An error was found after this document was signed. Please see the correction on page 5.

December 3, 2019

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

MEMORANDUM FOR: RECORD

SUBJECT: DETERMINATION REGARDING THE SUITABILITY OF PROPOSED DREDGED MATERIAL FROM THE KENMORE FEDERAL NAVIGATION CHANNEL EVALUATED UNDER SECTION 404 OF THE CLEAN WATER ACT FOR UNCONFINED OPEN-WATER DISPOSAL AT THE ELLIOTT BAY NON-DISPERSIVE DISPOSAL SITE.

1. **Introduction**. This memorandum reflects the consensus determination of the Dredged Material Management Program (DMMP) agencies (U.S. Army Corps of Engineers, Washington State Department of Ecology, Washington State Department of Natural Resources, and the Environmental Protection Agency) regarding the suitability/unsuitability of up to 34,350 cubic yards (cy) of dredged material from the Kenmore federal navigation channel for open-water disposal at the Elliott Bay non-dispersive site.

2. **Background**. The authorized federal navigation channel in Kenmore, WA runs approximately 2,900 feet from deep water in Lake Washington to the Kenmore industrial area, see Figure 1. The channel has an authorized width of 100 to 120 feet wide and a depth of -15 ft Lake Washington Low Water (LWLW) datum.

   The channel was last dredged in 1998. Since then sediment has accumulated in the navigation channel above the authorized depth, resulting in impacts to the ability of vessels to use the navigation channel. In 2014 a DMMP characterization was completed – the results of which were inconclusive due to the presence of dioxin at levels above the disposal site management objective of 4 pptr TEQ throughout the channel, with concentrations as high as 23 pptr TEQ. The DMMP agencies concluded in 2014 that additional testing, including a bioaccumulation evaluation for dioxins would be necessary to make a final determination on the suitability of the proposed dredged material for open-water disposal at Elliott Bay.

   This memo documents the additional sampling and testing that was conducted in 2019 to fully evaluate the sediment in the Kenmore navigation channel, including bioaccumulation testing for dioxin. Table 1 includes project summary and tracking information.

Table 1. Project Summary

Project ranking	High
Proposed dredging volume	34,350 cy
Proposed dredging depth	-15 ft MLLW (+ 2 ft overdepth)
1st draft SAP received	4 December 2018 Elliott Bay: 30 November 2018
Comments provided on 1st draft SAP	13 December 2018

	Elliott Bay: 13 December 2018
2nd draft SAP received	18 December 2018, both SAPs
Comments provided on 2nd draft SAP	8 January 2019 both SAPs
Final SAPs received	18 January 2019
SAPs approved	20 January 2019
Sampling dates	21 – 30 January, 18 February, 7 March and 13 March 2019
Draft data report received	5 September 2019
Comments provided on draft report	18 September 2019
2nd draft data report received	3 October 2019
Comments provided on 2nd draft report	16 October 2019
Final data report received	31 October 2019
EIM Study ID	KENMO19
Recency Expiration (high rank = 3 years)	No expiration – all unsuitable based on incomplete bioassay results. Additional biological testing could alter suitability and establish recency expiration date.

3. **Project Ranking, Sampling Requirements, and Bioaccumulation Study Design**. This project was ranked "high" by the DMMP agencies according to the guidelines set out in the DMMP User Manual for Kenmore, WA. In a high-ranked area the number of samples and analyses are calculated using the following guidelines (DMMP, 2014):
    - Maximum volume of sediment represented by each field sample = 4,000 cubic yards
    - Maximum volume of sediment represented by each analysis in the upper 4-feet of the dredging prism (surface sediment) = 4,000 cubic yards
    - Maximum volume of sediment represented by each analysis in the subsurface portion of the dredging prism = 12,000 cubic yards

    Based on calculated volumes plus additional contingency, 9 DMMUs were needed to characterize the total project volume of 34,350 CY. DMMUs were labeled KEN01 for DMMU1, KEN02 for DMMU 2 and so on. Table 2 shows calculated volumes for each DMMU and Figure 2 locates the DMMUs within the project area. The study design included the following elements:
    - The boundaries of DMMU 2 were kept consistent with the previous testing because that had been the DMMU with highest dioxin concentrations,
    - A full resampling and re-testing of the dredge prism was planned, since in addition to dioxins, there had been issues with other COCs, notably pesticides and phthalates, in the 2014 sampling event. Since the recency had expired on the 2014 sampling, new data was required.
    - Based on the project volume, two bioaccumulation tests were considered sufficient to evaluate bioaccumulation impacts from the project
    - The single DMMU with the highest concentration of dioxin would be analyzed for bioaccumulation, or, alternatively a composite of multiple DMMUs would be analyzed if there were more than one DMMU with dioxin concentrations elevated above the rest of the DMMUs.

- All the remaining DMMUs not included in the higher end bioaccumulation test would be composited together and analyzed for bioaccumulation as a single 'Supercomposite'.
- Since there was no way to know which DMMU would have highest dioxin concentration, all DMMUs were sampled so they would have enough volume to be tested for bioaccumulation individually. Therefore, 5 cores were needed from each DMMU to collect sufficient volume.
- Assumed no need to re-evaluate z-samples for anti-degradation compliance, since last time freshwater z-sample bioassays were run on all DMMUs and all passed. The DMMP agencies agreed there was no reason to suspect the quality of deep buried sediment would have changed since the 2014 testing. However, as a precautionary measure, z-samples were collected and archived.

Standard Tier 3 DMMP bioaccumulation testing utilizes a modified EPA protocol (Lee et al. 1989), which included co-testing of *Macoma nasuta* and *Nephtys caecoides* in the same test chambers. The modified EPA protocol – with static-renewal of overlying water, sediment addition, and no supplemental feeding – was selected for use in this study.

The length of exposure is a critical parameter in the design of the bioaccumulation test. The longer the exposure, the closer tissue concentrations approach a steady-state condition. The DMMP Manual does not provide a recommended exposure time specifically for dioxins, however, based on the previous testing results, existing guidance (DMMP, 2009), and experience from other projects, a 45-day exposure time was chosen.

Target Tissue Levels (TTLs) are used to compare tissue concentrations resulting from test sediments to determine suitability for open-water disposal. The 2018 DMMP User Manual includes a list of TTLs (Table 10-6), but does not include one for dioxins. Therefore it was agreed to use a similar comparison approach as was used for the Everett Marina study (DMMP, 2017), including:

a. Comparison of test sediment tissue concentrations to a reference sediment tissue concentration by use of a one-tailed t-test with an alpha level of 0.1.
b. Determination of whether there was a 20% difference between reference and test sediment tissue concentrations.
c. Evaluation of the importance of non-detect concentrations to the total TEQ calculations
d. Comparison to tissue PQLs as developed by Ecology (Ecology, 2018).
e. Evaluation of tissue concentrations from organisms living in the vicinity of the disposal site.

In consideration of the general lack of *in-situ* tissue data from the Elliott Bay disposal site vicinity, a separate laboratory bioaccumulation study was conducted during the same time frame to characterize dioxin concentrations in benthic tissues. Specifically, sediment was collected from 16 areas of Elliott Bay which were similar in depth and sediment type to the disposal site but outside the influence of disposal activities at the Elliott Bay site. These locations would be impacted by diffuse sources of contaminants and be consistent, in concept, with regional background. The surface sediment samples were mixed into a single composite sample (Elliott Bay Benchmark) and tested using the same bioaccumulation protocol used to test Kenmore sediments (Sealaska, 2019d).

4. **Sampling**. Sampling took place 21-30 January 2019 for sampling in the Kenmore navigation channel using a vibracore sampler aboard the *M/V Nancy Ann*. Reference sediment collection in Carr Inlet occurred on 19 February with a van Veen sampler and on 13 March with a power grab. Additional sediment was collected from KEN01 on 7 March using a vibracore. Five cores were collected from each of the 9 DMMUs, for a total of 45 cores, see Table 3 for coordinates and core collection information. Five cores per DMMU were necessary to collect sufficient sediment to run all chemical, bioassay and bioaccumulation testing on a single DMMU. Figure 2 shows the target and actual coring locations. The sampling and analysis plan (Sealaska, 2019a) was approved by the DMMP agencies prior to the start of sampling.

   All decisions regarding changing sampling locations and acceptance of cores was coordinated real-time with the DMMO. The following changes were approved:
   - After three failed attempts to obtain the minimum acceptable recovery rate of 75 percent for core C-2 in KEN01, the sampling location was moved approximately 50 ft to the southwest. Core C-2 was subsequently collected on the first attempt at the revised location,
   - After one failed attempt at location C-1 due to sand and gravel in the core, the sampling location was moved approximately 35 ft to the west. An acceptable sediment core was recovered on the first attempt at the revised position for C-1.
   - After three attempts at the target location for C-17 in KEN04, the highest percent recovery obtained was 70%. DMMO allowed 70 percent recovery at C-17.
   - After three failed attempts at location C-23, the sampling location was moved about 25 ft to the southeast. Cores collected at the original location suffered from poor retention of native glacial clay encountered below the dredge prism. An acceptable core was collected at the revised C-23 location on the first attempt.

   DMMU compositing information is shown in Table 4. One error was discovered on the last day of sediment core processing, resulting in several deviations from the sampling and compositing plan. Contractor staff discovered that KEN07-C34 (B) (the B designates a specific interval of the sediment core [i.e., the 16.9 to 19.9 ft interval]), had been inadvertently replaced with KEN09-C43 (B). A thin section of sediment (0.1 ft) from KEN09-C43 had been added to the dredge material (mudline to –17 ft LWLW) composite of KEN07 and the interval from –17 to –19 ft LWLW of KEN09-C43 had been added to the z-layer composite of KEN07. When the error was identified, the archive sample originally labeled "KEN07-C34 Z" was retrieved from ARI's freezer and relabeled to the correct sample ID, "KEN09-C43 Z". The following highlights the samples that were archived and/or submitted for analysis.
   - KEN07 composite, contains 0.1 ft from KEN09-C43 (–16.9 to –17.0 ft LWLW)
   - KEN07-C34 Z archive sample collected
   - KEN07-Z composite contains sediment from –17 to –19 ft LWLW interval from KEN09-C43 and was rendered unusable for testing
   - KEN09-43 Z archive sample collected
   - KEN09-C43 composited with other four KEN09 (C41, C42, C44, and C45) cores
   - KEN09-Z composite contains sediment from four cores (C41, C42, C44, and C45) instead of five.

These deviations had minimal impact on the project. No z-samples were analyzed as part of this characterization, and the small amount of DMMU material from KEN09-C43 that was combined with KEN07 (less than one measuring cup) was considered insignificant volumetrically (0.58 percent of the total volume).

Elliott Bay Benchmark

Field sampling occurred in a single day on 1 February 2019. Surface sediment samples were collected from 16 locations shown in Figure 3 using a 0.1 m^2 stainless steel double van Veen grab sampler deployed from the R/V *Nancy Ann* owned and operated by MSS (Burley, Washington). Sediment was mixed on 2 February 2019, at ARI to yield a single composite for testing.

5. **Review of Chemical Data and Bioaccumulation Study Design Modifications**. Analysis of conventionals and all standard DMMP COCs was conducted by Analytical Resources, Inc. of Tukwila, WA and Axys Environmental of Sydney, BC. The approved sampling and analysis plan (Sealaska, 2019a) was generally followed. All data was validated by an external third party at EPA Stage 2B and 10% of the dioxin data was validated at Stage 4. The final data presented in this memo are considered acceptable to be used in decision-making.

TBT was not measured per agreement with DMMP agencies based on results from 2015 sampling.

All 9 DMMUs were analyzed for the full list of DMMP COCs, including dioxins ~~and TBT~~ at the ARI laboratory in Tukwila, WA. All analytical results are shown in Table 5. Conventional results showed that the dredged material is a loam to silt loam, with 28-40 percent sand, 42-50 percent silt and 16-21 percent clay. Total organic carbon (TOC) was relatively high, ranging from 2.38-5.66 % in the dredged material; TOC >3.5% is considered by Ecology to be above the typical range for freshwater sediments (Ecology, 2017). All DMMP COC's were below SLs with the following exceptions:

- Butyl benzyl phthalate detected above the SL in KEN10 (duplicate of KEN02) and KEN07
- Total Chlordane non-detect above the SL in all 9 DMMUs
- 4,4'-DDE non-detect above the SL in KEN05

The elevated non-detect pesticide results were re-evaluated by the laboratory and reported at the lower limit of detection per DOD policy (DOD/DOE QSM, 2018),). The LOD is defined as:

> The smallest concentration of a substance that must be present in a sample in order to be detected at the detection limit with 99% confidence. At the LOD, the false negative rate (Type II error) is 1%. A LOD may be used as the lowest concentration for reliably reporting a non-detect of a specific analyte in a specific matrix with a specific method at 99% confidence.

Results in Table 5 are reported at the LOD for pesticide results via EPA Method 8081. When reporting at the LOD, only KEN02 and KEN03 still had total chlordane non-detect above the SL and KEN05 still had a non-detect exceedance of 4,4'-DDE.

USACE Navigation chose to pursue bioassay testing for the two DMMUs KEN02 and KEN07 with detected butyl benzyl phthalate exceedances, and high-resolution pesticide analysis via EPA method 1699 to lower the reporting limits to below SLs for KEN03 and KEN05. Bioassay results are discussed in Section 7 and high-resolution pesticide results are discussed below.

High Resolution Pesticide Analysis

EPA method 1699 is a high-resolution gas chromatography/high-resolution mass spectrometry (HRGC/HRMS) isotope dilution method. All high-resolution pesticide analyses were conducted by Axys Environmental of Sydney, BC. Pesticide results from EPA Method 1699 are shown in Table 6. The first round of results from KEN03 and KEN05 showed that 4,4'-DDE was non-detect in KEN05 below the SL and that total chlordane was detected above the SL in both DMMUs. It was not expected to find total chlordane in KEN05 because the results from EPA Method 8081 were non-detect at 1.49 U μg/kg. This prompted additional high-resolution pesticide analysis of the remaining DMMUs, with the exception of KEN02 which had already been shown to have failed the larval bioassay test at the time the second round of high-resolution pesticide analyses were initiated.

Results from the second round of high-resolution pesticide analysis are also shown in Table 6, and confirmed that total chlordane was detected above the SL in all DMMUs analyzed. By the time this data was received from the analytical laboratory the sediments had long expired the bioassay holding time of 56 days, so no further testing was pursued.

Dioxin Results

Dioxin results are shown in Table 5, all dioxin results are reported as sum TEQ with non-detect concentrations included at ½ the reported value (ND=1/2). KEN01 had the highest dioxin TEQ (16.5 J pptr TEQ) and was selected by the DMMP agencies to undergo bioaccumulation testing as an individual sample. Dioxin concentrations in the remaining DMMUs ranged from 6.1 J - 12.2 J pptr TEQ. These eight DMMUs were composited together into a single sample, hereafter referred to as the Supercomposite, for bioaccumulation testing. After being created, the Supercomposite was tested and found to have a dioxin concentration of 9.95 J pptr TEQ. The Elliott Bay benchmark sample was also tested for conventionals and dioxin, results are shown in Table 7. The dioxin concentration was 10.7 J pptr TEQ.

Three bioaccumulation reference samples were collected from Carr Inlet and tested for conventionals and dioxins. The results from these samples ranged from 2.5 J – 6.05 J pptr TEQ and are shown in Table 8.

KEN01 sediment volume requirements

After it was decided that KEN01 would be run individually for bioaccumulation testing, it was discovered that there wasn't enough volume of sediment to conduct the bioaccumulation testing using the standard set-up. After discussion with the contractor and the DMMP agencies, it was decided that additional sediment from the project area was needed to conduct the appropriate testing. On 13 March 2019, an additional five cores were collected from the same five sample locations (C-1 – C-5) and the additional sediment was composited with the original KEN01 sediment. Dioxin analysis of the newly composited KEN01, called KEN01-Comp, showed that the concentration was 15.0 J pptr TEQ which was less than the original concentration of 16.5 J pptr TEQ, but still above the dioxin concentration of the Supercomposite sample (9.95 pptr TEQ).

6. Bioassay Testing

Bioassay testing was carried out at the EcoAnalysts, Inc. laboratory in Port Gamble, WA. The standard suite of three DMMP tests: the amphipod mortality, larval development, and polychaete growth bioassays were conducted on two test sediments (KEN02 and KEN07) and a reference

sample. Interpretation guidelines are found in Table 12. Because test sediments were from a freshwater environment and the proposed disposal location is in marine waters, the sediment required acclimation to marine conditions prior to initiating the bioassay tests. These procedures are described in detail below.

All bioassay tests were initiated on 22 March, one day past the 56-day holding time for KEN02 and within the 56-day holding time for KEN07.

Bioassay Reference Collection

A bioassay reference sample was collected from Carr Inlet on 13 March. Table 9 shows field grain size results for all nine DMMUs and all Carr Inlet reference samples collected. Table 10 provides a summary of sediment collection information and Figure 4 shows the sampling areas within Carr Inlet. Reference sample CR-23 was selected for the bioassay reference because historic data from this location indicated that it best matched the grain size range of KEN02 and KEN07 (47-50% fines) based on wet-sieve field results. Field grain size results for CR-23 was 52% fines, which was considered a good match for the bioassay tests. Laboratory grain size analysis determined that the percent fines for CR-23 was 58.7%, and for KEN02 and KEN07 percent fines were 70.5 and 59.3, respectively.

Saltwater Acclimation Procedures

Non-contaminant-related effects can confound bioassay results if sediment conditions are not appropriate to test organisms. For these tests, acclimation of freshwater sediments to marine conditions was necessary to eliminate potential non-treatment effects such as increasing ammonia and/or sulfide concentrations and salinity levels outside of optimal ranges for testing conditions.

Established acclimation procedures were followed prior to the initiation of the juvenile polychaete and amphipod bioassays as prescribed in the SAP. On 5 March 2019 sediments for amphipod and polychaete bioassays (plus sacrificial chambers) were layered into test chambers per the specific test methodology, topped with filtered seawater, aerated, and kept under static conditions for nine days. Ammonia, temperature, pH and salinity were measured in overlying water daily starting on 11 March, and sulfides were measured daily starting on 13 March. Porewater measurements of these same parameters were also conducted intermittently on test sediments within sacrificial chambers (on 11, 15, 18, and 21 March). Porewater measurement results are available in Appendix K of the final Kenmore data report (Sealaska, 2019c).

Low porewater pH values were observed in all acclimated test chambers on 11 March, and there was a concern that pH values were low enough (i.e., <6) in some chambers that it would impact the organism's health. In addition, while un-ionized ammonia (UIA) concentrations were below organism toxicity trigger values, there was concern that UIA concentrations would increase in the amphipod and polychaete testing chambers as they continued to acclimate to the more typical higher pH values (7-8) associated with marine conditions. Ammonia purging via twice daily overlying water renewals began on 15 March and continued until testing was initiated 22 March, for the amphipod and polychaete test chambers. Due to the shifting pH and resulting ammonia concentrations, daily overlying water renewals were performed throughout the amphipod and juvenile polychaete testing period.

While acclimation is generally not required for the larval development test, sediment for the larval test was acclimated in the same manner as the amphipod and juvenile polychaete tests. Specifically, an individual chamber of acclimated sediment was decanted, and the appropriate amount of sediment was distributed to each of the larval test chambers and a surrogate water quality chamber.

Bioassay Results

Toxicity test results are summarized in Table 11, and comparisons of individual bioassay test controls and reference sediments to performance standards are provided in Table 12.

Amphipod 10-Day Mortality

The 10-day amphipod test using *Eohaustorius estuarius* was initiated on 22 March 2019. *E. estuarius* is the recommended species when clay content in the test sediment is <20%. The clay content in KEN07 was 17% and in KEN02 was 21.1%, above the recommended range for *E. estuarius*. All organisms survived in both the control and reference sediments, meeting the DMMP's performance standards for a valid test (Table 12). Mean amphipod mortality was 4 percent in KEN02 and was 9 percent in KEN07 (Table 11), indicating that the high clay content in KEN02 did not negatively affect organism health. There were no hits for either KEN02 or KEN07.

All water quality parameters (dissolved oxygen, temperature, salinity, and pH) were within the acceptable limits for the duration of the test. Measurements of total ammonia and total sulfides were generally made in overlying water at the beginning and end of the test. Ammonia values were below the published threshold concentrations of 30 mg/L for total ammonia and 0.8 mg/L for UIA (DMMP 2018). All sulfide concentrations in interstitial and overlying water were below the trigger value of 0.122 mg/L (DMMP 2018). Consequently, ammonia and sulfide concentrations were not expected to cause non-treatment effects.

Neanthes 20-Day Growth and Development

The 20-day juvenile infaunal growth test using *Neanthes arenaceodentata* was initiated on 22 March 2019. No mortality was observed in the control sediment, and mean individual growth (MIG) in the control sediment was 0.401 mg/individual/day ash free dry weight (AFDW). One replicate in the control had 100 percent mortality. The laboratory was not able to identify a reason for this and the water quality data did not indicate any issues. This replicate was statistically qualified as an outlier by performing a Grubbs' test and was not included in statistical data summaries or comparisons. All organisms survived in the CR-23 reference sediment, and MIG for the reference treatment was 0.361 mg/individual/day AFDW. Both control and reference treatments met the DMMP's performance standards for a valid test (Table 12). All organisms survived in both KEN02 and KEN07. MIG was 0.350 mg/individual/day AFDW for KEN02 and 0.337 mg/individual/day AFDW for KEN07.

All water quality parameters (dissolved oxygen, temperature, salinity, and pH) were within the acceptable limits for the duration of the test. Measurements of total ammonia and total sulfides were made in overlying water at the beginning and end of the test. Ammonia values were below the published threshold concentrations of 0.46 mg/L UIA (DMMP 2018). All sulfide concentrations in interstitial and overlying water were below the trigger value of 3.4 mg/L (DMMP 2018). Consequently, ammonia and sulfide concentrations were not expected to cause non-treatment effects.

Larval Development

The larval development test using *Mytilus galloprovincialis* was initiated on 22 March 2019. All ammonia concentrations were below threshold values and are not expected to have contributed to toxicity of the sediments.

Use of the resuspension protocol is recommended for sediments with high concentrations of fines, wood waste or other flocculent material (DMMP, 2013). There is no specific definition of "high concentration" of fines in the clarification paper, however the percent fines for KEN02 (70.5%) and KEN07 (59.3%) are considered high by the DMMP agencies. The resuspension protocol was appropriately used to terminate the test and enumerate larvae.

Results are reported as control-normalized normal survival, which is calculated by dividing the number of normal larvae from the test or reference treatment at the end of the exposure period by the number of normal larvae in the seawater control at the end of the exposure period. The combined normal survivorship in the control was 0.83 (83 percent), and the mean control-normalized normal survival was 0.91 (91 percent) in the reference treatment. Both control and reference treatments met the DMMP's performance standards for a valid test (Table 12). Mean control-normalized survival was 21 percent in KEN02 and 57 percent in KEN07.

A number of irregularities occurred during testing, including:

- One reference replicate had a much lower number of normal larvae when compared to the other four replicates for this sample. The laboratory was not able to identify a reason for this and the water quality data do not indicate any issues. This replicate was statistically qualified as an outlier by performing a Grubbs' test and was not included in statistical data summaries or comparisons
- Salinity was outside the recommended range of 28 ± 1 ppt in CR-23; salinity was 30 ppt on Days 1 and 2. Because the 30 ppt measurement is within the tolerance range of the test organisms, it is not expected to have had a negative effect on the test.
- The hydrogen sulfide concentration measured in overlying water for KEN02 (0.0026 mg/L) on Day 0 was above the trigger value of 0.0025 mg/L (DMMP 2015). Due to a laboratory oversight, sulfides were not measured on Day 1 and therefore hydrogen sulfide concentrations could not be calculated. By test termination on Day 2, sulfide concentrations had decreased to the level that they were not detected in KEN02.

  The hydrogen sulfide concentration is a calculated value of ion dissociations based on measurements of total dissolved sulfides, temperature, salinity, and pH. The dissociation curve with respect to pH is steepest within the range of 7 to 8, meaning that small pH changes within this range have a substantial impact on the calculated hydrogen sulfide concentration. For example, an increase in pH of 0.03 units results in a calculated hydrogen sulfide concentration below the trigger value. In addition, the hydrogen sulfide purging trigger was chosen based on the NOEC/LOEC threshold concentrations between 0.0041 and 0.0068 mg/L (Weston Solutions (2006). EcoAnalysts' bioassay report states that hydrogen sulfide "values below this range are not likely to elicit negative biological effects".

