3,100	6.46	0	0
12	3,275	10%	3,600	0	0	3,600	18.7	0	0
13	5,150	0%	5,150	0	0	5,150	11.5	0	0
		Total Volume (cy)	**45,750**	**10,100**	**6,800**	**28,850**	**VWA TEQ (pptr)**	**3.6**	**10.5**
		Total Dredged Volume (cy)			**16,900**				

Notes:
cy = cubic yard
DL = detection limit
DMMU = dredged material management unit
ND = non-detect
pptr = parts per trillion
TEQ = toxicity equivalence
VWA = volume-weighted average

[a] Volume estimated based on the federal navigation channel boundaries, total dredge elevation, and a 1V:1.5H side slope. Some volumes are slightly different from the original dredge plan because the project area boundary has been refined in the design phase.

[b] Contingency factor represents an additional 3 in. of sediment per year accumulating over 2 years.

[c] All final DMMU volume quantities are rounded to the nearest 50 cy.

[d] Although DMMU 3 is suitable for in-water disposal the small quantity to be dredged in this option will be disposed at an upland site.

Table 2. Dredged Material Disposal Volumes and Dioxin/Furan TEQ Volume Weighted Average (Option 5: Dredge Elevation of –4 ft MLLW)

	DMMU Volume (cy)								
DMMU	2023 Bathymetry Survey Estimated Volume [a]	Contingency Factor [b]	Final DMMU Volume [c]	In-Water Disposal Volume	Upland Disposal Volume	Volume Left in Place	Dioxin/Furan TEQ (ND=1/2 DL) (pptr)	In-Water Disposal Volume × TEQ (cy-pptr)	Upland Disposal Volume × TEQ (cy-pptr)
1	2,750	10%	3,000	0	0	3,000	5.18	0	0
2	2,595	10%	2,850	0	0	2,850	4.15	0	0
3	3,145	10%	3,450	0	0	3,450	4.23	0	0
4	3,950	10%	4,350	950	0	3,400	4.52	4294	0
5	3,700	10%	4,050	900	0	3,150	3.33	2997	0
6	3,970	10%	4,350	1,850	0	2,500	2.77	5125	0
7 (In-Water)	800	10%	900	300	0	600	8.47	2541	0
7 (Upland)	2,880	10%	3,150	0	1,100	2,050	8.47	0	9317
8	2,910	10%	3,200	1,550	0	1,650	2.67	4139	0
9	2,120	10%	2,300	0	1,750	550	4.06	0	7105
10	2,100	10%	2,300	0	1,700	600	19.3	0	32810
11	2,810	10%	3,100	0	0	3,100	6.46	0	0
12	3,275	10%	3,600	0	0	3,600	18.7	0	0
13	5,150	0%	5,150	0	0	5,150	11.5	0	0
		Total Volume (cy)	**45,750**	**5,550**	**4,550**	**35,650**	**VWA TEQ (pptr)**	**3.4**	**10.8**
		Total Dredged Volume (cy)		**10,100**					

Notes:
cy = cubic yard
DL = detection limit
DMMU = dredged material management unit
ND = non-detect
pptr = parts per trillion
TEQ = toxicity equivalence
VWA = volume-weighted average

[a] Volume estimated based on the federal navigation channel boundaries, total dredge elevation, and a 1V:1.5H side slope. Some volumes are slightly different from the original dredge plan because the project area boundary has been refined in the design phase.

[b] Contingency factor represents an additional 3 in. of sediment per year accumulating over 2 years.

[c] All final DMMU volume quantities are rounded to the nearest 50 cy.

Table 3. Antidegradation Leave Surface: Surface Area and Surface Area-Weighted Dioxin/Furan Concentrations for Specified Dredge Depths

Leave Surface DMMU	Dioxin/Furan Concentration (pptr TEQ (ND=1/2 DL))	Surface Area (square feet)					
		Pre-Dredge	Option 1 –8 ft MLLW	Option 2 –7 ft MLLW	Option 3 –6 ft MLLW	Option 4 –5 ft MLLW	Option 5 –4 ft MLLW
1	5.18	0	0	40,570	8,935	2,500	0
1-Z	4.58	0	53,455	0	0	0	0
2	4.15	0	0	33,520	26,350	7,040	0
2-Z/3-Z	10.07	0	91,860	0	0	0	0
3	4.23	0	0	41,250	16,935	2,545	1,170
4	4.52	36,282	0	8,350	25,480	28,380	26,890
5	3.33	35,672	0	5,535	26,890	30,280	29,500
6	2.77	39,735	0	10,310	10,540	23,070	27,325
7	8.47	33,594	0	645	18,210	31,445	32,525
8	2.67	24,535	0	0	0	20,365	18,200
9	4.06	17,009	[a]	[a]	[a]	[a]	[a]
10	19.30	11,777	[a]	[a]	[a]	[a]	[a]
11	6.46	0	24,535	23,530	22,075	0	0
12	18.70	0	[a]	[a]	[a]	[a]	[a]
Total Area (square feet) [b]		198,604	169,850	163,710	155,415	145,625	135,610
Total Area (acres)		4.56	3.90	3.76	3.57	3.34	3.11
Surface-Area Weighted Average Concentration		**5.23**	**7.82**	**4.68**	**4.88**	**4.58**	**4.61**

Notes:
DL = detection limit
DMMU = dredged material management unit
MLLW = mean lower low water
ND = non-detect
pptr TEQ = parts per trillion toxicity equivalence

[a] Area is excluded from surface area-weighted average concentration calculation because sand cover will be placed in this area.

[b] Total area varies based on the inclusion/exclusion of DMMUs 9 and 10, which are excluded from the surface area-weighted average concentration in Options 1-5 due to the placement of sand cover. Total area also varies based on the total project area, which decreases with shallower dredge depths because of the portion of the Project area that is already at or below the given Options' dredge depth.