  Taken together, this information provides evidence that the slightly elevated hydrogen sulfide

concentration at the beginning of the test was not likely to have caused significant non-treatment effects.

- pH in KEN02 at test termination was 6.8; below the recommended range of 7-9 . Average pH in KEN02 over the 48 hr testing period was 7.17; average pH in KEN07 was 7.33. Larval development of *M. Galloprovincialis* have been shown to be sensitive to timing of exposure to acidified seawater (Kapsenberg et al., 2018). The most acidified water used in the cited study was 7.4 – higher than the average pH in both of the test treatments – and that treatment resulted in only 56-64% normal larval development, compared to >95 normal development in the constant pH 8.1 and pH starting at 7.4 and increasing to 8.1 treatments. This information suggests that lower pH may have contributed to the reductions in normal development observed in both KEN02 and KEN07 sediments.

Summary

Both KEN02 and KEN07 passed the amphipod and *Neanthes* growth tests. Due to the number of irregularities in the larval development test, it is not possible to eliminate the influence of non-treatment effects on the test results. Therefore the results of the larval test are not considered valid for decision-making by the DMMP agencies. Without a full suite of bioassay results upon which to base a determination of the suitability of the test sediments, a decision cannot be made. Without further information to demonstrate the test sediment will not have more than a minor adverse effects to benthic toxicity, both KEN02 and KEN07 are considered unsuitable for open-water disposal. Re-testing of sediments using modified methods to either account for pH-induced impacts (low pH control) or to eliminate pH induced impacts (longer acclimation) would be allowed, but is not being pursued due to project timelines.

7. Bioaccumulation Testing

Bioaccumulation testing was conducted by EcoAnalysts Laboratory of Port Gamble, WA. Two species – an adult marine clam (*Macoma nasuta*) and an adult polychaete (*Nephtys caecoides*) – were exposed to sediment from the two composited test sediments, the Carr Inlet reference sediment, and the Elliott Bay Benchmark sample for 45 days. The species were co-tested, meaning they shared aquaria during the exposure. Five replicates were run for each test sediment, reference sediment, benchmark sediment, and negative control. An additional 175 ml of sediment was added to each test chamber every seven days. There was no supplemental feeding. The SAP (Sealaska, 2019a) provides additional details regarding the protocol and test conditions.

Static renewal is the standard method for DMMP bioaccumulation tests. For this project, flow-through conditions for the entire duration of exposure were allowed for the following reasons:

- It is the standard set-up used by the biological testing laboratory
- Dioxins/furans are highly hydrophobic, with log K_{ow} values that indicate that they tend to adsorb stongly to organic components in the sediment and are therefore very unlikely to be lost to the water.

Similar to bioassay testing, established acclimation procedures were followed prior to initiating the bioaccumulation exposure tests for KEN01-Comp and the Supercomposite. The test acclimation period began 5 March 2019 for the Supercomposite and 9 March 2019 for KEN01-Comp due to the

need to collect additional sediment from KEN01. Procedures for acclimating the freshwater sediments to marine testing conditions were performed in the same manner as the bioassay samples except that the chambers were maintained under flow-through conditions with clean seawater from North Hood Canal, Washington. Acclimation typically continues until a peak in interstitial ammonia concentrations (commonly overlying water is measured as a proxy) is observed. Water quality measurements did not start until 11 March so it was not possible to calculate unionized ammonia prior to that date. By 21 March, it was observed that ammonia concentrations in both exposure test sediments were decreasing or stable throughout testing procedures due to the continuous flow-through of overlying water during testing.

Two notable deviations to test conditions occurred. First, the tests were initiated on 22 March – two days past the standard 56-day holding time. Second, the flow rate was just above the recommended range for one replicate (CI16-8, day 33). The flow was adjusted to the appropriate range when this was observed. The replicate was within range the previous day that it was tested (day 28), therefore the flow rate exceedance of 1mL per 30 seconds lasted for a maximum of five days (total of 14.4L extra). The normal flow rate range is 38-56 mL/ 30 sec. The DMMP agencies have determined that none of these deviations had a significant impact on the test conditions or validity of the test results.

Testing was terminated on day 45 according to standard procedures. Mean organism survival in the control, test sediments and reference sediment ranged from 90-100%, and is shown in Table 13. At test termination there was sufficient tissue available for dioxin analysis in all test and reference treatments. Tissue samples were collected per the SAP and analyzed for dioxin and lipids. The analytical tissue results for all test, reference and benchmark sediments can be found in Table 14 for *Macoma* and in Table 15 for *Nephtys.*

In order to establish pre-test tissue concentrations, a sub-sample of test organisms was isolated prior to test initiation. These pre-test organisms were allowed to depurate for 24 hours, tissues removed and rinsed in deionized water, and then frozen for chemical analysis. Pre-test dioxin results are also presented in Table 14 for *Macoma* and Table 15 for *Nephtys*.

8. Bioaccumulation Test Results and Interpretation.

All dioxin concentrations discussed in this memo were calculated with non-detects equal to one-half the detection limit, and all tissue results are on a wet weight basis. *Macoma* and *Nephtys* tissue dioxin TEQ concentrations were low for the reference sediment, the Elliott Bay Benchmark sediment, and all test sediments, with TEQs well below 1 ng/kg wet weight in all cases. See Figures 5 and 6 for graphical depictions of the tissue dioxin TEQ results. For *Macoma*, tissue concentrations ranged from 0.149 to 0.257 ng/kg ww TEQ for the individual Carr Inlet reference and Elliott Bay Benchmark replicates and 0.146 to 0.375 ng/kg ww TEQ for the test sediment replicates. For *Nephtys*, tissue concentrations ranged from 0.0650 to 0.146 ng/kg ww TEQ for the individual reference and Elliott Bay Benchmark replicates and 0.0783 to 0.183 ng/kg ww TEQ for the test sediment replicates.

Pre-test tissue concentrations are an important indicator of the validity of the test. Pre-test tissue concentrations indicate the amount of bioaccumulation that has occurred prior to the start of the laboratory bioaccumulation tests. Dioxin tissue concentrations were analyzed in triplicate for each organism. *Macoma* pre-test tissue concentrations were low, ranging from 0.0913 to 0.146 ng/kg ww

TEQ, and with two of the three results non-detect. *Nephtys* pre-test tissue concentrations were higher, ranging from 0.109 U to 0.337 J ng/kg ww TEQ. In fact, the average pre-test tissue dioxin concentration in *Nephtys* was higher than any of the post-test results from KEN01 and the Supercomposite. This is due, in part, to one of the pre-test replicate results being significantly higher (0.337 J) than the other two (0.169 U – 0.109 U). Note both pre-test and post-test tissue concentrations are very low and near limits of detection.

As indicated previously, a TTL for the protection of human health and other higher trophic level species has not yet been established by the DMMP agencies for dioxin. In the absence of a TTL, the DMMP User Manual (DMMP, 2018) calls for comparison of test sediment tissue concentrations to Carr Inlet reference sediment tissue concentrations using a one-tailed t-test with an alpha level of 0.10.

Sealaska Environmental used the Gehan test to statistically compare the mean TEQ for the five replicate tissue samples from each test sediment to the mean TEQ for the five replicate tissue samples from the Carr Inlet reference for each test species. The Gehan test is a nonparametric test that handles data sets with NDs and multiple DLs, it assumes comparable shapes and variability. ProUCL recommends using the Gehan test when multiple detection limits are present in the data set (EPA, 2015). It is recommended that a minimum of 8–10 observations be used for hypothesis testing approaches such as the Gehan test; thus, results from tests applied to smaller data sets may not be reliable.

Results of using the Gehan test to compare total TEQs in test sediments to the Carr Inlet reference and Elliott Bay benchmark are shown in Table 16. KEN01 was statistically different than reference for *Macoma* but not *Nephtys*. The Supercomposite was not statistically different than reference for either species. The same comparison made against the Elliott Bay benchmark sample results showed that none of the test sediments were statistically different for either *Macoma* or *Nephtys*.

The DMMP verified the statistical results using BioStat, which are described in Table 17. Screenshots from the BioStat comparisons are provided in Attachment 1. In summary, KEN01 was found to be statistically different from reference for both species, but when compared to the Elliott Bay benchmark, only *Macoma* results were statistically different. For the Supercomposite, none of the results were statistically different from reference or benchmark for either of the test species.

DMMP agencies had agreed prior to testing that a statistically significant difference between test sediments and reference results would be a necessary but insufficient conditions for finding dredged material unsuitable for open-water disposal. Several additional lines of evidence were considered in evaluating the significance of the statistical difference, including a) percentage above reference; b) the role of non-detects; and c) comparison to practical quantitation limits (PQLs) and d) comparison to dioxin concentrations measured in field-collected polychaetes from unimpacted areas near the Elliott Bay disposal site.

a) Supercomposite tissue concentrations were less than 20% above reference for both tests species. KEN01 tissue concentrations were more than 20% above reference, 57 and 30% for *Macoma* and *Nephtys*, respectively.

b) Non-detect concentrations play a significant role in the summation of TEQs for all tissue samples analyzed for this project. 75.3% of the individual congener results for *Macoma* in Kenmore sediments were non-detect, and 75.9% of *Nephtys* results were non-detect. The Carr Inlet reference sediment had an even higher fraction of congeners that were non-detect, 80% for *Macoma* and 85.9% for *Nephtys*. For Elliott Bay benchmark tissue sample results, 69.4% of congener results were non-detect for *Macoma* and 78.8% of congener results were non-detect for *Nephtys*. With non-detects set equal to one half the detection limit, the contribution of non-detects to the TEQ for the test samples ranges from 65.7 to 93.7% for *Macoma* and 76.1 to 99.9% for *Nephtys*.

   Another way to demonstrate to effect of the contribution of non-detects is by comparing dioxin concentrations calculated with ND=1/2 DL to those calculated with ND set equal to zero (see Tables 14 and 15). With TEQ sums calculated with ND=0, the *Macoma* tissue concentrations for the Kenmore test sediments ranged from 0.0126 to 0.0774 ng/kg ww TEQ, compared with 0.146 to 0.375 ng/kg ww TEQ (ND=1.2 DL). For *Nephtys*, tissue concentrations in the test sediments with ND=0 ranged from 0.0000642 to 0.0439 ng/kg ww TEQ, compared with 0.0783 to 0.183 ng/kg ww TEQ (ND=1/2 DL). Overall, test sediment tissue concentrations were about an order of magnitude smaller when non-detect concentrations are not included. Alternative methods for addressing non-detects, such as Kaplan-Meier, were considered, but the large number of non-detect concentrations (>50%) precluded the use of that or similar methods.

c) Practical quantitation limits are an important consideration when concentrations are low. The PQL is the lowest concentration of an analyte that can be reliably measured within specified limits of precision and accuracy under routine laboratory operating conditions. Concentrations above the PQL can be measured with a high degree of confidence, while concentrations below the PQL are typically considered estimates. The PQL for each dioxin congener for this project was established as the lowest method calibration standard used by ARI to calibrate its instruments (Table 18). A broad evaluation of the significance of PQLs can be achieved by comparing tissue TEQs to the sum TEF-weighted PQLs. The sum of TEF-weighted PQLs was 11.41 pptr TEQ. Table 11-1 of Ecology's SCUM II establishes programmatic sediment and tissue PQLs for establishing PQL-based SCO and CSLs. The tissue PQL for dioxins as sum TEQ is 1 pptr ww TEQ (Ecology, 2018). As noted previously, *Macoma* tissue concentrations ranged from 0.146 to 0.375 pptr ww TEQ and *Nephtys* tissue concentrations ranged from 0.0783 to 0.164 pptr ww TEQ for the test sediment replicates. Since the Ecology PQL is less than the project TEF-weighted PQL for dioxin sum TEQs, comparison with Ecology's PQL is appropriate. All project dioxin sum TEQ tissue concentrations were less than Ecology's sum TEQ tissue PQL.

d) The DMMP evaluated the environmental significance of the bioaccumulation results by comparing them to monitoring data from the vicinity of the Elliott Bay disposal site. In 2007, as part of a special dioxin study, specimens from the polychaete genera *Glycidera*, *Travisia*, and *Maldanidae* were collected from 12 off-site stations (perimeter, transect and benchmark). Of these stations, the perimeter stations are closest to the disposal site, being located approximately 0.125 (760 ft) outside the site boundary. Given their limited mobility and the distance of the collection stations from the site, all polychaetes collected from the 12 off-site stations can be considered unimpacted by dredged material disposal and representative of

background conditions in Elliott Bay. Tissue results are shown below.

Table 19. Elliott Bay *in situ* dioxin tissue concentrations (ND=½DL)

Organism Genus	**Dioxin concentrations** (pptr ww TEQ, ND =½DL)
Glyciderae	0.307 – 2.51
Maldanidae	0.417 to 0.525
Travisia	0.662

In comparison, the dioxin concentrations in tissue from *Nephtys* exposed to sediment from the Kenmore navigation channel ranged from 0.0831 to 0.183 pptr ww TEQ. As can be seen from this comparison, the Kenmore *Nephtys* concentrations for both *Nephtys* and *Macoma* were less than tissue concentrations from all 12 Elliott Bay polychaete samples.

Summary

The bioaccumulation testing data are summarized in Table 20 and as follows: dredged material samples from Kenmore resulted in tissue concentrations that were statistically greater than reference for KEN01 but not for the Supercomposite. Kenmore tissue concentrations resulting from bioaccumulation exposures were more than 20% greater than reference concentrations for KEN01 but not the Supercomposite, despite the absolute concentrations being quite low in all samples. Total TEQs were largely driven by the large number of non-detect results, which contributed between 65.7- 99.9% of the total TEQ sums. Even when detected, only one congener, OCDD, had concentration above the laboratory's congener-specific PQL, all other detections were much lower than the PQL, which increases the uncertainty about the results. In addition, OCDD has one of the lowest TEFs and therefore the contribution of this congener is swamped by the non-detect results for congeners with higher TEF's. Finally, the Kenmore polychaete tissue results had lower dioxin concentrations than that observed in various polychaete species collected in the vicinity of the Elliott Bay disposal site (but not impacted by the site) in 2007.

These lines of evidence were carefully considered by the DMMP agencies, and taken together they demonstrate that there is not likely to be a significant bioaccumulation impact to the disposal site from either KEN01 or the Supercomposite. Therefore, with respect to bioaccumulation, all DMMUs from the Kenmore federal navigation channel are considered suitable for open-water disposal.

9. <u>Sediment Exposed by Dredging</u>. The sediment to be exposed by dredging must either meet the State of Washington Sediment Quality Standards (SQS) or the State's Antidegradation standard (Ecology, 2013) as outlined by DMMP guidance (DMMP, 2008).

Z-layer testing was completed in 2014, and included analysis of freshwater bioassays due to elevated nickel throughout the project. Nickel is considered to have an elevated natural background in the area (RSET 2015). All DMMU z-samples passed bioassay testing. The DMMP agencies reviewed the previous testing results and determined the results were still valid for deep sediments that have been undisturbed since the 2014 testing.

Therefore, the sediment to be exposed by dredging is not considered to be degraded relative to the currently exposed sediment surface. On this basis the DMMP agencies conclude that this project is in compliance with the State of Washington anti-degradation policy.

10. <u>Suitability Determination</u>. This memorandum documents the evaluation of the suitability of sediment proposed for dredging from the Kenmore federal navigation channel for open-water disposal at the Elliott Bay non-dispersive disposal site. The approved sampling and analysis plan was generally followed.

With respect to bioaccumulation, after full consideration of all lines of evidence, KEN01 and the Supercomposite passed bioaccumulation testing for dioxin.

With respect to benthic toxicity the results are summarized are Table 21. KEN02 and KEN07 had an incomplete suite of valid bioassays from which to make a determination. Therefore, in the absence of all the information needed to make a decision on bioassays, these two DMMUs are not suitable for open-water disposal. The remaining seven DMMUs had detected SL exceedances of total chlordane and no bioassays were run. Bioassay testing is needed to determine if these seven DMMUs are suitable, without this information they are not suitable for open-water disposal.

In summary, based on the results of the previously described testing, the DMMP agencies conclude that **all 34,350 CY are unsuitable** for open-water disposal at the Elliott Bay non-dispersive site based on the bioassay results. Bioassay re-testing of all DMMUs would be needed to make a final determination on the suitability of the proposed dredged material from the Kenmore navigation channel.

A determination regarding the suitability of the material for upland disposal at any location other than a permitted landfill must be coordinated with the local Health Department.

This suitability determination does not constitute final agency approval of the 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.

11. References.

DMMP, 2018. *Dredged Material Evaluation and Disposal Procedures (Users Manual)*. Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, December 2018.

DMMP, 2017. Determination Regarding the Suitability of Proposed Dredged Material from the Port of Everett Marina, Evaluated under Section 404 of the Clean Water Act, for Placement at the Dredged Materila Management Program's Unconfined Open-Water Disposal Site in Port Gardner. March 30, 2017

DMMP, 2015. *Modification to Ammonia and Sulfide Triggers for Purging and Reference Toxicant Testing for Marine Bioassays.* DMMP Clarification Paper prepared by Laura Inouye (Ecology), Erika Hoffman (EPA), and David Fox (USACE) for the Dredged Material Management Program, August 2015.

DMMP, 2013. *Bioassay Endpoint Refinements: Bivalve Larval and Neanthes Growth Bioassays.* Clarification paper prepared by David Kendall (USACE), Russ McMillan (Ecology), and Bill Gardiner, Brian Hester and Jack Word (NewFields, LLC) for the DMMP and SMS Programs, June, 2013.

DMMP, 2011. *Marine Sediment Quality Screening Levels: Adopting RSET Marine SLs for Use in DMMP.* A Clarification Paper prepared by Laura Inouye (Ecology) and David Fox (USACE) for the Dredged Material Management Program, June 2011.

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

DMMP, 2009. *Clarifications to the DMMP Bioaccumulation Protocol.* A DMMP Clarification Paper and SMS Technical Information Memorandum prepared by David Kendall (USACE) and Russ McMillan (Ecology) for the DMMP/SMS agencies. September 10, 2009.

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

Ecology, 2017. Sediment Cleanup User's Manual II (SCUM II): Guidance for Implementing the Cleanup Provisions of the Sediment Management Standards, Chapter 173-204 WAC. December 2017.

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

EPA, 2015. ProUCL Version 5.1 User Guide. Stasticial Software for Environmental Applications for Data Sets with and without Nondetect Observations. U.S. EPA Office of Research and Development, October 2015.

Kapsenburg L, Miglioli A, Bitter MC, Tambutte E, Dumollard R, Gattuso J-P, 2018. Ocean pH fluctuations affect mussel larvae at key developmental transitions. *Proc. R. Soc. B* **285**: 20182381. http://dx.doi.org/10.1098/rspb.2018.2381

RSET, 2015. *Proposal to Revise Freshwater Sediment Screening Levels.* RSET White prepared by Laura Inouye (Ecology), Jeremy Buck (USFWS), June Bergquist (IDEQ), Jonathan Freedman (EPA), and James McMillan (USACE) for the Regional Sediment Evaluation Team, November 17, 2014. Parts 1 and 3 were adopted by DMMP in October 2015.

Sealaska, 2019a. Final Sampling and Analysis Plan: Kenmore Navigation Channel. Prepared by Sealaska Technical Services for the Seattle District, U.S. Army Corps of Engineers, 18 January 2019.

Sealaska, 2019b. Final Sampling and Analysis Plan: Elliott Bay. Prepared by Sealaska Technical Services for the Seattle District, U.S. Army Corps of Engineers, 18 January 2019.

Sealaska, 2019c. Data Report: Kenmore Navigation Channel, Dredged Material Characterization, Kenmore, Washington. Prepared by Sealaska Technical Services for the Seattle District, U.S. Army Corps of Engineers, 31 October 2019.

Sealaska, 2019d. Data Report: Elliott Bay. Prepared by Sealaska Technical Services for the Seattle District, U.S. Army Corps of Engineers, 31 October 2019.

Weston Solutions, Inc. 2006. Site-Specific Sulfide Criterion for Produced-Water Discharges at Five California OCS Platforms. U.S. EPA Region IX, in support of General Permit #CAG280000. Technical Report 427-272.

12. Agency Signatures.

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

Concur:

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

Copies furnished:

DMMP signatories

John Hick, Navigation Section Chief

Elizabeth Chien, Navigation Section

Collin Ray, PECRB

Kim Carlton, Sealaska Environmental

Ken Israel, Sealaska Enivironmental

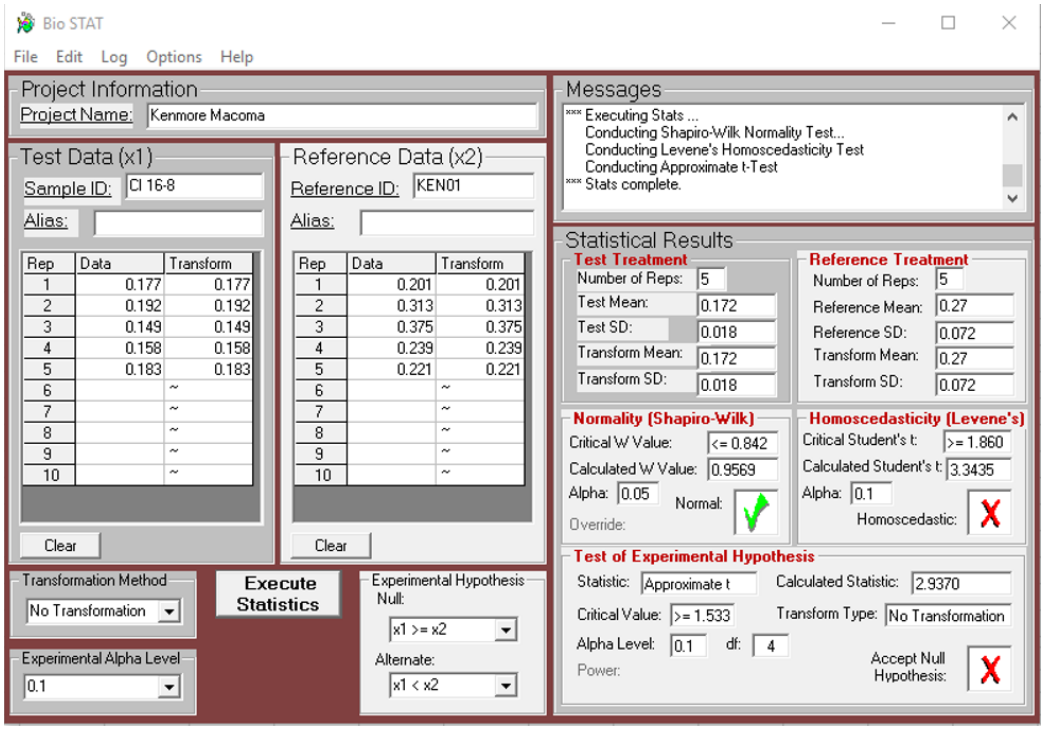
Keith Holiday, Sealaska Enivironmental

Sandy Browning, Integral Consulting

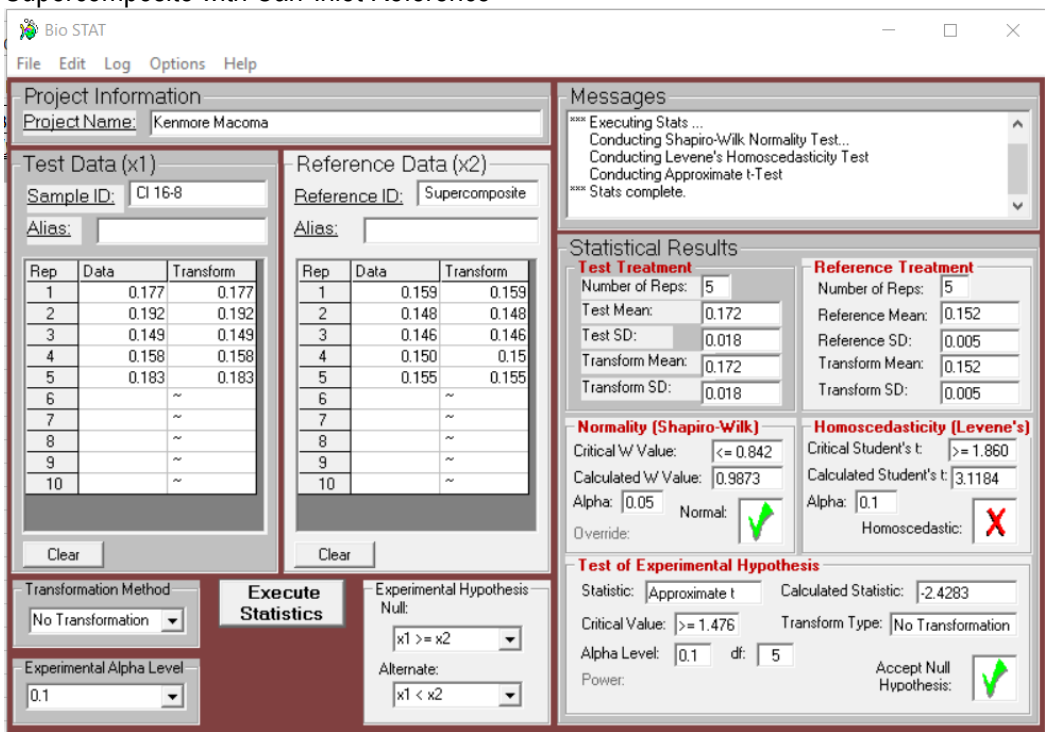
Attachment 1 – Screenshots of BioStat Results

Macoma Comparisons:

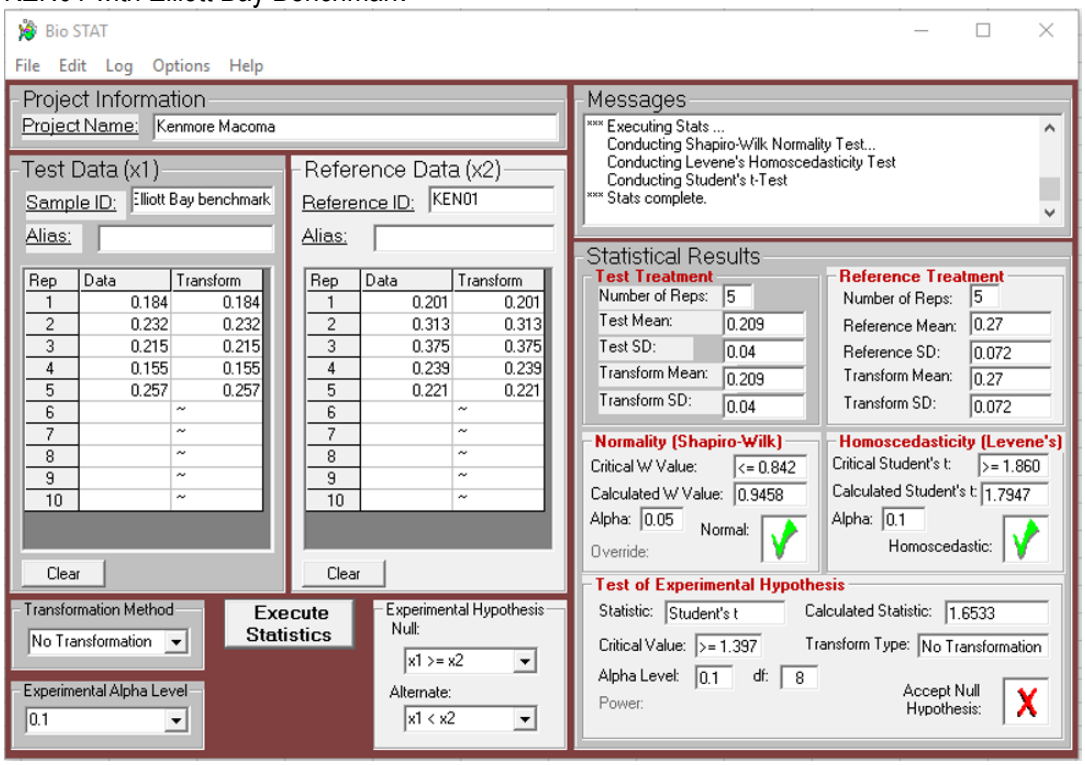
KEN01 with Carr Inlet Reference



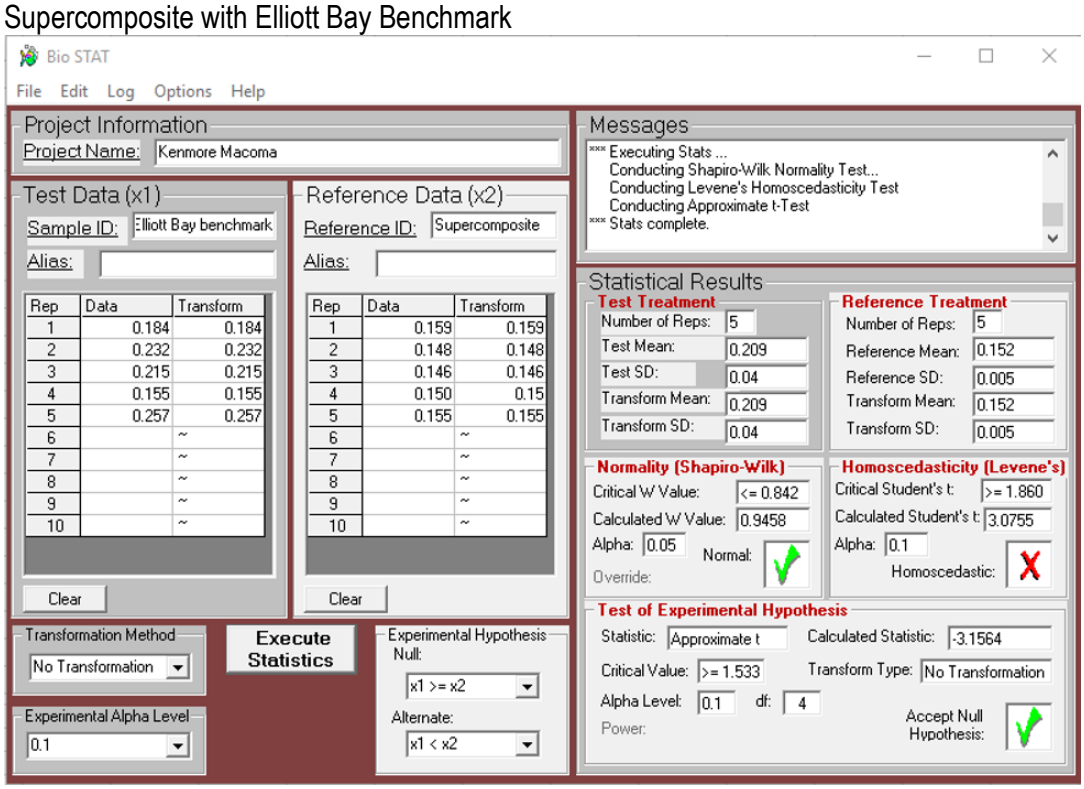
Supercomposite with Carr Inlet Reference



KEN01 with Elliott Bay Benchmark

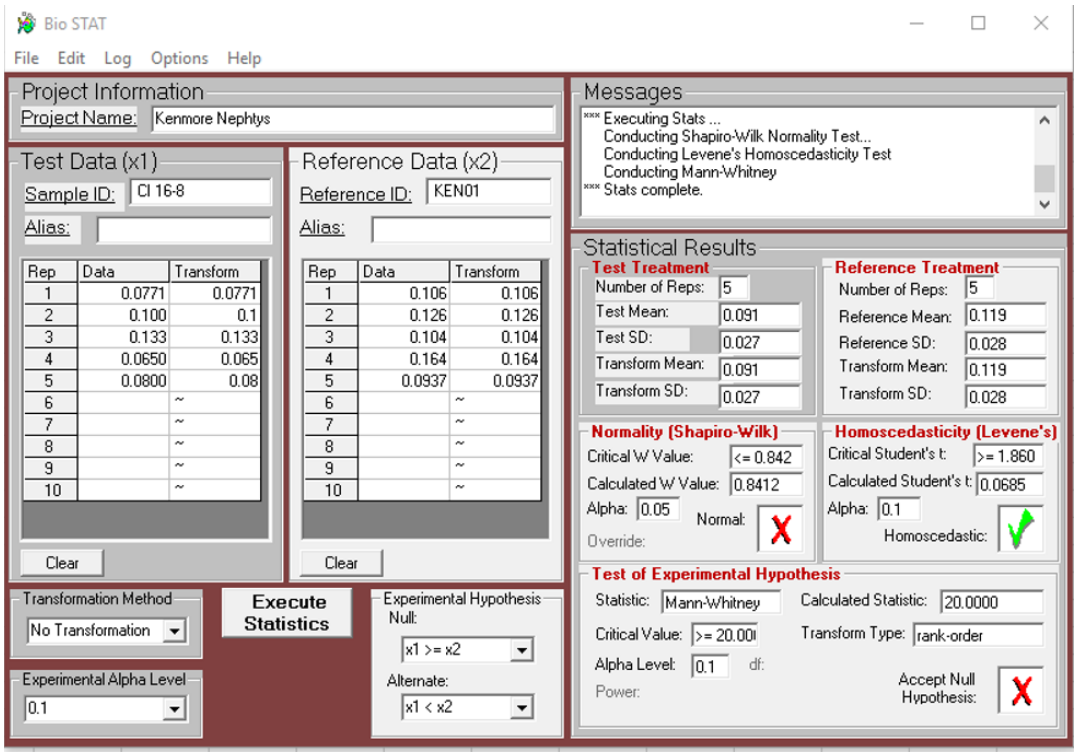


Supercomposite with Elliott Bay Benchmark

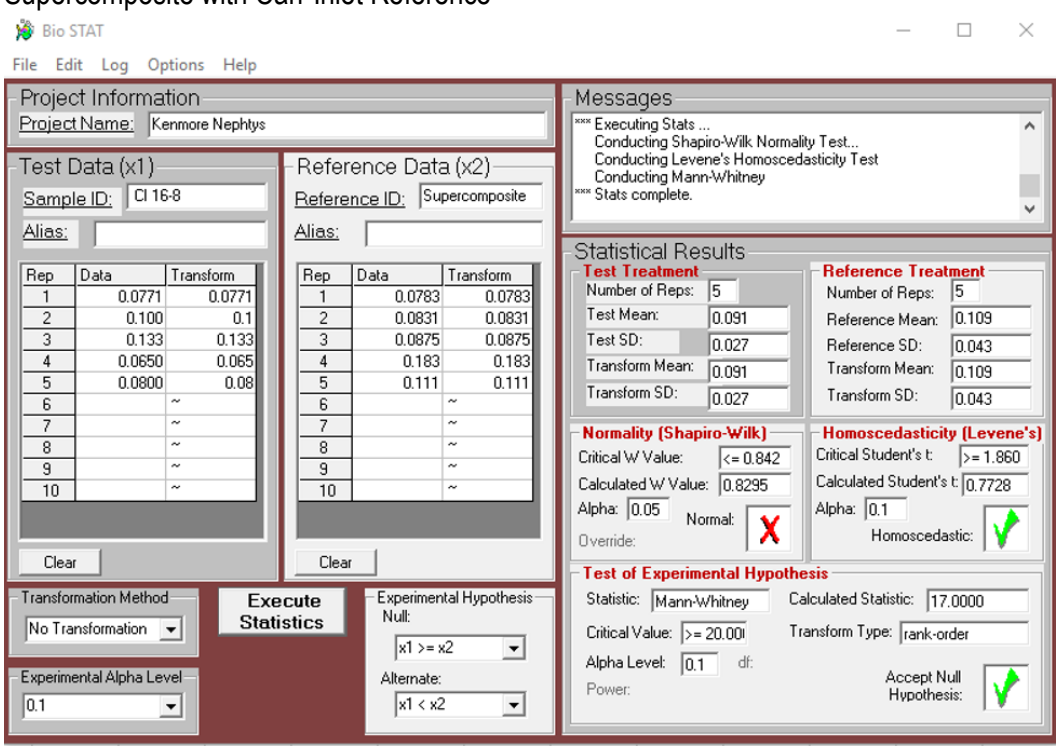


Nephtys Results

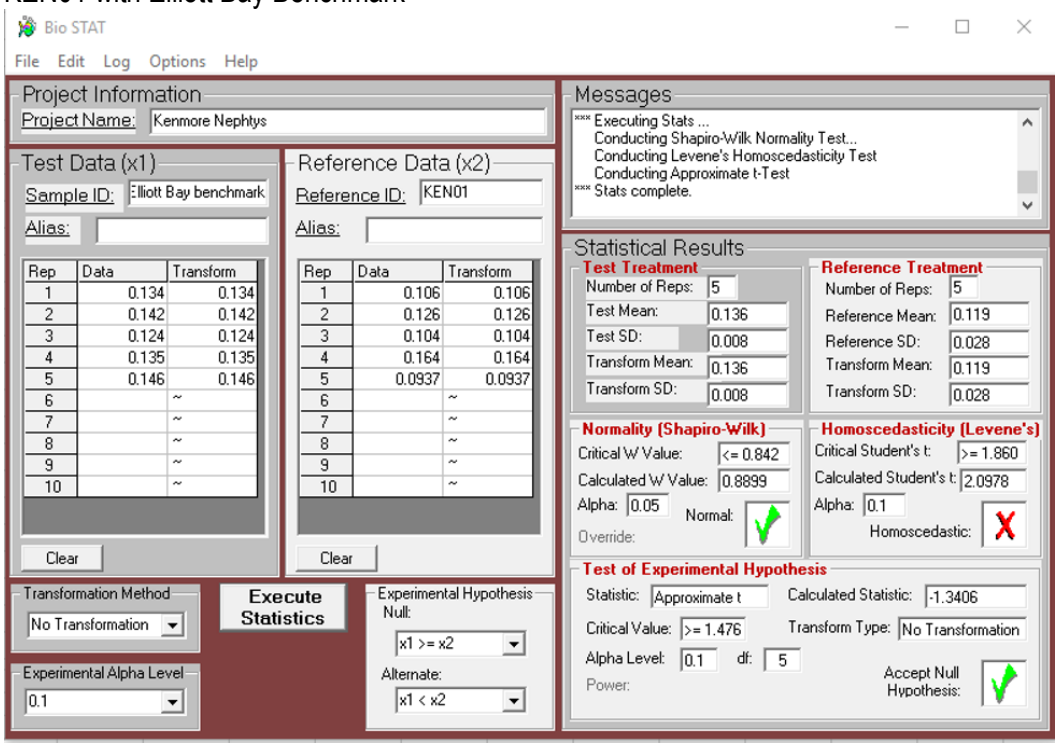
KEN01 with Carr Inlet Reference



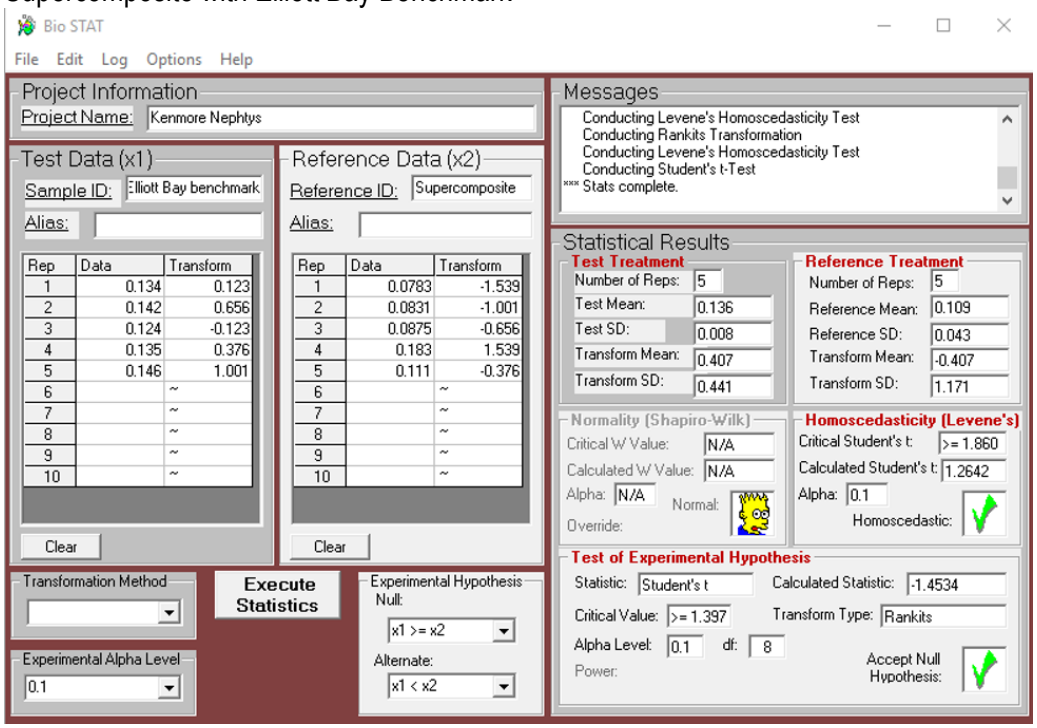
Supercomposite with Carr Inlet Reference

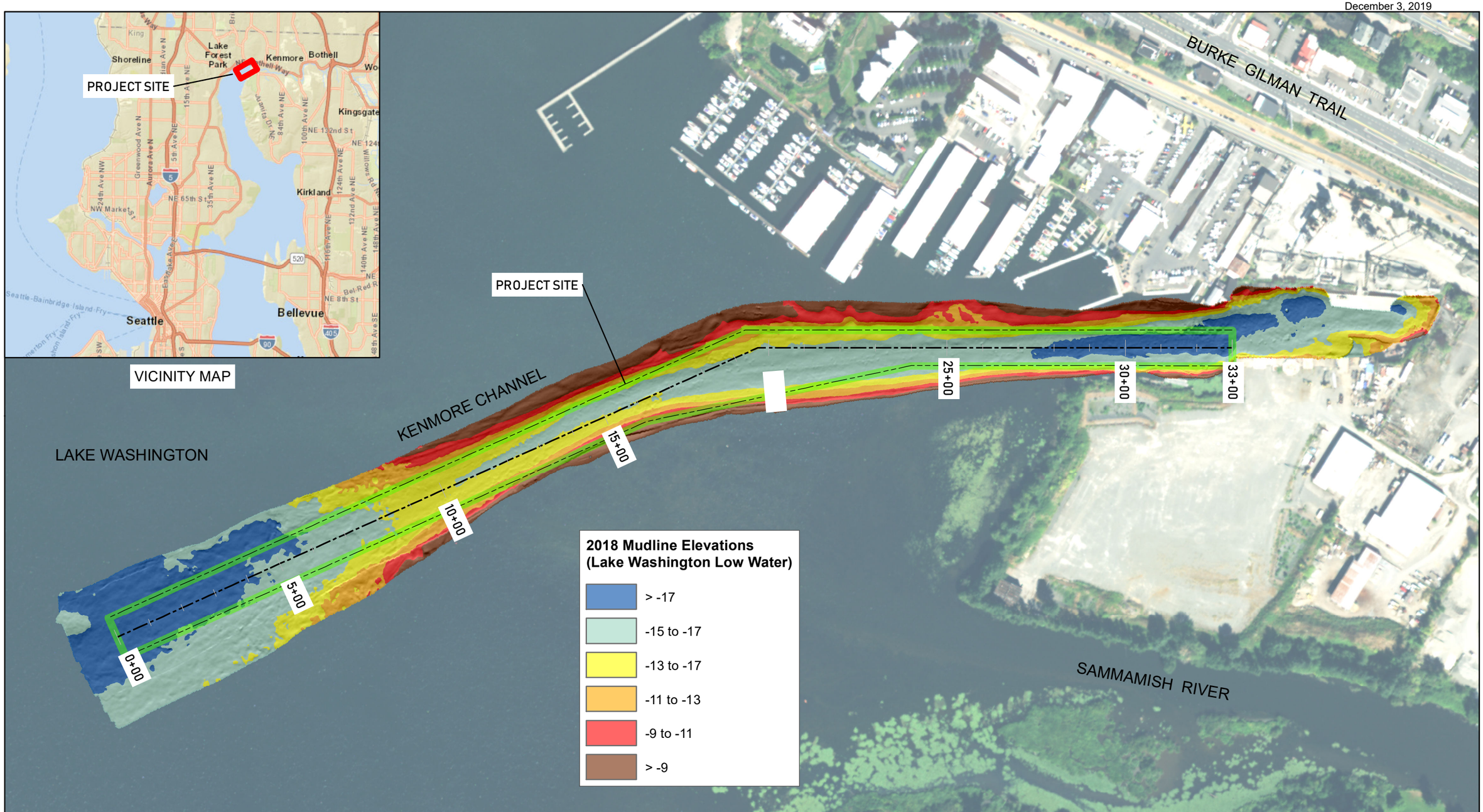


KEN01 with Elliott Bay Benchmark



Supercomposite with Elliott Bay Benchmark





ESTIMATED EXCAVATION QUANTITIES	
SURFACE MATERIAL	34,950 YD3

*QUANTITIES INCLUDE 2' OF OVER DREDGE WITH 30% ADDED. QUANTITIES ARE ROUNDED TO THE NEAREST 50 YD3.

LEGEND

- PROJECT BOUNDARY
- NAVIGATION CHANNEL
- NAVIGATION CHANNEL CENTERLINE
- EXISTING CONTOURS

NOTES:

1. BATHYMETRIC CONTOURS GENERATED FROM HYDRO SURVEY DATA COLLECTED JULY 16, 2018 BY USACE.
2. BASE MAP DRAWING INFORMATION PROVIDED BY USACE.
3. BACKGROUND IMAGE SOURCE: USGS 8/15/2017

SEATTLE DISTRICT MATOC
SEATTLE, WASHINGTON

VICINITY MAP FOR THE KENMORE FEDERAL NAVIGATION CHANNEL

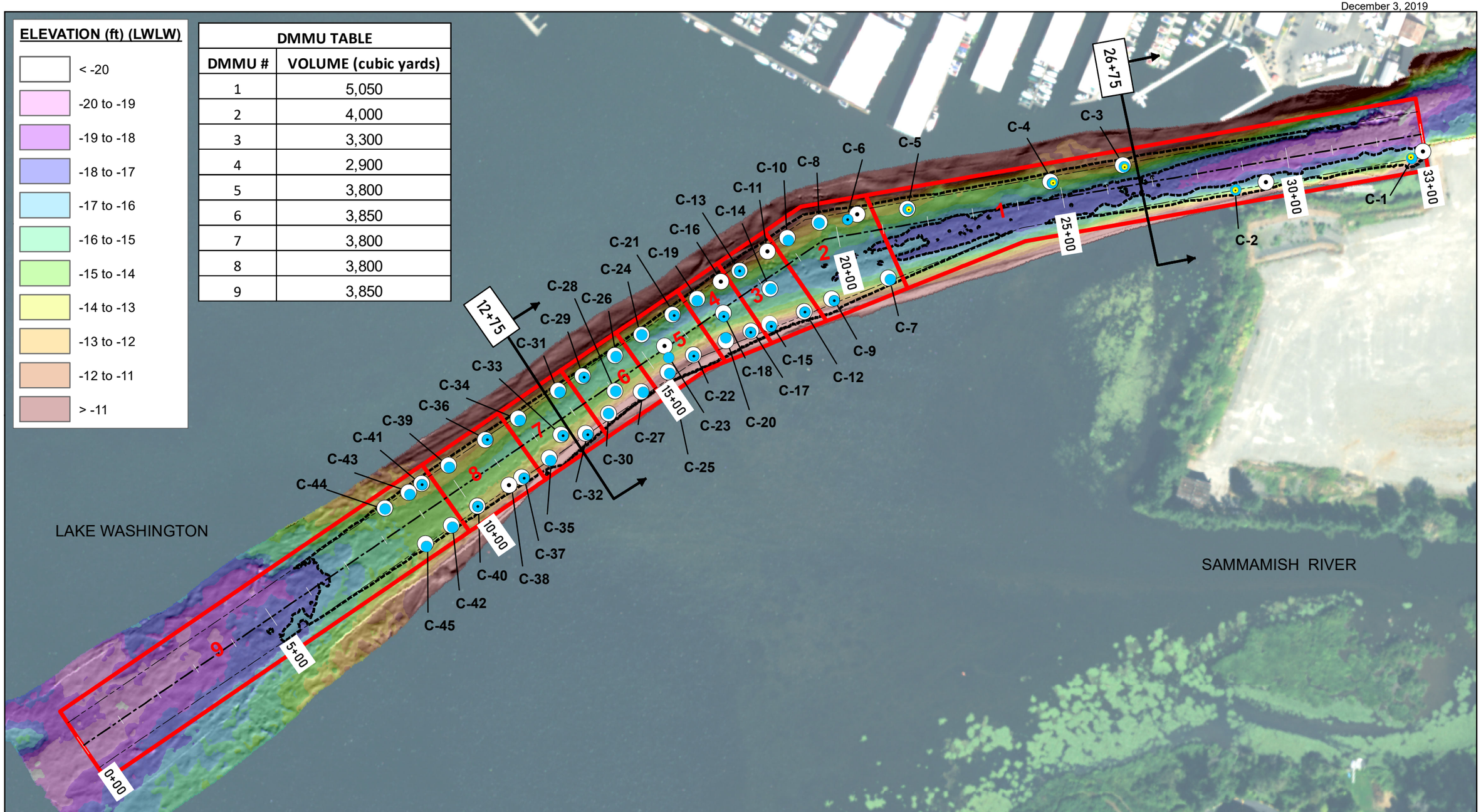
SEALASKA TECHNICAL

WA STATE PLANE NORTH, US FOOT VERTICAL LAKE WASHINGTON LOW WATER DATUM	Datum NAD 83	Scale 1:3,200

0 400 Feet
0 100 Meters

FIGURE 1

November 08, 2018



DMMU TABLE	
DMMU #	VOLUME (cubic yards)
1	5,050
2	4,000
3	3,300
4	2,900
5	3,800
6	3,850
7	3,800
8	3,800
9	3,850

LEGEND

- ACTUAL SAMPLE LOCATION (MAR 2019)
- ACTUAL SAMPLE LOCATION (JAN 2019)
- PROPOSED SAMPLE LOCATION
- DMMU
- SURFACE SEDIMENT BEING DREDGED IN ORDER TO REACH CHARACTERIZATION DEPTH OF -17 LWLW
- NAVIGATION CHANNEL
- NAVIGATION CHANNEL CENTERLINE

NOTES:

1. BATHYMETRIC MAP GENERATED FROM HYDRO SURVEY DATA COLLECTED JULY 16, 2018 BY USACE.
2. BASE MAP DRAWING INFORMATION PROVIDED BY USACE.
3. BACKGROUND IMAGE SOURCE: USGS 8/15/2017

SEATTLE DISTRICT MATOC
SEATTLE, WASHINGTON

KENMORE FEDERAL NAVIGATION CHANNEL DMMUs AND ACTUAL SEDIMENT SAMPLING LOCATIONS

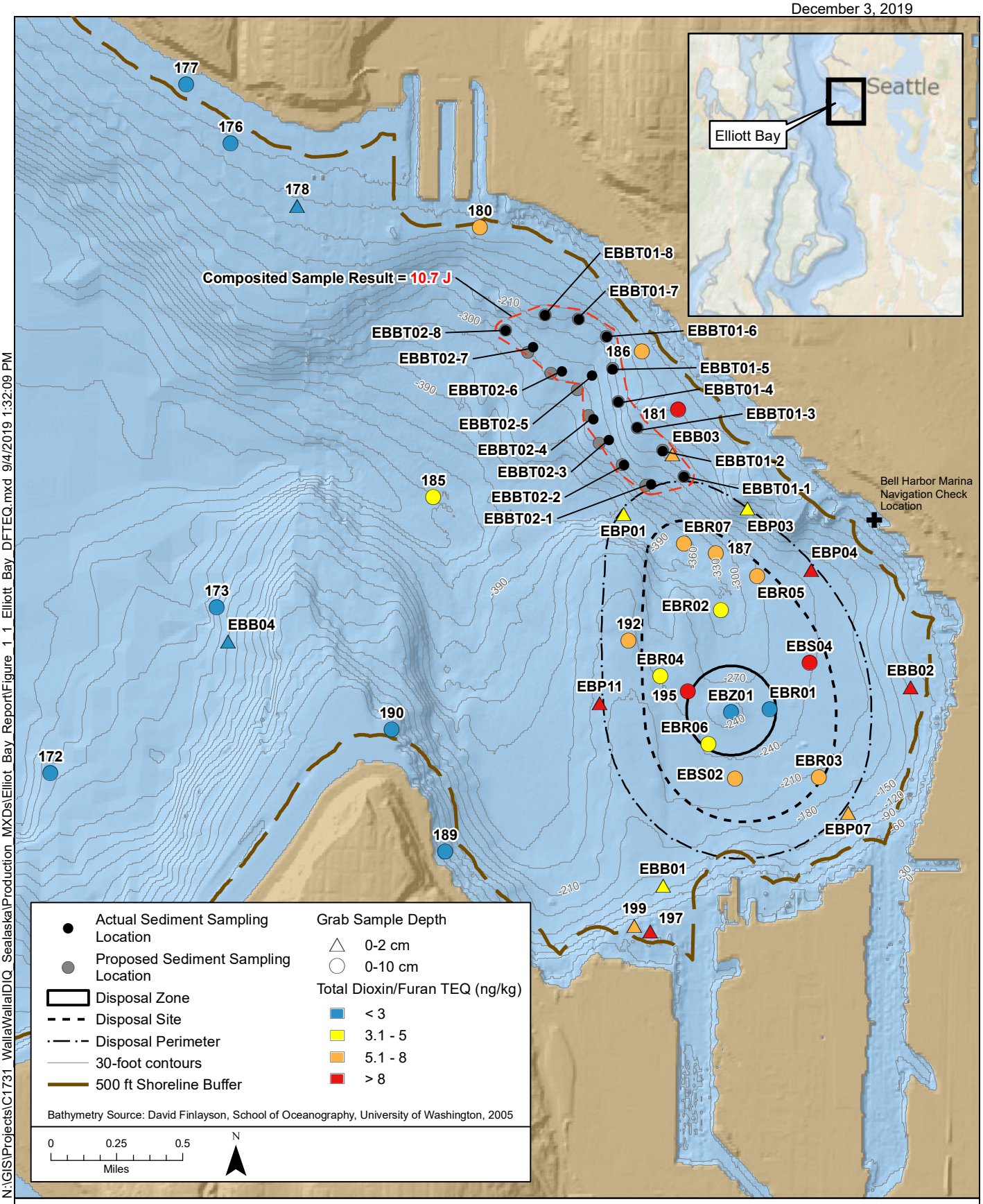
SEALASKA TECHNICAL

WA STATE PLANE NORTH, US FOOT VERTICAL LAKE WASHINGTON LOW WATER DATUM	Datum NAD 83	Scale 1:2,500

0 400 Feet
0 100 Meters

FIGURE 2

August 28, 2019



N:\GIS\Projects\C1731_WallaWallaDIQ_Sealaska\Production_MXDs\Elliot_Bay_Report\Figure_1_1_Elliott_Bay_DFTEQ.mxd 9/4/2019 1:32:09 PM

SEALASKA TECHNICAL

integral consulting inc.

Figure 3
Elliott Bay Benchmark Bioaccumulation Sampling Locations and Total Dioxin/Furan TEQ Data

DRAFT

LEGEND

- 2019 BIOACCUMULATION SAMPLE LOCATION
- 2019 BIOASSAY REFERENCE SAMPLE LOCATION
- PROPOSED REFERENCE SEDIMENT SAMPLING LOCATIONS
- CI-16-1 SAMPLE LOCATION ID

ACTUAL CARR INLET REFERENCE SEDIMENT SAMPLING STATIONS

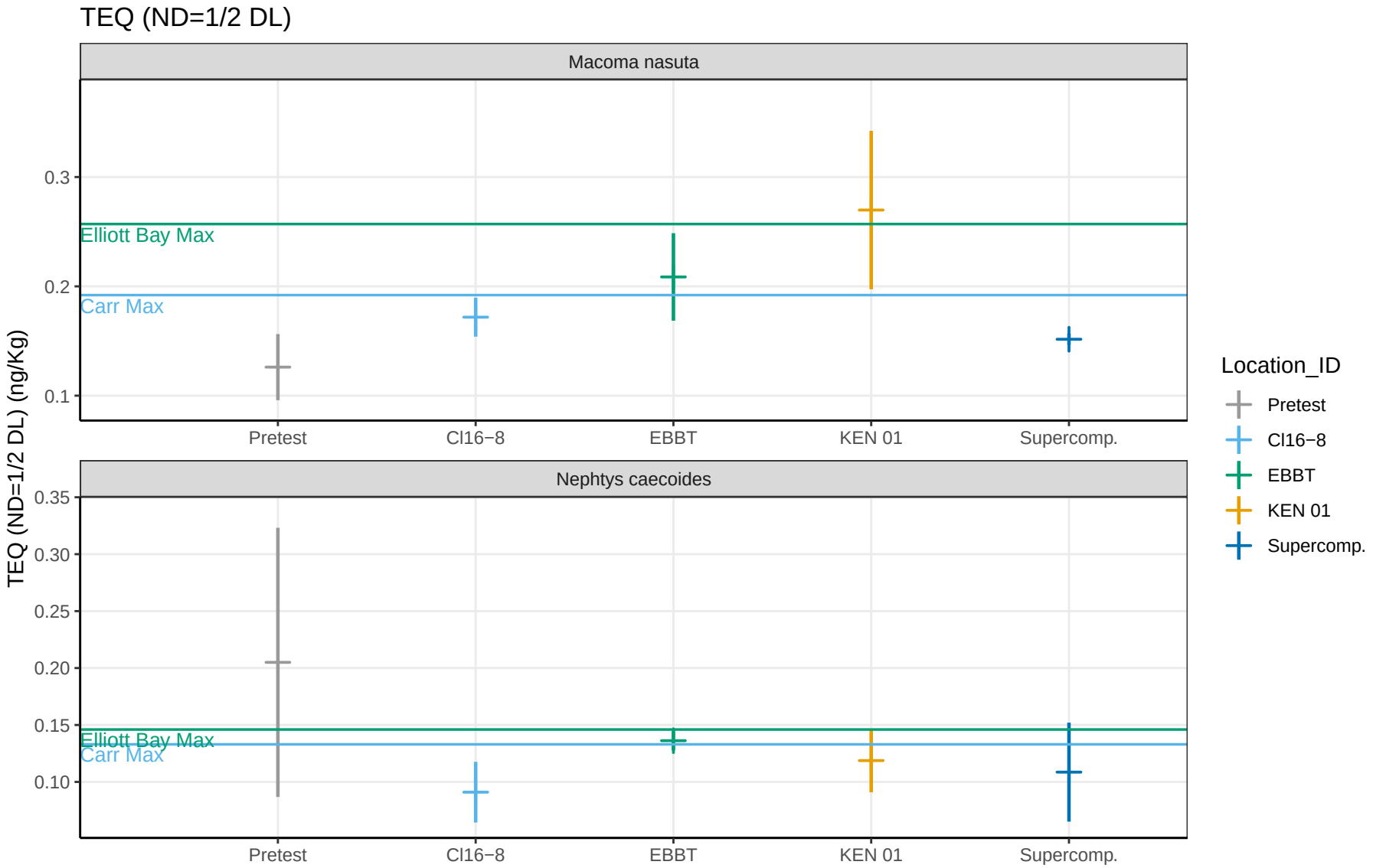
SEALASKA TECHNICAL

Coordinate System	Datum	Scale
GEOGRAPHIC	NAD 83	1:80,000

0 1 2 Miles
0 2 4 Kilometers

FIGURE 4

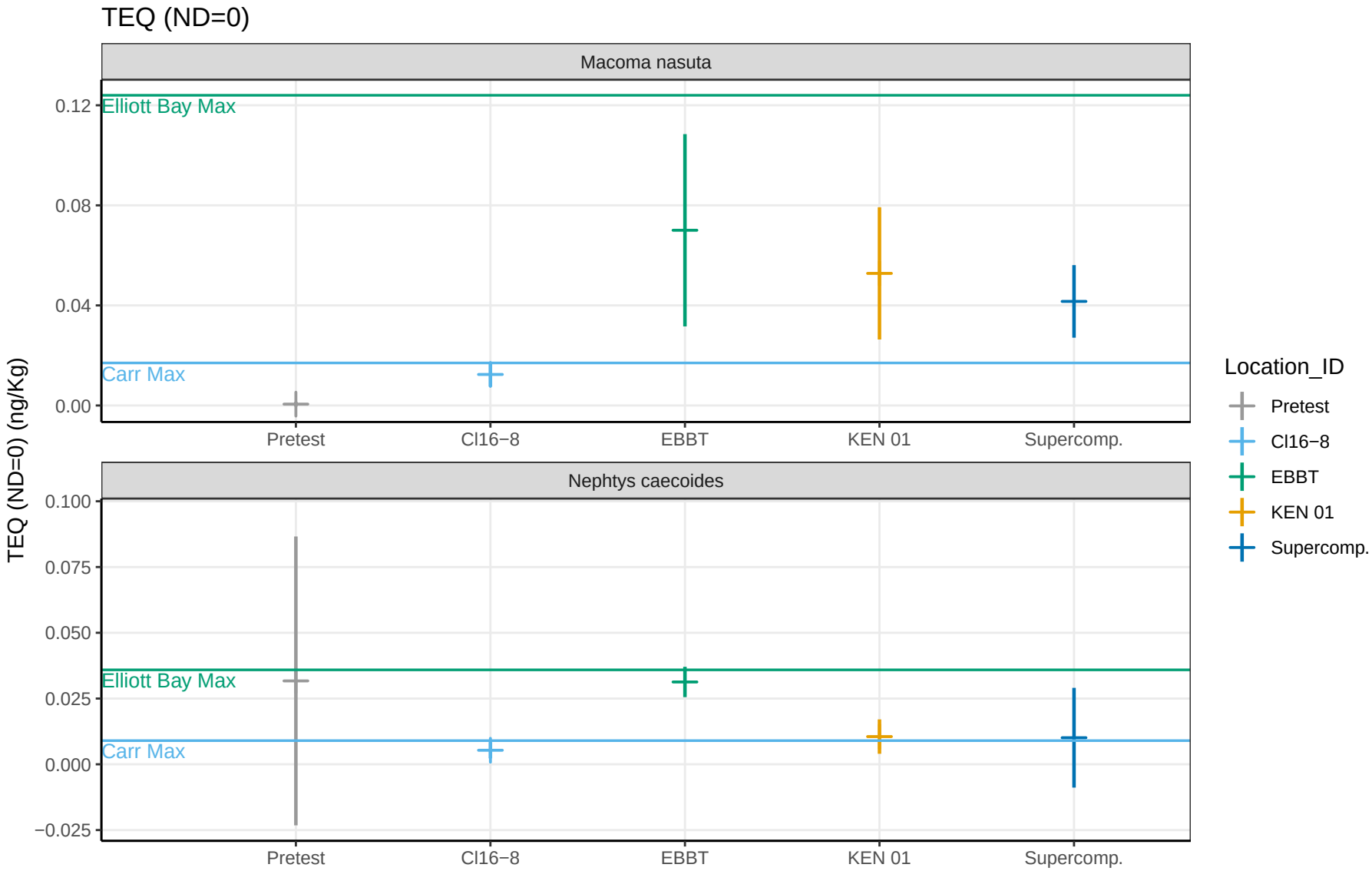
September 24, 2019



Legend: Solid points indicate detected values. Non−detects indicated by open points. Horizontal bar indicates the mean and the vertical bar is +/− the standard deviation. Pretest samples were included.

Figure 5

Scatter plots of the measured dioxin and furan concentrations in each species exposed by area



Legend: Solid points indicate detected values. Non−detects indicated by open points. Horizontal bar indicates the mean and the vertical bar is +/− the standard deviation. Pretest samples were included.

Figure 6

Scatter plots of the measured dioxin and furan concentrations in each species exposed by area

Table 2. DMMU Estimated Volumes and Volumes with Contingency Factor

	DMMU Volume (cy)		
DMMU [a]	2018 Hydrosurvey Estimated Volume [b]	Contingency Factor	Final DMMU Volume [c]
KEN01	3,873	30%	5,050
KEN02	3,081	30%	4,000
KEN03	2,528	30%	3,300
KEN04	2,207	30%	2,900
KEN05	2,904	30%	3,800
KEN06	2,962	30%	3,850
KEN07	2,912	30%	3,800
KEN08	2,904	30%	3,800
KEN09	2,953	30%	3,850
		Total	**34,350**

Notes:

cy = cubic yard

DMMU = dredged material management unit

LWLW = Lake Washington Low Water datum

[a] DMMUs are numbered sequentially from north to south.

[b] Volume estimated based on the federal navigation channel boundaries, a total dredge depth to -17 ft LWLW, and a 1V:2H side slope.

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

Table 3. Core Locations, Elevations, Penetration, Acquisition, and Percent Recovery

DMMU	Station	Core Attempt	Date	Latitude (NAD83)	Longitude (NAD83)	Northing (NAD83)	Easting (NAD83)	Lead-line Water Depth (ft)	Corrected Mudline Elevation[a] (ft LWLW)	Pen. (ft)	Acq. (ft)	Rec. (%)	Acquisition Elevation[b] (ft LWLW)
1	C-5	1	1/21/2019	47.7551	-122.2603	278689	1289420	13.8	-13.6	14	10.5	75	-24.1
1	C-4	1	1/21/2019	47.7556	-122.2592	278852	1289697	14.7	-14.5	14	13	93	-27.5
1	C-3	1	1/21/2019	47.7558	-122.2587	278939	1289833	13.6	-13.4	9.4	7.4	79	-20.8
1	C-1	2	1/21/2019	47.7565	-122.2563	279172	1290420	13.1	-12.9	7.4	7	95	-19.9
1	C-2	4	1/22/2019	47.7559	-122.2577	278974	1290081	15.5	-15.3	14	12.6	90	-27.9
1	C-1	4	3/7/2019	47.7565	-122.2563	279174	1290416	14.7	-13.9	6.2	4.7	76	-18.6
1	C-2	5	3/7/2019	47.7559	-122.2577	278974	1290080	15.5	-14.7	13.2	10.6	80	-25.3
1	C-3	2	3/7/2019	47.7558	-122.2587	278939	1289834	12.8	-12.0	13.3	12.5	94	-24.5
1	C-4	2	3/7/2019	47.7556	-122.2592	278853	1289699	14.3	-13.5	12.25	9.3	76	-22.8
1	C-5	2	3/7/2019	47.7551	-122.2603	278689	1289421	14.1	-13.3	14	11.25	80	-24.6
2	C-7	1	1/22/2019	47.7547	-122.2603	278531	1289436	14.5	-14.3	14	13	93	-27.3
2	C-9	1	1/22/2019	47.7544	-122.2607	278446	1289336	13.8	-13.5	11.6	9.7	84	-23.2
2	C-8	2	1/22/2019	47.7548	-122.2610	278594	1289247	12.4	-12.1	14	12.4	89	-24.5
2	C-10	2	1/23/2019	47.7547	-122.2612	278535	1289196	12.4	-12.1	14	12.1	86	-24.2
2	C-6	3	1/23/2019	47.7549	-122.2608	278622	1289303	13.0	-12.7	14	11.6	83	-24.3
3	C-11	1	1/23/2019	47.7545	-122.2614	278494	1289161	11.9	-11.6	14	13.3	95	-24.9
3	C-13	1	1/23/2019	47.7544	-122.2615	278436	1289119	12.1	-11.8	14	12.3	88	-24.1
3	C-12	1	1/23/2019	47.7543	-122.2609	278400	1289284	12.8	-12.6	13.2	11.2	85	-23.8
3	C-15	2	1/23/2019	47.7541	-122.2611	278346	1289226	11.8	-11.6	14	11.2	80	-22.8
3	C-14	1	1/24/2019	47.7544	-122.2612	278423	1289197	16.3	-16.0	8.9	7.9	89	-23.9
4	C-18	3	1/24/2019	47.7541	-122.2615	278330	1289120	15.9	-15.6	14	11.4	81	-27.0
4	C-17	3	1/24/2019	47.7541	-122.2613	278318	1289187	10.9	-10.6	14	9.8	70	-20.4
4	C-20	3	1/24/2019	47.7540	-122.2615	278287	1289140	12.0	-11.7	14	11.1	79	-22.8
4	C-16	1	1/25/2019	47.7543	-122.2617	278400	1289091	13.2	-13.0	10.8	9.5	88	-22.5
4	C-19	1	1/25/2019	47.7541	-122.2618	278343	1289054	14.0	-13.8	14	13.4	96	-27.2
5	C-21	1	1/25/2019	47.7540	-122.2620	278294	1289017	13.7	-13.4	14	13.7	98	-27.1
5	C-22	1	1/25/2019	47.7538	-122.2617	278226	1289088	11.1	-10.8	14	13.1	94	-23.9
5	C-25	1	1/25/2019	47.7537	-122.2618	278171	1289052	9.6	-9.3	14	12.1	86	-21.4
5	C-24	1	1/25/2019	47.7538	-122.2622	278230	1288965	14.9	-14.6	14	13.1	94	-27.7
5	C-23	4	1/25/2019	47.7537	-122.2619	278203	1289038	14.2	-13.9	14	8.2	59	-22.1

Table 3. Core Locations, Elevations, Penetration, Acquisition, and Percent Recovery

DMMU	Station	Core Attempt	Date	Latitude (NAD83)	Longitude (NAD83)	Northing (NAD83)	Easting (NAD83)	Lead-line Water Depth (ft)	Corrected Mudline Elevation[a] (ft LWLW)	Pen. (ft)	Acq. (ft)	Rec. (%)	Acquisition Elevation[b] (ft LWLW)
6	C-28	1	1/28/2019	47.7534	-122.2622	278094	1288954	14.5	-14.3	7.6	7.9	104	-22.2
7	C-31	1	1/28/2019	47.7533	-122.2627	278051	1288839	14.3	-14.1	12.7	9.8	77	-23.9
6	C-29	1	1/28/2019	47.7535	-122.2625	278100	1288878	14.8	-14.6	14	13.2	94	-27.8
6	C-26	1	1/28/2019	47.7536	-122.2623	278167	1288929	15.6	-15.4	14	11.9	85	-27.3
6	C-27	1	1/28/2019	47.7535	-122.2620	278113	1289011	8.9	-8.7	14	11.7	84	-20.4
6	C-30	1	1/28/2019	47.7533	-122.2622	278043	1288955	11.7	-11.5	14	13.2	94	-24.7
7	C-32	1	1/28/2019	47.7531	-122.2623	277984	1288928	10.1	-9.9	14	12.6	90	-22.5
7	C-35	1	1/28/2019	47.7529	-122.2625	277904	1288871	11.2	-11.0	12.5	10.1	81	-21.1
7	C-34	1	1/29/2019	47.7531	-122.2629	277963	1288778	13.4	-13.1	12.7	10.8	85	-23.9
7	C-33	1	1/29/2019	47.7531	-122.2625	277964	1288878	12.9	-12.6	14	11.8	84	-24.4
8	C-37	1	1/29/2019	47.7528	-122.2627	277846	1288830	12.2	-11.9	13.8	11.3	82	-23.2
8	C-38	1	1/29/2019	47.7527	-122.2628	277820	1288807	12.3	-12.0	14	11.1	79	-23.1
8	C-40	1	1/29/2019	47.7525	-122.2630	277753	1288756	13.3	-13.0	14	11.4	81	-24.4
8	C-36	2	1/29/2019	47.7529	-122.2631	277899	1288725	13.8	-13.5	14	11.1	79	-24.6
8	C-39	1	1/29/2019	47.7527	-122.2633	277813	1288668	13.0	-12.7	14	13.3	95	-26.0
9	C-45	2	1/29/2019	47.7522	-122.2633	277633	1288680	13.5	-13.2	14	13	93	-26.2
9	C-42	1	1/30/2019	47.7523	-122.2631	277692	1288719	13.4	-13.2	7.2	6.9	96	-20.1
9	C-41	1	1/30/2019	47.7525	-122.2635	277756	1288624	13.7	-13.5	14	11.9	85	-25.4
9	C-43	1	1/30/2019	47.7524	-122.2636	277727	1288607	14.1	-13.9	13.3	10.4	78	-24.3
9	C-44	2	1/30/2019	47.7523	-122.2637	277678	1288567	12.8	-12.6	14	11.5	82	-24.1

Notes:

Acq. = Acquisition

LWLW = Lake Washington Low Water datum

Pen. = Penetration

Rec. = Recovery

[a] Lake elevation-corrected. During a 2-day period before sampling the reported Lake Washington levels were 20.20 - 21.29 ft LWLW. These calculations are based on an average of 20.24 ft LWLW.

Mudline Elevation (LWLW) = Reported Lake Level (20.24 ft Corps' Datum) – measured lead-line water depth – 20 ft.

[b] Acquisition elevation = mudline elevation – length of acquired core; the target acquisition elevation was -19 ft LWLW to collect z-sample (-17 to -19 ft LWLW); sediment collected deeper than this elevation discarded during processing.

[c] Minimum percent recovery is 75% but 85% is the target. Also need to collect to elevation of -19 ft LWLW in order to obtain z-sample.

Table 4. Core Sampling Intervals

			Dredged Material Sampling			Z-layer Sampling		
			Mudline Elevation [a]	Design Elevation	Sampling Interval [b]	Design Elevation	Bottom Z-layer	Sampling Interval [b]
DMMU	Station	Core	(ft LWLW)	(ft LWLW)	(ft)	(ft LWLW)	(ft LWLW)	(ft)
KEN01	C1	1	-12.9	-17	0 - 4.1	-17	-19	4.1 - 6.1
KEN01	C2	2	-15.3	-17	0 - 1.7	-17	-19	1.7 - 3.7
KEN01	C3	3	-13.4	-17	0 - 3.6	-17	-19	3.6 - 5.6
KEN01	C4	4	-14.5	-17	0 - 2.5	-17	-19	2.5 - 4.5
KEN01	C5	5	-13.6	-17	0 - 3.4	-17	-19	3.4 - 5.4
KEN01R	C1	1	-13.9	-17	0 - 3.1	--	--	--
KEN01R	C2	2	-14.7	-17	0 - 2.3	--	--	--
KEN01R	C3	3	-12.0	-17	0 - 5	--	--	--
KEN01R	C4	4	-13.5	-17	0 - 3.5	--	--	--
KEN01R	C5	5	-13.3	-17	0 - 3.7	--	--	--
KEN02	C6	6	-12.7	-17	0 - 4.3	-17	-19	4.3 - 6.3
KEN02	C7	7	-14.3	-17	0 - 3.7	-17	-19	3.7 - 5.7
KEN02	C8	8	-12.2	-17	0 - 4.8	-17	-19	4.8 - 6.8
KEN02	C9	9	-13.6	-17	0 - 3.4	-17	-19	3.4 - 5.4
KEN02	C10	10	-12.1	-17	0 - 4.9	-17	-19	4.9 - 6.9
KEN03	C11	11	-11.6	-17	0 - 5.4	-17	-19	5.4 - 7.4
KEN03	C12	12	-12.6	-17	0 - 4.4	-17	-19	4.4 - 6.6
KEN03	C13	13	-11.8	-17	0 - 5.2	-17	-19	5.2- 7.2
KEN03	C14	14	-16.1	-17	0 - 0.8	-17	-19	0.8 - 2.8
KEN03	C15	15	-11.6	-17	0 - 5.4	-17	-19	5.4 -7.4
KEN04	C16	16	-13.0	-17	0 - 4	-17	-19	4.0 - 6.0
KEN04	C17	17	-10.7	-17	0 - 6.3	-17	-19	6.3- 8.3
KEN04	C18	18	-15.6	-17	0 - 1.4	-17	-19	1.4 - 3.4
KEN04	C19	19	-13.8	-17	0 - 3.2	-17	-19	3.2 - 5.2
KEN04	C20	20	-11.8	-17	0 - 5.2	-17	-19	5.2 - 7.2
KEN05	C21	21	-13.5	-17	0 - 3.5	-17	-19	3.5 - 5.5
KEN05	C22	22	-10.9	-17	0 - 6.1	-17	-19	6.1 - 8.0
KEN05	C23	23	-14.0	-17	0 - 3.0	-17	-19	3.0 - 5.0
KEN05	C24	24	-14.6	-17	0 - 2.4	-17	-19	2.4 - 4.4
KEN05	C25	25	-9.4	-17	0 - 7.6	-17	-19	7.6 - 9.6
KEN06	C26	26	-15.4	-17	0 - 1.6	-17	-19	1.6 - 3.6
KEN06	C27	27	-8.7	-17	0 - 9.3	-17	-19	9.3 - 11.0
KEN06	C28	28	-14.3	-17	0 - 2.7	-17	-19	2.7 - 4.7
KEN06	C29	29	-14.6	-17	0 - 2.4	-17	-19	2.4 - 4.4
KEN06	C30	30	-11.5	-17	0 - 5.5	-17	-19	5.5 - 7.5
KEN07	C31	31	-14.1	-17	0 - 2.9	-17	-19	2.9 - 4.9
KEN07	C32	32	-9.9	-17	0 - 7.1	-17	-19	7.1 - 9.1
KEN07	C33	33	-12.7	-17	0 - 4.3	-17	-19	4.3 - 6.3
KEN07	C34	34	-13.2	-17	0 - 3.8	-17	-19	3.8 - 5.8
KEN07	C35	35	-11.0	-17	0 - 6.0	-17	-19	6.0 - 8.0
KEN08	C36	36	-13.6	-17	0 - 3.4	-17	-19	3.4 - 5.4
KEN08	C37	37	-12.0	-17	0 - 5.0	-17	-19	5.0 - 7.0

Table 4. Core Sampling Intervals

			Dredged Material Sampling			Z-layer Sampling		
			Mudline Elevation [a]	Design Elevation	Sampling Interval [b]	Design Elevation	Bottom Z-layer	Sampling Interval [b]
DMMU	Station	Core	(ft LWLW)	(ft LWLW)	(ft)	(ft LWLW)	(ft LWLW)	(ft)
KEN08	C38	38	-12.1	-17	0 - 4.9	-17	-19	4.9 - 6.9
KEN08	C39	39	-12.8	-17	0 - 4.2	-17	-19	4.2 - 6.2
KEN08	C40	40	-13.1	-17	0 - 3.9	-17	-19	3.9 - 5.9
KEN09	C41	41	-13.5	-17	0 - 3.5	-17	-19	3.5 - 5.5
KEN09	C42	42	-13.2	-17	0 - 3.8	-17	-19	3.8 - 5.8
KEN09	C43	43	-13.9	-17	0 - 3.1	-17	-19	3.1 - 5.1[c]
KEN09	C44	44	-12.6	-17	0 - 4.4	-17	-19	4.4 - 6.4
KEN09	C45	45	-13.3	-17	0 - 3.7	-17	-19	3.7 - 5.7

Notes:

-- = not available

DMMU = dredged material management unit

LWLW = Lake Washington Low Water Datum

[a] Lake elevation-corrected. During the sample period the reported Lake Washington levels were 21.85 - 21.92. These calculations are based on an average of 21.9 ft.

[b] Sampling Interval represents the feet below the mudline (0). For the z-layer samples, the interval began at the bottom of the dredged material sample.

[c] See Section 2.3 for compositing deviation.

Table 5. Analytical Results Compared to DMMP Guideline Values[a]

		DMMP			KEN01							KEN01-comp						KEN02						
						Qualifiers							Qualifiers						Qualifiers					
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL
Grain Size																								
Percent Fines (Silt/Clay)	percent	--	--	--	65.9				0.1	--	0.1	59.5				0.1	0.1	70.5				0.1	--	0.1
Percent Fines (field measurement)	percent				54	--	--	--	--	--	--	NA	--	--	--	--	--	50	--	--	--	--	--	--
Clay: 0 to 3.9 microns (calculated)	percent	--	--	--	20.1							17.1						21.1						
Silt: 3.9 to 62.5 microns (calculated)	percent	--	--	--	45.6							42.4						49.4						
Sand: 62.5 to 2,000 microns (calculated)	percent	--	--	--	34							40.1						29.1						
Gravel: >2,000 microns (2 mm) (calculated)	percent	--	--	--	0.1							0.5						0.4						
Conventionals																								
N-ammonia	mg/kg	--	--	--	209				21.7	--	21.7	214				49.7	49.7	269				24	--	24
Preserved total solids	percent	--	--	--	32.9				0.04	--	0.04	35.01				0.04	0.04	32.2				0.04	--	0.04
Total organic carbon	percent	--	--	--	5.66				0.02	--	0.02	4.09				0.02	0.02	4.92				0.02	--	0.02
Total solids	percent	--	--	--	33.6				0.04	--	0.04	35.72				0.04	0.04	32.1				0.04	--	0.04
Total sulfides	mg/kg	--	--	--	314				58.6	--	58.6	162				13.4	13.4	393				57.7	--	57.7
Total volatile solids	percent	--	--	--	12.5				0.01	--	0.01	10.97				0.01	0.01	13.2				0.01	--	0.01
Metals																								
Antimony	mg/kg	150	---	200	0.09	UJ	J	UJ	0.05	--	0.57	NA						0.14	UJ	J	UJ	0.05	--	0.61
Arsenic	mg/kg	57	507.1	700	11.4	J		J	0.06	--	0.57	NA						10.1				0.07	--	0.61
Cadmium	mg/kg	5.1	--	14	0.64				0.09	--	0.29	NA						0.57				0.09	--	0.3
Chromium	mg/kg	260	--	---	52.9	J		J	0.2	--	1.43	NA						46.9				0.21	--	1.52
Copper	mg/kg	390	--	1,300	53.1	J		J	0.97	--	1.43	NA						37.6				1.04	--	1.52
Lead	mg/kg	450	975	1,200	32.2	J		J	0.19	--	0.29	NA						24.3				0.21	--	0.03
Mercury	mg/kg	0.41	1.5	2.3	0.0909	J		J	0.0152	--	0.0722	NA						0.0749	U	U		0.0157	--	0.0749
Nickel	mg/kg	---	---	---	48.2	J		J	0.14	--	1.43	NA						45.2				0.15	--	1.52
Selenium	mg/kg	---	3	---	1.71				1.25	--	1.43	NA						1.93				1.34	--	1.52
Silver	mg/kg	6.1	--	8.4	0.17	J	J		0.05	--	0.57	NA						0.16	J	J		0.05	--	0.61
Zinc	mg/kg	410	--	3,800	191	J		J	2.3	--	11.4	NA						162				2.5	--	12.2
Polycyclic Aromatic Hydrocarbons																								
Naphthalene	µg/kg	2,100	---	2,400	24.7				5.1	--	19.6	NA						7.6	J	J		5.2	--	19.7
Acenaphthylene	µg/kg	560	---	1,300	22.6				4.7	--	19.6	NA						19.7	U	U		4.7	--	19.7
Acenaphthene	µg/kg	500	---	2,000	84.6				5	--	19.6	NA						6.3	J	J		5.1	--	19.7
Fluorene	µg/kg	540	---	3,600	77.8				4.8	--	19.6	NA						9.8	J	J		4.9	--	19.7
Phenanthrene	µg/kg	1,500	---	21,000	460				4.6	--	19.6	NA						64.2				4.6	--	19.7
Anthracene	µg/kg	960	---	13,000	107				5.8	--	19.6	NA						16.4	J	J		5.8	--	19.7
2-Methylnaphthalene[b]	µg/kg	670	---	1,900	14.8	J	J		5.5	--	19.6	NA						19.7	U	U		5.6	--	19.7
Total LPAH[b]	µg/kg	5,200	---	29,000	776.7	J						NA						104.3	J					
Fluoranthene	µg/kg	1,700	4,600	30,000	717				4.4	--	19.6	NA						153				4.5	--	19.7
Pyrene	µg/kg	2,600	11,980	16,000	662				5.4	--	19.6	NA						144				5.5	--	19.7
Benz(a)anthracene	µg/kg	1,300	---	5,100	269				5.1	--	19.6	NA						55.9				5.1	--	19.7
Chrysene	µg/kg	1,400	---	21,000	422				5.1	--	19.6	NA						104				5.1	--	19.7
Benzofluoranthenes, total	µg/kg	3,200	---	9,900	613				10	--	39.2	NA						219				10	--	39.4
Benzo(a)pyrene	µg/kg	1,600	---	3,600	218				6.3	--	19.6	NA						75.2				6.4	--	19.7
Indeno(1,2,3-c,d)pyrene	µg/kg	600	---	4,400	61.8				5.9	--	19.6	NA						32.7				5.9	--	19.7
Dibenz(a,h)anthracene	µg/kg	230	---	1,900	21.4				6	--	19.6	NA						11.9	J	J		6.1	--	19.7
Benzo(ghi)perylene	µg/kg	670	---	3,200	64.1				5.7	--	19.6	NA						33.6				5.7	--	19.7
Total HPAH	µg/kg	12,000	---	69,000	3048.3							NA						829.3	J					
Total PAHs[b]	µg/kg	---	---	---	3825	J						NA						933.6	J					
Chlorinated Hydrocarbons																								
1,4-Dichlorobenzene	µg/kg	110	---	120	19.6	U	U		4.3	--	19.6	NA						19.7	U	U		4.3	--	19.7
1,2-Dichlorobenzene	µg/kg	35	---	110	19.6	U	U		4.6	--	19.6	NA						19.7	U	U		4.6	--	19.7
1,2,4-Trichlorobenzene	µg/kg	31	---	64	19.6	U	U		5.8	--	19.6	NA						19.7	U	U		5.9	--	19.7
Hexachlorobenzene (HCB)	µg/kg	22	168	230	19.6	U	U		4.6	--	19.6	NA						19.7	U	U		4.7	--	19.7
beta-Hexachlorocyclohexane	µg/kg	---	---	---	0.75	U	U		0.27	0.75	1.49	NA						0.74	U	U		0.27	0.74	1.48

Table 5. Analytical Results Compared to DMMP Guideline Values[a]

		DMMP			KEN01							KEN01-comp						KEN02						
						Qualifiers							Qualifiers						Qualifiers					
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL
Phthalates																								
Dimethyl phthalate	µg/kg	71	---	1,400	19.6	U	U		6.3	--	19.6	NA						19.7	U	U		6.3	--	19.7
Diethyl phthalate	µg/kg	200	---	1,200	19.6	U	U		17.3	--	19.6	NA						19.7	UJ	U	J	17.4	--	19.7
Di-n-butyl phthalate	µg/kg	1,400	---	5,100	37.4	U	B	U	5.2	--	19.6	NA						18.2	U	J,B	U	5.2	--	19.7
Butyl benzyl phthalate	µg/kg	63	---	970	26				7.9	--	19.6	NA						23	J		J	7.9	--	19.7
Bis(2-ethylhexyl) phthalate	µg/kg	1,300	---	8,300	456				28.2	--	48.9	NA						370				28.4	--	49.3
Di-n-octyl phthalate	µg/kg	6,200	---	6,200	19.6	U	U		8.5	--	19.6	NA						19.7	U	U		8.6	--	19.7
Phenols																								
Phenol	µg/kg	420	---	1,200	26.5				8.1	--	19.6	NA						15.2	J	J		8.1	--	19.7
2-Methylphenol	µg/kg	63	---	77	19.6	U	U		7.7	--	19.6	NA						19.7	U	U		7.7	--	19.7
4-Methylphenol	µg/kg	670	---	3,600	206				14.4	--	19.6	NA						188				14.5	--	19.7
2,4-Dimethylphenol	µg/kg	29	---	210	5.5	J	J		2.1	--	24.5	NA						3.5	J	J		2.1	--	24.6
Pentachlorophenol	µg/kg	400	504	690	97.9	UJ	U	J	30.6	--	97.9	NA						98.5	UJ	U	J	30.8	--	98.5
Miscellaneous Extractables																								
Benzyl alcohol	µg/kg	57	---	870	19.6				14.6	--	19.6	NA						16.9	J	J		14.7	--	19.7
Benzoic acid	µg/kg	650	---	760	281				57.8	--	196	NA						264				58.2	--	197
Dibenzofuran	µg/kg	540	---	1,700	18.4	J	J		4.5	--	19.6	NA						19.7	U	U		4.5	--	19.7
Hexachlorobutadiene	µg/kg	11	---	270	4.9	U	U		0.7	--	4.9	NA						4.9	U	U		0.7	--	4.9
N-Nitrosodiphenylamine	µg/kg	28	---	130	19.6	U	U		9.4	--	19.6	NA						19.7	U	U		9.4	--	19.7
Carbazole	µg/kg	---	---	---	22.9				7.2	--	19.6	NA						10.2	J	J		7.3	--	19.7
Pesticides																								
4,4'-DDD	µg/kg	16	---	---	1.49	U	U		0.96	1.49	2.99	NA						1.48	U	U		0.95	1.48	2.95
4,4'-DDE	µg/kg	9	---	---	1.49	U	U		0.4	1.49	2.99	NA						1.48	U	U		0.4	1.48	2.95
4,4'-DDT	µg/kg	12	---	---	1.49	U	U		0.97	1.49	2.99	NA						1.48	U	U		0.96	1.48	2.95
Total 4,4'-DDx	µg/kg	---	50	69	1.49	U						NA						1.48	U					
Aldrin	µg/kg	10	---	---	1.49	U	U		1.1	1.49	1.49	NA						1.48	U	U		1.09	1.48	1.48
trans-Chlordane	µg/kg	---	---	---	1.49	U	U		0.98	1.49	1.49	NA						5.91	U	U,UJK		5.91	5.91	5.91
cis-Chlordane	µg/kg	---	---	---	0.75	U	U		0.33	0.75	1.49	NA						0.74	U	U		0.33	0.74	1.48
cis-Nonachlor	µg/kg	---	---	---	1.49	U	U		0.63	1.49	2.99	NA						1.48	U	U		0.62	1.48	2.95
trans-Nonachlor	µg/kg	---	---	---	1.49	U	U		0.68	1.49	2.99	NA						1.48	U	U		0.67	1.48	2.95
Oxychlordane	µg/kg	---	---	---	1.49	U	U		0.38	1.49	2.99	NA						1.48	U	U		0.38	1.48	2.95
Total Chlordane[c]	µg/kg	2.8	37	---	1.49	U						NA						5.91	U					
Dieldrin	µg/kg	1.9	---	1,700	1.49	U	U		0.34	1.49	2.99	NA						1.48	U	U		0.34	1.48	2.95
Heptachlor	µg/kg	1.5	---	270	0.75	U	U		0.14	0.75	1.49	NA						0.74	U	U		0.14	0.74	1.48
Endrin ketone	µg/kg	---	---	---	1.49	U	U		0.84	1.49	2.99	NA						1.48	U	U		0.83	1.48	2.95
Polychlorinated biphenyls																								
Aroclor 1016	µg/kg	---	---	---	4	U	U		1.6	--	4	NA						3.9	U	U		1.5	--	3.9
Aroclor 1221	µg/kg	---	---	---	4	U	U		1.6	--	4	NA						3.9	U	U		1.5	--	3.9
Aroclor 1232	µg/kg	---	---	---	4	U	U		1.6	--	4	NA						3.9	U	U		1.5	--	3.9
Aroclor 1242	µg/kg	---	---	---	4	U	U		1.6	--	4	NA						3.9	U	U		1.5	--	3.9
Aroclor 1248	µg/kg	---	---	---	12				1.6	--	4	NA						5.8				1.5	--	3.9
Aroclor 1254	µg/kg	---	---	---	32.5	J	J	J	1.6	--	4	NA						19.3	J	J	J	1.5	--	3.9
Aroclor 1260	µg/kg	---	---	---	8.2				0.6	--	4	NA						6.6				0.6	--	3.9
Aroclor 1262	µg/kg	---	---	---	4	U	U		0.6	--	4	NA						3.9	U	U		0.6	--	3.9
Aroclor 1268	µg/kg	---	---	---	4	U	U		0.6	--	4	NA						3.9	U	U		0.6	--	3.9
Total PCB Aroclors	µg/kg	130	---	3,100	52.7	J						NA						31.7	J					
Total PCB Aroclors	mg/kg TOCN		38[d]		0.9311							NA						0.6443						

Table 5. Analytical Results Compared to DMMP Guideline Values[a]

		DMMP			KEN01							KEN01-comp						KEN02						
						Qualifiers							Qualifiers						Qualifiers					
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL
Dioxins/Furans																								
2,3,7,8-TCDD	pg/g	--	--	--	0.644	U*	J,EMPC	U	0.212	--	0.997	0.46	U*	J,EMPC	U	0.057	0.997	0.551	U*	J,EMPC	U	0.103	--	0.998
1,2,3,7,8-PeCDD	pg/g	--	--	--	3.31				0.244	--	0.997	2.69				0.105	0.997	2.77				0.154	--	0.998
1,2,3,4,7,8-HxCDD	pg/g	--	--	--	5.21				0.308	--	0.997	4.46				0.190	0.997	3.94				0.154	--	0.998
1,2,3,6,7,8-HxCDD	pg/g	--	--	--	19				0.294	--	0.997	17.9				0.182	0.997	12.7				0.145	--	0.998
1,2,3,7,8,9-HxCDD	pg/g	--	--	--	10.8				0.314	--	0.997	9.8				0.194	0.997	8.03				0.156	--	0.998
1,2,3,4,6,7,8-HpCDD	pg/g	--	--	--	538				0.755	--	2.49	563				0.396	2.49	361	J		J	0.363	--	2.5
OCDD	pg/g	--	--	--	4430	J	B,E	J	1.20	--	9.97	4250	J	B,E	J	0.553	9.97	3030	J	B	J	0.691	--	9.98
2,3,7,8-TCDF	pg/g	--	--	--	2.57	U*	J,EMPC	U	0.217	--	0.997	1.37	U*	J,EMPC	U	0.094	0.997	1.36				0.154	--	0.998
1,2,3,7,8-PeCDF	pg/g	--	--	--	1.47				0.171	--	0.997	1.18				0.138	0.997	1.22				0.205	--	0.998
2,3,4,7,8-PeCDF	pg/g	--	--	--	1.46				0.155	--	0.997	1.25				0.127	0.997	1.14				0.166	--	0.998
1,2,3,4,7,8-HxCDF	pg/g	--	--	--	3.62				0.241	--	0.997	2.94				0.084	0.997	2.94				0.124	--	0.998
1,2,3,6,7,8-HxCDF	pg/g	--	--	--	3.36				0.306	--	0.997	2.31				0.098	0.997	2.75				0.204	--	0.998
1,2,3,7,8,9-HxCDF	pg/g	--	--	--	1.44		B		0.270	--	0.997	1.31				0.123	0.997	1.27		B		0.153	--	0.998
2,3,4,6,7,8-HxCDF	pg/g	--	--	--	4.12				0.236	--	0.997	2.04				0.139	0.997	2.62				0.148	--	0.998
1,2,3,4,6,7,8-HpCDF	pg/g	--	--	--	65.6				0.283	--	0.997	55.6				0.111	0.997	59.6	J		J	0.174	--	0.998
1,2,3,4,7,8,9-HpCDF	pg/g	--	--	--	3.86				0.388	--	0.997	2.99				0.139	0.997	3.46				0.239	--	0.998
OCDF	pg/g	--	--	--	190				0.985	--	1.99	138				0.177	1.99	166	J		J	0.395	--	2
TEQ	pg/g	4 -10[e]	10[e]	---																				
TEQ (ND=1/2 DL)	pg/g				16.5	J			0.741		3.17	15.0	J			0.321	3.17	12.2	J			0.445		3.17
TEQ (ND=0)	pg/g				16.0	J			0		0	14.7	J			0	0	11.9	J			0		0

Notes: All results shown are on a dry weight basis.

a - The EDL is provided for dioxin/furan results rather than the MDL

Yellow shaded cells exceed SL; red shaded cells exceed BT; gray shaded cells indicate samples were reanalyzed using high resolution methods (see Table 4-2).

-- = no criteria
BT = bioaccumulation trigger
DMMP = Dredged Material Management Program
EDL = estimated detection limit
ML = maximum level
MDL = method detection limit
MRL = method reporting limit
NA= not analyzed
PCB = polychlorinated biphenyl
SL = screening level
SVOC = semivolatile organic
TOCN = total organic carbon normalized
Val. = validation

B = analyte detected in an associated method blank at a concentration greater than one-half of ARI's reporting limit or 5 percent of the regulatory limit or 5 percent of the analyte concentration in the san

E = The analyte concentration exceeds the upper limit of the calibration range of the instrument established by the initial calibration

EMPC = Estimated maximum possible concentration defined in EPA Statement of WorkDLM02.2 as a value "calculated for 2,3,7,8-substituted isomers for which the quantitation and/or confirmation ion(s) has signal to noise in excess of 2.5, but does not meet identification criteria" (dioxin/furan analysis only)

J = estimated concentration

U = indicates the target analyte was not detected at the reported concentration

U* = EMPC value flagged as undetected

K = Raised reporting limit due to interference This analyte is not detected above the reporting limit (RL) or if noted, not detected above the limit of detection (LOD).

K* = [HR-Pesticides] - Peak detected but did not meet all quantification criteria, result reported represents the estimated maximum possible concentration.

[a] Criteria from DMMP Table 8-3 (DMMP 2016).

[b] 2-Methylnaphthalene is not included in the summation for total LPAH for marine projects.

[c] Sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane

[d] This value is normalized to total organic carbon, and is expressed in mg/kg carbon.

[e] Puget Sound only.

Table 5. Analytical Results Compared to DMMP Guideline Values[a]

		DMMP			KEN10 (Split of KEN02)							KEN03							KEN04						
						Qualifiers							Qualifiers							Qualifiers					
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL
Grain Size																									
Percent Fines (Silt/Clay)	percent	--	--	--	71.3				0.1	--	0.1	64.6				0.1	--	0.1	59.5				0.1	--	0.1
Percent Fines (field measurement)	percent				--	--	--	--	--	--	--	42	--	--	--	--	--	--	61	--	--	--	--	--	--
Clay: 0 to 3.9 microns (calculated)	percent	--	--	--	21							19.2							17.7						
Silt: 3.9 to 62.5 microns (calculated)	percent	--	--	--	50.2							45.4							41.8						
Sand: 62.5 to 2,000 microns (calculated)	percent	--	--	--	28.6							35.4							40.2						
Gravel: >2,000 microns (2 mm) (calculated)	percent	--	--	--	0							0.2							0.3						
Conventionals																									
N-ammonia	mg/kg	--	--	--	280				23.9	--	23.9	322				18.4	--	18.4	263				19.7	--	19.7
Preserved total solids	percent	--	--	--	30.9				0.04	--	0.04	34.5				0.04	--	0.04	40.7				0.04	--	0.04
Total organic carbon	percent	--	--	--	6.31				0.02	--	0.02	2.38				0.02	--	0.02	5.43	J		J	0.02	--	0.02
Total solids	percent	--	--	--	32.5				0.04	--	0.04	35.2				0.04	--	0.04	39				0.04	--	0.04
Total sulfides	mg/kg	--	--	--	445				63.6	--	63.6	286				57.9	--	57.9	180				49	--	49
Total volatile solids	percent	--	--	--	14.3				0.01	--	0.01	12.9				0.01		0.01	11.5				0.01	--	0.01
Metals																									
Antimony	mg/kg	150	---	200	0.1	UJ	J	UJ	0.05	--	0.56	0.08	UJ	J	UJ	0.05	--	0.57	0.06	UJ	J	UJ	0.04	--	0.48
Arsenic	mg/kg	57	507.1	700	8.8				0.06	--	0.56	11				0.06	--	0.57	8.91				0.05	--	0.48
Cadmium	mg/kg	5.1	--	14	0.54				0.08	--	0.28	0.66				0.08	--	0.28	0.43	J		J	0.07	--	0.24
Chromium	mg/kg	260	--	---	42				0.36	--	1.4	51.1				0.2	--	1.41	40.7				0.31	--	1.2
Copper	mg/kg	390	--	1,300	35.6				0.95	--	1.4	38				0.96	--	1.41	29.5	J		J	0.81	--	1.2
Lead	mg/kg	450	975	1,200	21.7				0.19	--	0.28	30.5				0.19	--	0.28	22.7				0.16	--	0.24
Mercury	mg/kg	0.41	1.5	2.3	0.104	J		J	0.0151	--	0.0719	0.117	J		J	0.0136	--	0.0646	0.0838	J		J	0.0123	--	0.0586
Nickel	mg/kg	---	---	---	39.3				0.14	--	1.4	49.9				0.14	--	1.41	40.2	J		J	0.12	--	1.2
Selenium	mg/kg	---	3	---	1.43				1.23	--	1.4	2.03				1.24	--	1.41	1.2	U	U		1.05	--	1.2
Silver	mg/kg	6.1	--	8.4	0.13	J	J		0.05	--	0.56	0.17	J	J		0.05	--	0.57	0.13	J	J		0.04	--	0.48
Zinc	mg/kg	410	--	3,800	145				2.3	--	11.2	164				2.3	--	11.3	122	J		J	2	--	9.6
Polycyclic Aromatic Hydrocarbons																									
Naphthalene	µg/kg	2,100	---	2,400	9.3	J	J		5.2	--	19.7	9.7	J	J		5.1	--	19.4	9.1	J	J		5.2	--	19.7
Acenaphthylene	µg/kg	560	---	1,300	6.6	J	J		4.7	--	19.7	5.4	J	J		4.6	--	19.4	19.7	U	U		4.7	--	19.7
Acenaphthene	µg/kg	500	---	2,000	8.4	J	J		5.1	--	19.7	8.5	J	J		5	--	19.4	8.1	J	J		5.1	--	19.7
Fluorene	µg/kg	540	---	3,600	12.2	J	J		4.9	--	19.7	12.9	J	J		4.8	--	19.4	11.8	J	J		4.9	--	19.7
Phenanthrene	µg/kg	1,500	---	21,000	84.7				4.6	--	19.7	103				4.6	--	19.4	110				4.6	--	19.7
Anthracene	µg/kg	960	---	13,000	21.7				5.8	--	19.7	22.9				5.8	--	19.4	20.8				5.8	--	19.7
2-Methylnaphthalene[b]	µg/kg	670	---	1,900	6.6	J	J		5.6	--	19.7	6.5	J	J		5.5	--	19.4	5.9	J	J		5.6	--	19.7
Total LPAH[b]	µg/kg	5,200	---	29,000	142.9	J						162.4	J						159.8	J					
Fluoranthene	µg/kg	1,700	4,600	30,000	184				4.5	--	19.7	218				4.4	--	19.4	208	J		J	4.5	--	19.7
Pyrene	µg/kg	2,600	11,980	16,000	182				5.5	--	19.7	211				5.4	--	19.4	202	J		J	5.5	--	19.7
Benz(a)anthracene	µg/kg	1,300	---	5,100	72.8				5.1	--	19.7	80.1				5	--	19.4	74.2				5.1	--	19.7
Chrysene	µg/kg	1,400	---	21,000	133				5.1	--	19.7	138				5.1	--	19.4	128				5.1	--	19.7
Benzofluoranthenes, total	µg/kg	3,200	---	9,900	285				10	--	39.4	292				9.9	--	38.8	278				10.1	--	39.5
Benzo(a)pyrene	µg/kg	1,600	---	3,600	99.8				6.4	--	19.7	102				6.3	--	19.4	94.8				6.4	--	19.7
Indeno(1,2,3-c,d)pyrene	µg/kg	600	---	4,400	39.7				5.9	--	19.7	38.2				5.8	--	19.4	33.1	J		J	5.9	--	19.7
Dibenz(a,h)anthracene	µg/kg	230	---	1,900	16.2	J	J		6.1	--	19.7	12.4	J	J		6	--	19.4	10.6	J	J		6.1	--	19.7
Benzo(ghi)perylene	µg/kg	670	---	3,200	45.3				5.7	--	19.7	39.8				5.6	--	19.4	34.8	J		J	5.7	--	19.7
Total HPAH	µg/kg	12,000	---	69,000	1057.8	J						1131.5	J						1063.5	J					
Total PAHs[b]	µg/kg	---	---	---	1200.7	J						1293.9							1223.3						
Chlorinated Hydrocarbons																									
1,4-Dichlorobenzene	µg/kg	110	---	120	19.7	U	U		4.3	--	19.7	19.4	U	U		4.3	--	19.4	19.7	U	U		4.3	--	19.7
1,2-Dichlorobenzene	µg/kg	35	---	110	19.7	U	U		4.6	--	19.7	19.4	U	U		4.5	--	19.4	19.7	U	U		4.6	--	19.7
1,2,4-Trichlorobenzene	µg/kg	31	---	64	19.7	U	U		5.9	--	19.7	19.4	U	U		5.8	--	19.4	19.7	U	U		5.9	--	19.7
Hexachlorobenzene (HCB)	µg/kg	22	168	230	19.7	U	U		4.7	--	19.7	19.4	U	U		4.6	--	19.4	19.7	U	U		4.7	--	19.7
beta-Hexachlorocyclohexane	µg/kg	---	---	---	0.74	U	U		0.27	0.74	1.48	1.48	U	U		0.27	0.74	1.48	0.74	U	U		0.27	0.74	1.48

Table 5. Analytical Results Compared to DMMP Guideline Values[a]

		DMMP			KEN10 (Split of KEN02)							KEN03							KEN04						
						Qualifiers							Qualifiers							Qualifiers					
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL
Phthalates																									
Dimethyl phthalate	µg/kg	71	---	1,400	19.7	U	U		6.3	--	19.7	37				6.3	--	19.4	21.2				6.4	--	19.7
Diethyl phthalate	µg/kg	200	---	1,200	85.4	J		J	17.4	--	19.7	19.4	U	U		17.2	--	19.4	19.7	U	U		17.5	--	19.7
Di-n-butyl phthalate	µg/kg	1,400	---	5,100	18.5	U	J,B	U	5.2	--	19.7	16	U	J,B	U	5.2	--	19.4	12.8	U	J,B	U	5.2	--	19.7
Butyl benzyl phthalate	µg/kg	63	---	970	92.9	J		J	7.9	--	19.7	44.4				7.8	--	19.4	27.4				7.9	--	19.7
Bis(2-ethylhexyl) phthalate	µg/kg	1,300	---	8,300	530				28.4	--	49.2	546				28	--	48.5	527				28.4	--	49.3
Di-n-octyl phthalate	µg/kg	6,200	---	6,200	19.7	U	U		8.6	--	19.7	19.4	U	U		8.5	--	19.4	19.7	U	U		8.6	--	19.7
Phenols																									
Phenol	µg/kg	420	---	1,200	19.4	J	J		8.1	--	19.7	19.1	J	J		8	--	19.4	17.7	J	J		8.1	--	19.7
2-Methylphenol	µg/kg	63	---	77	19.7	U	U		7.7	--	19.7	19.4	U	U		7.6	--	19.4	19.7	U	U		7.7	--	19.7
4-Methylphenol	µg/kg	670	---	3,600	266				14.5	--	19.7	202				14.3	--	19.4	443	J		J	14.5	--	19.7
2,4-Dimethylphenol	µg/kg	29	---	210	3.5	J	J		2.1	--	24.6	3.6	J	J		2.1	--	24.3	2.8	J	J		2.1	--	24.7
Pentachlorophenol	µg/kg	400	504	690	98.5	UJ	U	J	30.8	--	98.5	97.1	UJ	U	J	30.4	--	97.1	98.6	UJ	U	J	30.9	--	98.6
Miscellaneous Extractables																									
Benzyl alcohol	µg/kg	57	---	870	21				14.7	--	19.7	20.7				14.5	--	19.4	24.1				14.7	--	19.7
Benzoic acid	µg/kg	650	---	760	312				58.2	--	197	306				57.4	--	194	242				58.3	--	197
Dibenzofuran	µg/kg	540	---	1,700	6.1	J	J		4.5	--	19.7	6.8	J	J		4.5	--	19.4	6.1	J	J		4.5	--	19.7
Hexachlorobutadiene	µg/kg	11	---	270	4.9	U	U		0.7	--	4.9	4.9	U	U		0.7	--	4.9	4.9	U	U		0.7	--	4.9
N-Nitrosodiphenylamine	µg/kg	28	---	130	19.7	U	U		9.4	--	19.7	19.4	U	U		9.3	--	19.4	19.7	UJ	U	J	9.4	--	19.7
Carbazole	µg/kg	---	---	---	12	J	J		7.3	--	19.7	13.5	J	J		7.2	--	19.4	11.8	J	J		7.3	--	19.7
Pesticides																									
4,4'-DDD	µg/kg	16	---	---	1.48	U	U		0.95	1.48	2.96	1.48	U	U		0.95	1.48	2.96	1.48	U	U		0.95	1.48	2.96
4,4'-DDE	µg/kg	9	---	---	1.48	U	U		0.4	1.48	2.96	1.48	U	U		0.4	1.48	2.96	1.48	U	U		0.4	1.48	2.96
4,4'-DDT	µg/kg	12	---	---	1.48	U	U		0.96	1.48	2.96	1.48	U	U		0.96	1.48	2.96	1.48	U	U		0.96	1.48	2.96
Total 4,4'-DDx	µg/kg	---	50	69	1.48	U						1.48	U			--		--	1.48	U			--		--
Aldrin	µg/kg	10	---	---	1.48	U	U		1.09	1.48	1.48	1.48	U	U		1.09	1.48	1.48	1.48	U	U		1.09	1.48	1.48
trans-Chlordane	µg/kg	---	---	---	1.48	U	U		0.97	1.48	1.48	5.62	U	U,UJK		5.62	5.62	5.62	1.48	U	U		0.97	1.48	1.48
cis-Chlordane	µg/kg	---	---	---	0.74	U	U		0.33	0.74	1.48	0.74	U	U		0.33	0.74	1.48	0.74	U	U		0.33	0.74	1.48
cis-Nonachlor	µg/kg	---	---	---	1.48	U	U		0.62	1.48	2.96	1.48	U	U		0.62	1.48	2.96	1.48	U	U		0.62	1.48	2.96
trans-Nonachlor	µg/kg	---	---	---	1.48	U	U		0.67	1.48	2.96	17.8	U	U,UJK		17.8	17.8	17.8	1.48	U	U		0.67	1.48	2.96
Oxychlordane	µg/kg	---	---	---	1.48	U	U		0.38	1.48	2.96	1.48	U	U		0.38	1.48	2.96	1.48	U	U		0.38	1.48	2.96
Total Chlordane[c]	µg/kg	2.8	37	---	1.48	U						17.8	U						1.48	U					
Dieldrin	µg/kg	1.9	---	1,700	1.48	U	U		0.34	1.48	2.96	1.48	U	U		0.34	1.48	2.96	1.48	U	U		0.34	1.48	2.96
Heptachlor	µg/kg	1.5	---	270	0.74	U	U		0.14	0.74	1.48	0.74	U	U		0.14	0.74	1.48	0.74	U	U		0.14	0.74	1.48
Endrin ketone	µg/kg	---	---	---	1.48	U	U		0.83	1.48	2.96	1.48	U	U		0.83	1.48	2.96	1.48	U	U		0.83	1.48	2.96
Polychlorinated biphenyls																									
Aroclor 1016	µg/kg	---	---	---	3.9	U	U		1.5	--	3.9	3.9	U	U		1.5	--	3.9	4	U	U		1.5	--	4
Aroclor 1221	µg/kg	---	---	---	3.9	U	U		1.5	--	3.9	3.9	U	U		1.5	--	3.9	4	U	U		1.5	--	4
Aroclor 1232	µg/kg	---	---	---	3.9	U	U		1.5	--	3.9	3.9	U	U		1.5	--	3.9	4	U	U		1.5	--	4
Aroclor 1242	µg/kg	---	---	---	3.9	U	U		1.5	--	3.9	3.9	U	U		1.5	--	3.9	4	U	U		1.5	--	4
Aroclor 1248	µg/kg	---	---	---	5.8				1.5	--	3.9	76.6	J	J		1.5	--	3.9	5.5				1.5	--	4
Aroclor 1254	µg/kg	---	---	---	20.3	J	J	J	1.5	--	3.9	32	J	J	J	1.5	--	3.9	18.9	J	J	J	1.5	--	4
Aroclor 1260	µg/kg	---	---	---	4.8				0.6	--	3.9	5.4				0.6	--	3.9	4.3				0.6	--	4
Aroclor 1262	µg/kg	---	---	---	3.9	U	U		0.6	--	3.9	3.9	U	U		0.6	--	3.9	4	U	U		0.6	--	4
Aroclor 1268	µg/kg	---	---	---	3.9	U	U		0.6	--	3.9	3.9	U	U		0.6	--	3.9	4	U	U		0.6	--	4
Total PCB Aroclors	µg/kg	130	---	3,100	30.9	J						114	J						28.7	J					
Total PCB Aroclors	mg/kg TOCN		38[d]		0.4897							4.7899							0.5285						

Table 5. Analytical Results Compared to DMMP Guideline Values[a]

		DMMP			KEN10 (Split of KEN02)							KEN03							KEN04						
						Qualifiers							Qualifiers							Qualifiers					
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL
Dioxins/Furans																									
2,3,7,8-TCDD	pg/g	--	--	--	0.471	U*	J,EMPC	U	0.157	--	0.999	0.391	J	J		0.179	--	0.996	0.429	U*	J,EMPC	U	0.037	--	0.993
1,2,3,7,8-PeCDD	pg/g	--	--	--	1.6				0.326	--	0.999	1.49	U*	J,EMPC	U	0.296	--	0.996	2.15				0.0880	--	0.993
1,2,3,4,7,8-HxCDD	pg/g	--	--	--	2.34	U*	J,EMPC	U	0.209	--	0.999	2.24				0.195	--	0.996	2.88				0.105	--	0.993
1,2,3,6,7,8-HxCDD	pg/g	--	--	--	8.17				0.201	--	0.999	7.95				0.188	--	0.996	10.3				0.102	--	0.993
1,2,3,7,8,9-HxCDD	pg/g	--	--	--	4.86				0.214	--	0.999	4.81				0.200	--	0.996	6.45				0.108	--	0.993
1,2,3,4,6,7,8-HpCDD	pg/g	--	--	--	207	J		J	0.541	--	2.5	194				0.471	--	2.49	238				0.233	--	2.48
OCDD	pg/g	--	--	--	1630	J	B	J	0.787	--	9.99	1450	J	B	J	0.748	--	9.96	1770	J	B	J	0.392	--	9.93
2,3,7,8-TCDF	pg/g	--	--	--	0.908	U*	J,EMPC	U	0.267	--	0.999	0.857	J	J		0.124	--	0.996	1.17				0.100	--	0.993
1,2,3,7,8-PeCDF	pg/g	--	--	--	0.699	U*	J,EMPC	U	0.203	--	0.999	0.712	J	J		0.211	--	0.996	0.988	J	J		0.068	--	0.993
2,3,4,7,8-PeCDF	pg/g	--	--	--	0.688	U*	J,EMPC	U	0.196	--	0.999	0.846	J	J		0.198	--	0.996	1.07				0.063	--	0.993
1,2,3,4,7,8-HxCDF	pg/g	--	--	--	1.77	U*	J,EMPC	U	0.193	--	0.999	2.05				0.176	--	0.996	2.37				0.069	--	0.993
1,2,3,6,7,8-HxCDF	pg/g	--	--	--	1.54	U*	J,EMPC	U	0.212	--	0.999	1.67				0.200	--	0.996	1.86				0.0800	--	0.993
1,2,3,7,8,9-HxCDF	pg/g	--	--	--	0.9	J	J,B		0.232	--	0.999	0.207	U	U	U	0.207	--	0.996	1.14		B		0.0990	--	0.993
2,3,4,6,7,8-HxCDF	pg/g	--	--	--	1.88	U*	J,EMPC	U	0.231	--	0.999	1.12	U*	J,EMPC	U	0.210	--	0.996	2.74				0.0860	--	0.993
1,2,3,4,6,7,8-HpCDF	pg/g	--	--	--	29.8	J		J	0.228	--	0.999	27.3				0.274	--	0.996	42.4				0.103	--	0.993
1,2,3,4,7,8,9-HpCDF	pg/g	--	--	--	1.84				0.284	--	0.999	1.88				0.342	--	0.996	2.3				0.138	--	0.993
OCDF	pg/g	--	--	--	84.5	J		J	0.608	--	2	70.4				0.649	--	1.99	75.5				0.138	--	1.99
TEQ	pg/g	4 -10[e]	10[e]	---																					
TEQ (ND=1/2 DL)	pg/g				6.66	J			0.735		3.18	6.12	J			0.70202		3.17	8.99	J			0.226		3.16
TEQ (ND=0)	pg/g				5.89	J			0		0	5.31	J			0		0	8.77	J			0		0

Notes: All results shown are on a dry weight basis.

a - The EDL is provided for dioxin/furan results rather than the MDL

Yellow shaded cells exceed SL; red shaded cells exceed BT; gray shaded cells indicate samples were reanalyzed using high resolution methods (see Table 4-2).

-- = no criteria
BT = bioaccumulation trigger
DMMP = Dredged Material Management Program
EDL = estimated detection limit
ML = maximum level
MDL = method detection limit
MRL = method reporting limit
NA= not analyzed
PCB = polychlorinated biphenyl
SL = screening level
SVOC = semivolatile organic
TOCN = total organic carbon normalized
Val. = validation

B = analyte detected in an associated method blank at a concentration greater than one-half of ARI's reporting limit or 5 percent of the regulatory limit or 5 percent of the analyte concentration in the sample

E = The analyte concentration exceeds the upper limit of the calibration range of the instrument established by the initial calibration

EMPC = Estimated maximum possible concentration defined in EPA Statement of WorkDLM02.2 as a value "calculated for 2,3,7,8-substituted isomers for which the quantitation and/or confirmation ion(s) has signal to noise in excess of 2.5, but does not meet identification criteria" (dioxin/furan analysis only)

J = estimated concentration

U = indicates the target analyte was not detected at the reported concentration

U* = EMPC value flagged as undetected

K = Raised reporting limit due to interference This analyte is not detected above the reporting limit (RL) or if noted, not detected above the limit of detection (LOD).

K* = [HR-Pesticides] - Peak detected but did not meet all quantification criteria, result reported represents the estimated maximum possible concentration.

[a] Criteria from DMMP Table 8-3 (DMMP 2016).

[b] 2-Methylnaphthalene is not included in the summation for total LPAH for marine projects.

[c] Sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane

[d] This value is normalized to total organic carbon, and is expressed in mg/kg carbon.

[e] Puget Sound only.

Table 5. Analytical Results Compared to DMMP Guideline Values[a]

		DMMP			KEN05							KEN06							KEN07						
						Qualifiers							Qualifiers							Qualifiers					
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL
Grain Size																									
Percent Fines (Silt/Clay)	percent	--	--	--	64.3				0.1	--	0.1	58.9				0.1	--	0.1	59.3				0.1	--	0.1
Percent Fines (field measurement)	percent				51	--	--	--	--	--	--	48	--	--	--	--	--	--	47	--	--	--	--	--	--
Clay: 0 to 3.9 microns (calculated)	percent	--	--	--	18.4							16.8							17.1						
Silt: 3.9 to 62.5 microns (calculated)	percent	--	--	--	45.9							42							42.2						
Sand: 62.5 to 2,000 microns (calculated)	percent	--	--	--	35.5							40.4							40.7						
Gravel: >2,000 microns (2 mm) (calculated)	percent	--	--	--	0.2							0.7							0						
Conventionals																									
N-ammonia	mg/kg	--	--	--	275				20.8	--	20.8	352				49.5	--	49.5	265				16.7	--	16.7
Preserved total solids	percent	--	--	--	38.1				0.04	--	0.04	38.2				0.04	--	0.04	40				0.04	--	0.04
Total organic carbon	percent	--	--	--	4.57				0.02	--	0.02	4.3				0.02	--	0.02	3.95				0.02	--	0.02
Total solids	percent	--	--	--	38.1				0.04	--	0.04	37.7				0.04	--	0.04	41.19				0.04	--	0.04
Total sulfides	mg/kg	--	--	--	22.9				2.36	--	2.36	165				12	--	12	221				44.6	--	44.6
Total volatile solids	percent	--	--	--	12.3				0.01	--	0.01	13.1				0.01	--	0.01	11.86				0.01	--	0.01
Metals																									
Antimony	mg/kg	150	---	200	0.51	UJ	U	J	0.05	--	0.51	0.5	UJ	U	J	0.05	--	0.5	0.47	UJ	U	J	0.04	--	0.47
Arsenic	mg/kg	57	507.1	700	11.1				0.06	--	0.51	11.2				0.06	--	0.5	10.2				0.05	--	0.47
Cadmium	mg/kg	5.1	--	14	0.61				0.08	--	0.26	0.47				0.08	--	0.25	0.56				0.07	--	0.23
Chromium	mg/kg	260	--	---	51.2				0.18	--	1.28	46.6				0.18	--	1.26	45.4				0.16	--	1.17
Copper	mg/kg	390	--	1,300	41.8				0.87	--	1.28	33.2				0.85	--	1.26	31.8				0.8	--	1.17
Lead	mg/kg	450	975	1,200	28				0.17	--	0.26	22.9				0.17	--	0.25	23.7				0.16	--	0.23
Mercury	mg/kg	0.41	1.5	2.3	0.069	J		J	0.0018	--	0.0562	0.0892	J		J	0.0105	--	0.0499	0.11	J		J	0.0101	--	0.0482
Nickel	mg/kg	---	---	---	47.8				0.13	--	1.28	45.3				0.55	--	1.26	47.7				0.12	--	1.17
Selenium	mg/kg	---	3	---	1.37				1.13	--	1.28	1.17	J			1.1	--	1.26	1.27				1.03	--	1.17
Silver	mg/kg	6.1	--	8.4	0.14	J	J		0.04	--	0.51	0.14	J			0.04	--	0.5	0.19	J	J		0.04	--	0.47
Zinc	mg/kg	410	--	3,800	157				2.1	--	10.3	140				2.4	--	10	139				1.9	--	9.4
Polycyclic Aromatic Hydrocarbons																									
Naphthalene	µg/kg	2,100	---	2,400	8.2	J	J		5.2	--	19.8	8.8	J			5.1	--	19.5	5.7	J	J		5.2	--	19.9
Acenaphthylene	µg/kg	560	---	1,300	19.8	U	U		4.7	--	19.8	19.5	U			4.7	--	19.5	19.9	U	U		4.7	--	19.9
Acenaphthene	µg/kg	500	---	2,000	8.3	J	J		5.1	--	19.8	10.4	J			5	--	19.5	6.4	J	J		5.1	--	19.9
Fluorene	µg/kg	540	---	3,600	12.5	J	J		4.9	--	19.8	13.1	J			4.8	--	19.5	10.7	J	J		4.9	--	19.9
Phenanthrene	µg/kg	1,500	---	21,000	109				4.6	--	19.8	97.1				4.6	--	19.5	96.9				4.7	--	19.9
Anthracene	µg/kg	960	---	13,000	24				5.9	--	19.8	23.7				5.8	--	19.5	18.7	J	J		5.9	--	19.9
2-Methylnaphthalene[b]	µg/kg	670	---	1,900	19.8	U	U		5.6	--	19.8	5.9	J			5.5	--	19.5	19.9	U	U		5.6	--	19.9
Total LPAH[b]	µg/kg	5,200	---	29,000	162	J						153.1	J						138.4						
Fluoranthene	µg/kg	1,700	4,600	30,000	249				4.5	--	19.8	223				4.4	--	19.5	208	J			4.5	--	19.9
Pyrene	µg/kg	2,600	11,980	16,000	237				5.5	--	19.8	199				5.4	--	19.5	188				5.5	--	19.9
Benz(a)anthracene	µg/kg	1,300	---	5,100	89.9				5.1	--	19.8	71				5.1	--	19.5	71.2				5.1	--	19.9
Chrysene	µg/kg	1,400	---	21,000	166				5.2	--	19.8	131				5.1	--	19.5	124				5.2	--	19.9
Benzofluoranthenes, total	µg/kg	3,200	---	9,900	350				10.1	--	39.6	291				9.9	--	39	291				10.1	--	39.7
Benzo(a)pyrene	µg/kg	1,600	---	3,600	123				6.4	--	19.8	97.4				6.3	--	19.5	96.7				6.4	--	19.9
Indeno(1,2,3-c,d)pyrene	µg/kg	600	---	4,400	44.8				5.9	--	19.8	37.1				5.8	--	19.5	35.7				5.9	--	19.9
Dibenz(a,h)anthracene	µg/kg	230	---	1,900	16.7	J	J		6.1	--	19.8	12.2	J			6	--	19.5	13.3	J	J		6.1	--	19.9
Benzo(ghi)perylene	µg/kg	670	---	3,200	47.8				5.8	--	19.8	41				5.7	--	19.5	37				5.8	--	19.9
Total HPAH	µg/kg	12,000	---	69,000	1324.2	J						1102.7	J						1064.9	J					
Total PAHs[b]	µg/kg	---	---	---	1486.2	J						1255.8	J						1203.3						
Chlorinated Hydrocarbons																									
1,4-Dichlorobenzene	µg/kg	110	---	120	19.8	U	U		4.3	--	19.8	19.5	U			4.3	--	19.5	19.9	U	U		4.4	--	19.9
1,2-Dichlorobenzene	µg/kg	35	---	110	19.8	U	U		4.6	--	19.8	19.5	U			4.5	--	19.5	19.9	U	U		4.6	--	19.9
1,2,4-Trichlorobenzene	µg/kg	31	---	64	19.8	U	U		5.9	--	19.8	19.5	U			5.8	--	19.5	19.9	U	U		5.9	--	19.9
Hexachlorobenzene (HCB)	µg/kg	22	168	230	19.8	U	U		4.7	--	19.8	19.5	U			4.6	--	19.5	19.9	U	U		4.7	--	19.9
beta-Hexachlorocyclohexane	µg/kg	---	---	---	0.75	U	U		0.27	0.75	1.49	0.73	U			0.27	0.73	1.46	0.74	U	U		0.27	0.74	1.48

Table 5. Analytical Results Compared to DMMP Guideline Values[a]

		DMMP			KEN05							KEN06							KEN07						
						Qualifiers							Qualifiers							Qualifiers					
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL
Phthalates																									
Dimethyl phthalate	µg/kg	71	---	1,400	19.8	U	U		6.4	--	19.8	36.8				6.3	--	19.5	19.9	U	U		6.4	--	19.9
Diethyl phthalate	µg/kg	200	---	1,200	19.8	U	U		17.5	--	19.8	19.5		U		17.3	--	19.5	24.3				17.6	--	19.9
Di-n-butyl phthalate	µg/kg	1,400	---	5,100	13.2	U	J,B	U	5.3	--	19.8	16.8	U	J,B	U	5.2	--	19.5	21.9	U	B	U	5.3	--	19.9
Butyl benzyl phthalate	µg/kg	63	---	970	34.9				8	--	19.8	42.8				7.9	--	19.5	70.7				8	--	19.9
Bis(2-ethylhexyl) phthalate	µg/kg	1,300	---	8,300	523				28.5	--	49.5	465				28.1	--	48.8	459				28.6	--	49.6
Di-n-octyl phthalate	µg/kg	6,200	---	6,200	19.8	U	U		8.6	--	19.8	19.5	U	U		8.5	--	19.5	19.9	U	U		8.7	--	19.9
Phenols																									
Phenol	µg/kg	420	---	1,200	24.8				8.1	--	19.8	19.3	J	J		8	--	19.5	14.4	J	J		8.2	--	19.9
2-Methylphenol	µg/kg	63	---	77	19.8	U	U		7.8	--	19.8	19.5	U	U		7.6	--	19.5	19.9	U	U		7.8	--	19.9
4-Methylphenol	µg/kg	670	---	3,600	417				14.5	--	19.8	222				14.3	--	19.5	223				14.6	--	19.9
2,4-Dimethylphenol	µg/kg	29	---	210	3.3	J	J		2.1	--	24.7	3.1	J	J		2.1	--	24.4	24.8	U	U		2.2	--	24.8
Pentachlorophenol	µg/kg	400	504	690	99	UJ	U	J	31	--	99	97.5	UJ	U	J	30.5	--	97.5	99.3	UJ	U	J	31.1	--	99.3
Miscellaneous Extractables																									
Benzyl alcohol	µg/kg	57	---	870	22.8				14.7	--	19.8	18	J	J		14.5	--	19.5	19.9	U	U		14.8	--	19.9
Benzoic acid	µg/kg	650	---	760	292				58.5	--	198	299				57.6	--	195	189	J	J		58.7	--	199
Dibenzofuran	µg/kg	540	---	1,700	19.8	U	U		4.6	--	19.8	6.7	J	J		4.5	--	19.5	19.9	U	U		4.6	--	19.9
Hexachlorobutadiene	µg/kg	11	---	270	4.9	U	U		0.7	--	4.9	4.9	U	U		0.7	--	4.9	5	U	U		0.7	--	5
N-Nitrosodiphenylamine	µg/kg	28	---	130	19.8	U	U		9.5	--	19.8	19.5	U	U		9.3	--	19.5	19.9	U	U		9.5	--	19.9
Carbazole	µg/kg	---	---	---	15.3	J	J		7.3	--	19.8	17.4	J	J		7.2	--	19.5	13	J	J		7.3	--	19.9
Pesticides																									
4,4'-DDD	µg/kg	16	---	---	14.9	U	U,UJK		14.9	14.9	14.9	13.2	U	U,UJK		13.2	13.2	13.2	11.8	U	U,UJK		11.8	11.8	11.8
4,4'-DDE	µg/kg	9	---	---	10.5	U	U,UJK		10.5	10.5	10.5	1.46	U	U		0.4	1.46	2.93	1.48	U	U		0.4	1.48	2.95
4,4'-DDT	µg/kg	12	---	---	1.49	U	U		0.97	1.49	2.99	1.46	U	U		0.95	1.46	2.93	1.48	U	U		0.96	1.48	2.95
Total 4,4'-DDx	µg/kg	---	50	69	14.9	U			--	--	--	13.2	U						11.8	U					
Aldrin	µg/kg	10	---	---	1.49	U	U		1.1	1.49	1.49	1.46	U	U		1.08	1.46	1.46	1.48	U	U		1.09	1.48	1.48
trans-Chlordane	µg/kg	---	---	---	1.49	U	U		0.98	1.49	1.49	1.46	U	U		0.96	1.46	1.46	1.48	U	U		0.97	1.48	1.48
cis-Chlordane	µg/kg	---	---	---	0.75	U	U		0.33	0.75	1.49	0.73	U	U		0.33	0.73	1.46	0.74	U	U		0.33	0.74	1.48
cis-Nonachlor	µg/kg	---	---	---	1.49	U	U		0.63	1.49	2.99	1.46	U	U		0.62	1.46	2.93	1.48	U	U		0.62	1.48	2.95
trans-Nonachlor	µg/kg	---	---	---	1.49	U	U		0.68	1.49	2.99	1.46	U	U		0.67	1.46	2.93	1.48	U	U		0.67	1.48	2.95
Oxychlordane	µg/kg	---	---	---	1.49	U	U		0.38	1.49	2.99	1.46	U	U		0.37	1.46	2.93	1.48	U	U		0.38	1.48	2.95
Total Chlordane[c]	µg/kg	2.8	37	---	1.49	U			--	--	--	1.46	U						1.48	U					
Dieldrin	µg/kg	1.9	---	1,700	1.49	U	U		0.34	1.49	2.99	1.46	U	U		0.34	1.46	2.93	1.48	U	U		0.34	1.48	2.95
Heptachlor	µg/kg	1.5	---	270	0.75	U	U		0.14	0.75	1.49	0.73	U	U		0.14	0.73	1.46	0.74	U	U		0.14	0.74	1.48
Endrin ketone	µg/kg	---	---	---	1.49	U	U		0.84	1.49	2.99	1.46	U	U		0.83	1.46	2.93	1.48	U	U		0.83	1.48	2.95
Polychlorinated biphenyls																									
Aroclor 1016	µg/kg	---	---	---	4	U	U		1.6	--	4	3.9	U	U		1.5	--	3.9	3.9	U	U		1.5	--	3.9
Aroclor 1221	µg/kg	---	---	---	4	U	U		1.6	--	4	3.9	U	U		1.5	--	3.9	3.9	U	U		1.5	--	3.9
Aroclor 1232	µg/kg	---	---	---	4	U	U		1.6	--	4	3.9	U	U		1.5	--	3.9	3.9	U	U		1.5	--	3.9
Aroclor 1242	µg/kg	---	---	---	4	U	U		1.6	--	4	3.9	U	U		1.5	--	3.9	3.9	U	U		1.5	--	3.9
Aroclor 1248	µg/kg	---	---	---	5.5				1.6	--	4	5.5				1.5	--	3.9	4.6				1.5	--	3.9
Aroclor 1254	µg/kg	---	---	---	19.8	J	J	J	1.6	--	4	17.9	J	J	J	1.5	--	3.9	15.5	J	J	J	1.5	--	3.9
Aroclor 1260	µg/kg	---	---	---	4.5				0.6	--	4	3.3	J	J		0.6	--	3.9	3.8	J	J		0.6	--	3.9
Aroclor 1262	µg/kg	---	---	---	4	U	U		0.6	--	4	3.9	U	U		0.6	--	3.9	3.9	U	U		0.6	--	3.9
Aroclor 1268	µg/kg	---	---	---	4	U	U		0.6	--	4	3.9	U	U		0.6	--	3.9	3.9	U	U		0.6	--	3.9
Total PCB Aroclors	µg/kg	130	---	3,100	29.8	J						26.7	J						23.9	J					
Total PCB Aroclors	mg/kg TOCN		38[d]		0.6521							0.6209							0.6051						

Table 5. Analytical Results Compared to DMMP Guideline Values[a]

		DMMP			KEN05							KEN06							KEN07						
						Qualifiers							Qualifiers							Qualifiers					
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL
Dioxins/Furans																									
2,3,7,8-TCDD	pg/g	--	--	--	0.415	U*	J,EMPC	U	0.043	--	0.998	0.379	U*	J,EMPC	U	0.0710	--	0.997	0.352	U*	J,EMPC	U	0.0690	--	0.997
1,2,3,7,8-PeCDD	pg/g	--	--	--	1.95	U*	J,EMPC	U	0.097	--	0.998	1.85				0.183	--	0.997	1.55				0.113	--	0.997
1,2,3,4,7,8-HxCDD	pg/g	--	--	--	2.7				0.108	--	0.998	2.69				0.121	--	0.997	2.16				0.0950	--	0.997
1,2,3,6,7,8-HxCDD	pg/g	--	--	--	8.06				0.103	--	0.998	8.27				0.112	--	0.997	7.52				0.0900	--	0.997
1,2,3,7,8,9-HxCDD	pg/g	--	--	--	5.58				0.110	--	0.998	6.25				0.121	--	0.997	4.5				0.0960	--	0.997
1,2,3,4,6,7,8-HpCDD	pg/g	--	--	--	232				0.240	--	2.5	222				0.236	--	2.49	184				0.225	--	2.49
OCDD	pg/g	--	--	--	1760	J	B	J	0.522	--	9.98	1660	J	B	J	0.525	--	9.97	1480	J	B	J	0.550	--	9.97
2,3,7,8-TCDF	pg/g	--	--	--	1.02				0.0560	--	0.998	0.964	J	J		0.0650	--	0.997	0.898	U*	J,EMPC	U	0.0820	--	0.997
1,2,3,7,8-PeCDF	pg/g	--	--	--	0.863	J	J		0.0790	--	0.998	0.77	J	J		0.115	--	0.997	0.595	J	J		0.0780	--	0.997
2,3,4,7,8-PeCDF	pg/g	--	--	--	0.861	J	J		0.0750	--	0.998	0.937	J	J		0.112	--	0.997	0.779	U*	J,EMPC	U	0.0680	--	0.997
1,2,3,4,7,8-HxCDF	pg/g	--	--	--	1.99				0.0660	--	0.998	2.23				0.0770	--	0.997	1.66				0.0820	--	0.997
1,2,3,6,7,8-HxCDF	pg/g	--	--	--	1.57				0.0870	--	0.998	1.55				0.113	--	0.997	1.47				0.111	--	0.997
1,2,3,7,8,9-HxCDF	pg/g	--	--	--	0.937	J	J,B		0.103	--	0.998	0.978	U*	B,J,EMPC	U	0.128	--	0.997	0.758	U*	J,B,EMPC	U	0.111	--	0.997
2,3,4,6,7,8-HxCDF	pg/g	--	--	--	2.32				0.108	--	0.998	2.31	U*	J,EMPC	U	0.136	--	0.997	1.34				0.102	--	0.997
1,2,3,4,6,7,8-HpCDF	pg/g	--	--	--	30.8				0.0960	--	0.998	37.9				0.155	--	0.997	28.5				0.106	--	0.997
1,2,3,4,7,8,9-HpCDF	pg/g	--	--	--	2.1				0.129	--	0.998	2.8				0.207	--	0.997	1.85	U*	J,EMPC	U	0.144	--	0.997
OCDF	pg/g	--	--	--	69.4				0.209	--	2	98.7				0.327	--	1.99	69.3				0.293	--	1.99
TEQ	pg/g	4 -10[e]	10[e]	---																					
TEQ (ND=1/2 DL)	pg/g				7.08	J			0.244		3.17	7.86	J			0.385		3.17	6.41	J			0.287		3.17
TEQ (ND=0)	pg/g				5.90	J			0		0	7.50	J			0		0	6.02	J			0		0

Notes: All results shown are on a dry weight basis.

a - The EDL is provided for dioxin/furan results rather than the MDL

Yellow shaded cells exceed SL; red shaded cells exceed BT; gray shaded cells indicate samples were reanalyzed using high resolution methods (see Table 4-2).

-- = no criteria
BT = bioaccumulation trigger
DMMP = Dredged Material Management Program
EDL = estimated detection limit
ML = maximum level
MDL = method detection limit
MRL = method reporting limit
NA= not analyzed
PCB = polychlorinated biphenyl
SL = screening level
SVOC = semivolatile organic
TOCN = total organic carbon normalized
Val. = validation

B = analyte detected in an associated method blank at a concentration greater than one-half of ARI's reporting limit or 5 percent of the regulatory limit or 5 percent of the analyte concentration in the sample

E = The analyte concentration exceeds the upper limit of the calibration range of the instrument established by the initial calibration

EMPC = Estimated maximum possible concentration defined in EPA Statement of WorkDLM02.2 as a value "calculated for 2,3,7,8-substituted isomers for which the quantitation and/or confirmation ion(s) has signal to noise in excess of 2.5, but does not meet identification criteria" (dioxin/furan analysis only)

J = estimated concentration

U = indicates the target analyte was not detected at the reported concentration

U* = EMPC value flagged as undetected

K = Raised reporting limit due to interference This analyte is not detected above the reporting limit (RL) or if noted, not detected above the limit of detection (LOD).

K* = [HR-Pesticides] - Peak detected but did not meet all quantification criteria, result reported represents the estimated maximum possible concentration.

[a] Criteria from DMMP Table 8-3 (DMMP 2016).

[b] 2-Methylnaphthalene is not included in the summation for total LPAH for marine projects.

[c] Sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane

[d] This value is normalized to total organic carbon, and is expressed in mg/kg carbon.

[e] Puget Sound only.

Table 5. Analytical Results Compared to DMMP Guideline Values[a]

		DMMP			KEN08							KEN09							Supercomposite					
						Qualifiers							Qualifiers							Qualifiers				
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	MRL
Grain Size																								
Percent Fines (Silt/Clay)	percent	--	--	--	62.1				0.1	--	0.1	59.5				0.1	--	0.1	63.2				0.1	0.1
Percent Fines (field measurement)	percent				51	--	--	--	--	--	--	52	--	--	--	--	--	--	NA	--	--	--	--	--
Clay: 0 to 3.9 microns (calculated)	percent	--	--	--	17.2							16.3							17.8					
Silt: 3.9 to 62.5 microns (calculated)	percent	--	--	--	45							43.2							45.4					
Sand: 62.5 to 2,000 microns (calculated)	percent	--	--	--	37.8							40.4							36.5					
Gravel: >2,000 microns (2 mm) (calculated)	percent	--	--	--	0							0.2							0.2					
Conventionals																								
N-ammonia	mg/kg	--	--	--	300				16.2	--	16.2	288				17.1	--	17.1	626				46	46
Preserved total solids	percent	--	--	--	39.9				0.04	--	0.04	40.6				0.04	--	0.04	37.74				0.04	0.04
Total organic carbon	percent	--	--	--	3.93				0.02	--	0.02	5.18				0.02	--	0.02	6.23	J		J	0.2	0.2
Total solids	percent	--	--	--	40.3				0.04	--	0.04	41.1				0.04	--	0.04	39.12				0.04	0.04
Total sulfides	mg/kg	--	--	--	125				24.1	--	24.1	122				23.8	--	23.8	219				25	25
Total volatile solids	percent	--	--	--	10.7				0.01	--	0.01	10.7				0.01	--	0.01	12.07				0.01	0.01
Metals																								
Antimony	mg/kg	150	---	200	0.48	UJ	U	J	0.04	--	0.48	0.45	UJ	U	J	0.04	--	0.45	NA					
Arsenic	mg/kg	57	507.1	700	9.21				0.05	--	0.48	7.6				0.05	--	0.45	NA					
Cadmium	mg/kg	5.1	--	14	0.5				0.07	--	0.24	0.37				0.07	--	0.22	NA					
Chromium	mg/kg	260	--	---	43.1				0.31	--	1.2	36				0.16	--	1.12	NA					
Copper	mg/kg	390	--	1,300	28.9				0.82	--	1.2	25.4				0.76	--	1.12	NA					
Lead	mg/kg	450	975	1,200	21.9				0.16	--	0.24	19				0.15	--	0.22	NA					
Mercury	mg/kg	0.41	1.5	2.3	0.101	J		J	0.00986	--	0.047	0.107	J		J	0.00862	--	0.0411	NA					
Nickel	mg/kg	---	---	---	41.9				0.12	--	1.2	35.6				0.11	--	1.12	NA					
Selenium	mg/kg	---	3	---	1.23				1.06	--	1.2	1.11	J	J		0.99	--	1.12	NA					
Silver	mg/kg	6.1	--	8.4	0.14	J	J		0.04	--	0.48	0.1	J	J		0.04	--	0.45	NA					
Zinc	mg/kg	410	--	3,800	126				2	--	9.6	102				1.8	--	9	NA					
Polycyclic Aromatic Hydrocarbons																								
Naphthalene	µg/kg	2,100	---	2,400	19.7	U	U		5.2	--	19.7	6	J	J		5.2	--	19.9	NA					
Acenaphthylene	µg/kg	560	---	1,300	19.7	U	U		4.7	--	19.7	7.3	J	J		4.7	--	19.9	NA					
Acenaphthene	µg/kg	500	---	2,000	6.1	J	J		5.1	--	19.7	7.6	J	J		5.1	--	19.9	NA					
Fluorene	µg/kg	540	---	3,600	11.8	J	J		4.9	--	19.7	12	J	J		4.9	--	19.9	NA					
Phenanthrene	µg/kg	1,500	---	21,000	84				4.6	--	19.7	111				4.7	--	19.9	NA					
Anthracene	µg/kg	960	---	13,000	16.5	J	J		5.8	--	19.7	23.4				5.9	--	19.9	NA					
2-Methylnaphthalene[b]	µg/kg	670	---	1,900	19.7	U	U		5.6	--	19.7	19.9	U	U		5.6	--	19.9	NA					
Total LPAH[b]	µg/kg	5,200	---	29,000	118.4							167.3	J						NA					
Fluoranthene	µg/kg	1,700	4,600	30,000	197				4.5	--	19.7	238				4.5	--	19.9	NA					
Pyrene	µg/kg	2,600	11,980	16,000	178				5.5	--	19.7	230				5.5	--	19.9	NA					
Benz(a)anthracene	µg/kg	1,300	---	5,100	66.5				5.1	--	19.7	82				5.2	--	19.9	NA					
Chrysene	µg/kg	1,400	---	21,000	133				5.1	--	19.7	143				5.2	--	19.9	NA					
Benzofluoranthenes, total	µg/kg	3,200	---	9,900	287				10.1	--	39.4	321				10.1	--	39.8	NA					
Benzo(a)pyrene	µg/kg	1,600	---	3,600	94.6				6.4	--	19.7	112				6.4	--	19.9	NA					
Indeno(1,2,3-c,d)pyrene	µg/kg	600	---	4,400	33.9				5.9	--	19.7	38.1	J		J	6	--	19.9	NA					
Dibenz(a,h)anthracene	µg/kg	230	---	1,900	12.1	J	J		6.1	--	19.7	13.2	J	J		6.1	--	19.9	NA					
Benzo(ghi)perylene	µg/kg	670	---	3,200	39.2				5.7	--	19.7	42.9	J		J	5.8	--	19.9	NA					
Total HPAH	µg/kg	12,000	---	69,000	1041.3	J						1220.2	J						NA					
Total PAHs[b]	µg/kg	---	---	---	1159.7							1387.5	J						NA					
Chlorinated Hydrocarbons																								
1,4-Dichlorobenzene	µg/kg	110	---	120	19.7	U	U		4.3	--	19.7	19.9	U	U		4.4	--	19.9	NA					
1,2-Dichlorobenzene	µg/kg	35	---	110	19.7	U	U		4.6	--	19.7	19.9	U	U		4.6	--	19.9	NA					
1,2,4-Trichlorobenzene	µg/kg	31	---	64	19.7	U	U		5.9	--	19.7	19.9	U	U		5.9	--	19.9	NA					
Hexachlorobenzene (HCB)	µg/kg	22	168	230	19.7	U	U		4.7	--	19.7	19.9	U	U		4.7	--	19.9	NA					
beta-Hexachlorocyclohexane	µg/kg	---	---	---	0.75	U	U		0.27	0.75	1.49	0.75	U	U		0.27	0.75	1.49	NA					

Table 5. Analytical Results Compared to DMMP Guideline Values[a]

		DMMP			KEN08							KEN09							Supercomposite					
						Qualifiers							Qualifiers							Qualifiers				
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	MRL
Phthalates																								
Dimethyl phthalate	µg/kg	71	---	1,400	7.7	J	J		6.3	--	19.7	19.9	U	U		6.4	--	19.9	NA					
Diethyl phthalate	µg/kg	200	---	1,200	18.3	J	J		17.5	--	19.7	19.9	U	U		17.6	--	19.9	NA					
Di-n-butyl phthalate	µg/kg	1,400	---	5,100	10.9	U	J,B	U	5.2	--	19.7	12.7	U	J,B	U	5.3	--	19.9	NA					
Butyl benzyl phthalate	µg/kg	63	---	970	36.1				7.9	--	19.7	26.8				8	--	19.9	NA					
Bis(2-ethylhexyl) phthalate	µg/kg	1,300	---	8,300	692				28.4	--	49.3	578				28.7	--	49.7	NA					
Di-n-octyl phthalate	µg/kg	6,200	---	6,200	19.7	U	U		8.6	--	19.7	19.9	U	U		8.7	--	19.9	NA					
Phenols																								
Phenol	µg/kg	420	---	1,200	12	J	J		8.1	--	19.7	14.3	J	J		8.2	--	19.9	NA					
2-Methylphenol	µg/kg	63	---	77	19.7	U	U		7.7	--	19.7	19.9	U	U		7.8	--	19.9	NA					
4-Methylphenol	µg/kg	670	---	3,600	293				14.5	--	19.7	157				14.6	--	19.9	NA					
2,4-Dimethylphenol	µg/kg	29	---	210	24.6	U	U		2.1	--	24.6	2.3	J	J		2.2	--	24.9	NA					
Pentachlorophenol	µg/kg	400	504	690	98.6	UJ	U	J	30.9	--	98.6	99.5	UJ	U	J	31.1	--	99.5	NA					
Miscellaneous Extractables																								
Benzyl alcohol	µg/kg	57	---	870	19.7	U	U		14.7	--	19.7	19.9	U	U		14.8	--	19.9	NA					
Benzoic acid	µg/kg	650	---	760	138	J	J		58.3	--	197	130	J	J		58.8	--	199	NA					
Dibenzofuran	µg/kg	540	---	1,700	19.7	U	U		4.5	--	19.7	19.9	U	U		4.6	--	19.9	NA					
Hexachlorobutadiene	µg/kg	11	---	270	4.9	U	U		0.7	--	4.9	5	U	U		0.7	--	5	NA					
N-Nitrosodiphenylamine	µg/kg	28	---	130	19.7	U	U		9.4	--	19.7	19.9	U	U		9.5	--	19.9	NA					
Carbazole	µg/kg	---	---	---	11.8	J	J		7.3	--	19.7	12.9	J	J		7.3	--	19.9	NA					
Pesticides																								
4,4'-DDD	µg/kg	16	---	---	1.49	U	U		0.96	1.49	2.98	12	U	U,UJK		12	12	12	NA					
4,4'-DDE	µg/kg	9	---	---	1.49	U	U		0.4	1.49	2.98	1.49	U	U		0.4	1.49	2.99	NA					
4,4'-DDT	µg/kg	12	---	---	1.49	U	U		0.97	1.49	2.98	1.49	U	U		0.97	1.49	2.99	NA					
Total 4,4'-DDx	µg/kg	---	50	69	1.49	U						12	U						NA					
Aldrin	µg/kg	10	---	---	1.49	U	U		1.1	1.49	1.49	1.49	U	U		1.1	1.49	1.49	NA					
trans-Chlordane	µg/kg	---	---	---	1.49	U	U		0.98	1.49	1.49	1.49	U	U		0.98	1.49	1.49	NA					
cis-Chlordane	µg/kg	---	---	---	0.75	U	U		0.33	0.75	1.49	0.75	U	U		0.33	0.75	1.49	NA					
cis-Nonachlor	µg/kg	---	---	---	1.49	U	U		0.63	1.49	2.98	1.49	U	U		0.63	1.49	2.99	NA					
trans-Nonachlor	µg/kg	---	---	---	1.49	U	U		0.68	1.49	2.98	1.49	U	U		0.68	1.49	2.99	NA					
Oxychlordane	µg/kg	---	---	---	1.49	U	U		0.38	1.49	2.98	1.49	U	U		0.38	1.49	2.99	NA					
Total Chlordane[c]	µg/kg	2.8	37	---	1.49	U						1.49	U						NA					
Dieldrin	µg/kg	1.9	---	1,700	1.49	U	U		0.34	1.49	2.98	1.49	U	U		0.34	1.49	2.99	NA					
Heptachlor	µg/kg	1.5	---	270	0.75	U	U		0.14	0.75	1.49	0.75	U	U		0.14	0.75	1.49	NA					
Endrin ketone	µg/kg	---	---	---	1.49	U	U		0.84	1.49	2.98	1.49	U	U		0.84	1.49	2.99	NA					
Polychlorinated biphenyls																								
Aroclor 1016	µg/kg	---	---	---	4	U	U		1.5	--	4	4	U	U		1.6	--	4	NA					
Aroclor 1221	µg/kg	---	---	---	4	U	U		1.5	--	4	4	U	U		1.6	--	4	NA					
Aroclor 1232	µg/kg	---	---	---	4	U	U		1.5	--	4	4	U	U		1.6	--	4	NA					
Aroclor 1242	µg/kg	---	---	---	4	U	U		1.5	--	4	4	U	U		1.6	--	4	NA					
Aroclor 1248	µg/kg	---	---	---	5.1				1.5	--	4	6.2				1.6	--	4	NA					
Aroclor 1254	µg/kg	---	---	---	18.5	J	J	J	1.5	--	4	28.3	J	J	J	1.6	--	4	NA					
Aroclor 1260	µg/kg	---	---	---	4.4				0.6	--	4	6.3				0.6	--	4	NA					
Aroclor 1262	µg/kg	---	---	---	4	U	U		0.6	--	4	4	U	U		0.6	--	4	NA					
Aroclor 1268	µg/kg	---	---	---	4	U	U		0.6	--	4	4	U	U		0.6	--	4	NA					
Total PCB Aroclors	µg/kg	130	---	3,100	28	J						40.8	J						NA					
Total PCB Aroclors	mg/kg TOCN		38[d]		0.7125							0.7876							NA					

Table 5. Analytical Results Compared to DMMP Guideline Values[a]

		DMMP			KEN08							KEN09							Supercomposite					
						Qualifiers							Qualifiers							Qualifiers				
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	LOD	MRL	Result	Final	Lab	Val.	MDL[a]	MRL
Dioxins/Furans																								
2,3,7,8-TCDD	pg/g	--	--	--	0.4	U*	J, EMPC	U	0.0710	--	0.997	0.357	U*	J, EMPC	U	0.0460	--	0.998	0.418	J	J		0.139	0.999
1,2,3,7,8-PeCDD	pg/g	--	--	--	1.7				0.135	--	0.997	1.53				0.0980	--	0.998	2.13				0.297	0.999
1,2,3,4,7,8-HxCDD	pg/g	--	--	--	2.32				0.111	--	0.997	2.17				0.0800	--	0.998	4.01				0.199	0.999
1,2,3,6,7,8-HxCDD	pg/g	--	--	--	7.08				0.105	--	0.997	6.84				0.0790	--	0.998	10.5				0.195	0.999
1,2,3,7,8,9-HxCDD	pg/g	--	--	--	5.02				0.113	--	0.997	4.68				0.0830	--	0.998	7.05				0.205	0.999
1,2,3,4,6,7,8-HpCDD	pg/g	--	--	--	178				0.202	--	2.49	169				0.210	--	2.49	301				0.471	2.5
OCDD	pg/g	--	--	--	1390	J	B	J	0.517	--	9.97	1280	J	B	J	0.446	--	9.98	2540		B		0.634	9.99
2,3,7,8-TCDF	pg/g	--	--	--	0.868	J	J		0.0690	--	0.997	0.793	J	J		0.0600	--	0.998	1.2				0.170	0.999
1,2,3,7,8-PeCDF	pg/g	--	--	--	0.753	U*	J,EMPC	U	0.0840	--	0.997	0.679	J	J		0.143	--	0.998	1.15	U*	J,EMPC	U	0.185	0.999
2,3,4,7,8-PeCDF	pg/g	--	--	--	0.752	U*	J,EMPC	U	0.0810	--	0.997	0.762	J	J		0.136	--	0.998	0.922	U*	J,EMPC	U	0.170	0.999
1,2,3,4,7,8-HxCDF	pg/g	--	--	--	1.77				0.0620	--	0.997	1.79				0.0620	--	0.998	2.19				0.169	0.999
1,2,3,6,7,8-HxCDF	pg/g	--	--	--	1.36				0.0880	--	0.997	1.4				0.0900	--	0.998	2.05				0.174	0.999
1,2,3,7,8,9-HxCDF	pg/g	--	--	--	0.803	J	J,B		0.0890	--	0.997	0.733	J	J,B		0.0810	--	0.998	0.936	J	J		0.170	0.999
2,3,4,6,7,8-HxCDF	pg/g	--	--	--	2.28				0.127	--	0.997	1.14				0.108	--	0.998	2.49				0.171	0.999
1,2,3,4,6,7,8-HpCDF	pg/g	--	--	--	27.7				0.123	--	0.997	25.5				0.0890	--	0.998	37.3				0.140	0.999
1,2,3,4,7,8,9-HpCDF	pg/g	--	--	--	1.89				0.170	--	0.997	1.62	U*	J,EMPC	U	0.134	--	0.998	2.6				0.176	0.999
OCDF	pg/g	--	--	--	66.9				0.225	--	1.99	60.9				0.292	--	2	98.4				0.334	2
TEQ	pg/g	4 -10[e]	10[e]	---																				
TEQ (ND=1/2 DL)	pg/g				6.69	J			0.314		3.17	6.27	J			0.258		3.17	9.95	J			0.64601	3.18
TEQ (ND=0)	pg/g				6.36	J			0		0	6.08	J			0		0	9.79	J			0	0

Notes: All results shown are on a dry weight basis.

a - The EDL is provided for dioxin/furan results rather than the MDL

Yellow shaded cells exceed SL; red shaded cells exceed BT; gray shaded cells indicate samples were reanalyzed using high resolution methods (see Table 4-2).

-- = no criteria
BT = bioaccumulation trigger
DMMP = Dredged Material Management Program
EDL = estimated detection limit
ML = maximum level
MDL = method detection limit
MRL = method reporting limit
NA= not analyzed
PCB = polychlorinated biphenyl
SL = screening level
SVOC = semivolatile organic
TOCN = total organic carbon normalized
Val. = validation

B = analyte detected in an associated method blank at a concentration greater than one-half of ARI's reporting limit or 5 percent of the regulatory limit or 5 percent of the analyte concentration in the sample

E = The analyte concentration exceeds the upper limit of the calibration range of the instrument established by the initial calibration

EMPC = Estimated maximum possible concentration defined in EPA Statement of WorkDLM02.2 as a value "calculated for 2,3,7,8-substituted isomers for which the quantitation and/or confirmation ion(s) has signal to noise in excess of 2.5, but does not meet identification criteria" (dioxin/furan analysis only)

J = estimated concentration

U = indicates the target analyte was not detected at the reported concentration

U* = EMPC value flagged as undetected

K = Raised reporting limit due to interference This analyte is not detected above the reporting limit (RL) or if noted, not detected above the limit of detection (LOD).

K* = [HR-Pesticides] - Peak detected but did not meet all quantification criteria, result reported represents the estimated maximum possible concentration.

[a] Criteria from DMMP Table 8-3 (DMMP 2016).

[b] 2-Methylnaphthalene is not included in the summation for total LPAH for marine projects.

[c] Sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane

[d] This value is normalized to total organic carbon, and is expressed in mg/kg carbon.

[e] Puget Sound only.

Table 6. High Resolution Pesticides Analytical Results[a]

					KEN01 - High Resolution Pesticides Only						KEN03 - High Resolution Pesticides Only						KEN04 - High Resolution Pesticides Only						KEN05 - High Res Pesticides Only					
			DMMP			Qualifiers						Qualifiers						Qualifiers						Qualifiers				
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL	MRL	Result	Final	Lab	Val.	MDL	MRL	Result	Final	Lab	Val.	MDL	MRL	Result	Final	Lab	Val.	MDL	MRL
Chlorinated Hydrocarbons																												
Hexachlorobenzene (HCB)	µg/kg	22	168	230	0.153	U	J	U	--	0.0191	0.093	J	J		--	0.018	0.197	U	J	U	--	0.0191	0.108	J	J		--	0.0182
Pesticides																												
2,4'-DDD	µg/kg	---	---	---	0.855	J	J		--	0.0492	0.920	J	J		--	0.0360	0.844	J	J		--	0.0383	0.961	J	J			0.0364
2,4'-DDE	µg/kg	---	---	---	0.115	J	J		--	0.0382	0.132	J	J		--	0.0360	0.187	J	J		--	0.0383	0.124	J	J			0.0364
2,4'-DDT	µg/kg	---	---	---	0.109	J	J		--	0.0760	0.129	J	J		--	0.0546	0.138	J	J		--	0.0495	0.146	J	J			0.0644
4,4'-DDD	µg/kg	16	---	---	3.29				--	0.0645	3.74				--	0.0402	3.48				--	0.0385	3.76					0.0419
4,4'-DDE	µg/kg	9	---	---	3.81				--	0.0382	4.14				--	0.0360	4.42				--	0.0383	4.08					0.0364
4,4'-DDT	µg/kg	12	---	---	0.284	J	J		--	0.0919	0.487	J	J		--	0.0758	0.325	J	J		--	0.0584	0.383	J	J			0.0931
Total 4,4'-DDx	µg/kg	---	50	69	7.38	J	J		--	--	8.37	J	J		--	--	8.23	J	J		--	--	8.22	J	J		--	--
Aldrin	µg/kg	10	---	---	0.123	J	J	J	--	0.0382	0.0700	J	J		--	0.0360	0.120	J	J		--	0.0383	0.0920	U*	K*,J	U		0.0364
alpha-Hexachlorocyclohexane	µg/kg	---	---	---	0.0382	U	U			0.0382	0.0360	U	U			0.0360	0.0383	U	U			0.0383	0.0364	U	U			0.0364
beta-Hexachlorocyclohexane	µg/kg	---	---	---	0.0390	U*	KJ	U		0.0382	0.0360	U	U			0.0360	0.0383	U	U			0.0383	0.0364	U	U			0.0364
delta-Hexachlorocyclohexane	µg/kg	---	---	---	0.0956	U	U		--	0.0956	0.0901	U	U		--	0.0901	0.0957	U	U		--	0.0957	0.0911	U	U			0.0911
gamma-Hexachlorocyclohexane	µg/kg	---	---	---	0.0590	U	J	U		0.0382	0.0360	U	U			0.0360	0.0590	U	J	U		0.0383	0.0364	U	U			0.0364
trans-Chlordane	µg/kg	---	---	---	1.17	J	J		--	0.0382	1.43	J	J		--	0.0360	1.45	J	J		--	0.0383	1.24	J	J			0.0364
cis-Chlordane	µg/kg	---	---	---	0.932	J	J		--	0.0382	1.06	J	J		--	0.0360	1.18	J	J		--	0.0383	1.06	J	J			0.0364
cis-Nonachlor	µg/kg	---	---	---	0.529	U	J	U	--	0.0530	0.699	U*	K*,J	U	--	0.0360	0.587	U	J	U	--	0.0428	0.641	U*	K*,J	U		0.0617
trans-Nonachlor	µg/kg	---	---	---	0.814	J	J		--	0.0382	1.01	J	J		--	0.0360	1.03	J	J		--	0.0383	0.925	J	J			0.0364
Oxychlordane	µg/kg	---	---	---	0.116	U	U		--	0.116	0.0390	U*	K*,J	U	--	0.0360	0.0821	U	U		--	0.0821	0.0364	U	U			0.0364
Total Chlordane[b]	µg/kg	2.8	37	---	2.92	J	J		--	--	3.50	J	J		--	--	3.66	J	J		--	--	3.23	J	J			
Dieldrin	µg/kg	1.9	---	1,700	0.11	J	J		--	0.0956	0.159	J	J		--	0.0901	0.609	J	J		--	0.0957	0.128	U*	K*,J	U		0.0911
Heptachlor	µg/kg	1.5	---	270	0.0427	U	U			0.0427	0.0360	U	U			0.0360	0.0383	U	U			0.0383	0.0364	U	U			0.0364
Heptachlor epoxide	µg/kg	---	---	---	0.0956	U	U		--	0.0956	0.0901	U	U		--	0.0901	0.0957	U	U		--	0.0957	0.0911	U	U			0.0911
Endrin	µg/kg	---	---	---	0.0956	U	U		--	0.0956	0.0901	UJ	U	J	--	0.0901	0.0957	U	U		--	0.0957	0.0911	UJ	U	J		0.0911
Endrin aldehyde	µg/kg	---	---	---	0.0956	U	U		--	0.0956	0.0901	U	U		--	0.0901	0.0957	U	U		--	0.0957	0.0911	U	U			0.0911
Endrin ketone	µg/kg	---	---	---	0.0956	UJ	U	J	--	0.0956	0.0901	U	U		--	0.0901	0.0957	UJ	U	J	--	0.0957	0.0911	U	U			0.0911
alpha-Endosulfan	µg/kg	---	---	---	0.184	U*	KJ	U	--	0.0956	0.0901	U	U		--	0.0901	0.155	U*	KJ	U	--	0.0957	0.216	U*	K*,J	U		0.0911
beta-Endosulfan	µg/kg	---	---	---	0.466	U*	KJ	U		0.0956	0.417	U*	K*,J	U		0.0901	0.382	U*	KJ	U		0.0957	0.513	U*	K*,J	U		0.0911
Endosulfan sulfate	µg/kg	---	---	---	0.0956	U	U			0.0956	0.122	U*	K*,J	U		0.0901	0.0957	U	U			0.0957	0.0911	U	U			0.0911
Methoxychlor	µg/kg	---	---	---	0.195	U	U			0.195	0.180	U	U			0.180	0.191	U	U			0.191	0.182	U	U			0.182
Mirex	µg/kg	---	---	---	0.0382	U	U			0.0382	0.0360	U	U			0.0360	0.0383	U	U			0.0383	0.0364	U	U			0.0364

Notes:

Yellow shaded cells exceed SL
All results shown are on a dry weight basis.

--- = no criteria
-- = not analyzed
BT = bioaccumulation trigger
DMMP = Dredged Material Management Program
MDL = method detection limit
ML = maximum level
MRL = method reporting limit
NA = not available
SL = screening level
Val. = validation

J = estimated concentration
U = the target analyte was not detected at the reported concentration
K = Raised reporting limit due to interference This analyte is not detected above the reporting limit (RL) or if noted, not detected above the limit of detection (LOD).

K* = [HR-Pesticides] - Peak detected but did not meet all quantification criteria, result reported represents the estimated maximum possible concentration.

[a] Criteria from DMMP Table 8-3 (DMMP 2016).
[b] Sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane

Table 6. High Resolution Pesticides Analytical Results[a]

					KEN06 - High Resolution Pesticides Only						KEN07 - High Resolution Pesticides Only						KEN08 - High Resolution Pesticides Only						KEN09 - High Resolution Pesticides Only					
			DMMP			Qualifiers						Qualifiers						Qualifiers						Qualifiers				
Analyte	Units	SL	BT	ML	Result	Final	Lab	Val.	MDL	MRL	Result	Final	Lab	Val.	MDL	MRL	Result	Final	Lab	Val.	MDL	MRL	Result	Final	Lab	Val.	MDL	MRL
Chlorinated Hydrocarbons																												
Hexachlorobenzene (HCB)	µg/kg	22	168	230	0.0990	U	J	U	--	0.0200	0.133	U	J	U	--	0.0200	0.119	U	J	U	--	0.0197	0.0970	U	J	U	--	0.0195
Pesticides																												
2,4'-DDD	µg/kg	---	---	---	0.764	J	J		--	0.0399	0.737	J	J		--	0.0400	0.722	J	J		--	0.0420	0.733	J	J		--	0.0390
2,4'-DDE	µg/kg	---	---	---	0.0900	J	J		--	0.0399	0.107	J	J		--	0.0400	0.110	J	J		--	0.0394	0.114	J	J		--	0.0390
2,4'-DDT	µg/kg	---	---	---	0.114	J	J		--	0.0523	0.115	J	J		--	0.0524	0.120	J	J		--	0.0653	0.100	J	J		--	0.0400
4,4'-DDD	µg/kg	16	---	---	3.13				--	0.0457	3.03				--	0.0412	2.92				--	0.0550	3.08				--	0.0390
4,4'-DDE	µg/kg	9	---	---	3.39				--	0.0399	3.47				--	0.0400	3.56				--	0.0394	3.43				--	0.0390
4,4'-DDT	µg/kg	12	---	---	0.341	J	J		--	0.0605	0.300	J	J		--	0.0607	0.477	J	J		--	0.0758	0.353	J	J		--	0.0462
Total 4,4'-DDx	µg/kg	---	50	69	6.86	J	J		--	--	6.80	J	J		--	--	6.96	J	J		--	--	6.86	J	J		--	--
Aldrin	µg/kg	10	---	---	0.0930	J	J		--	0.0399	0.0870	J	J		--	0.0400	0.0870	U*	KJ	U	--	0.0394	0.0670	J	J		--	0.0390
alpha-Hexachlorocyclohexane	µg/kg	---	---	---	0.0399	U	U			0.0399	0.0400	U	U			0.0400	0.0394	U	U			0.0394	0.0390	U	U		--	0.0390
beta-Hexachlorocyclohexane	µg/kg	---	---	---	0.0399	U	U			0.0399	0.0420	U*	KJ	U		0.0400	0.0394	U	U			0.0394	0.0390	U	U		--	0.0390
delta-Hexachlorocyclohexane	µg/kg	---	---	---	0.0998	U	U		--	0.0998	0.100	U	U		--	0.100	0.0984	U	U		--	0.0984	0.0975	U	U		--	0.0975
gamma-Hexachlorocyclohexane	µg/kg	---	---	---	0.0710	U	J	U		0.0399	0.0770	U	J	U		0.0400	0.0730	U	J	U		0.0394	0.0700	U	J	U	--	0.0390
trans-Chlordane	µg/kg	---	---	---	1.19	J	J		--	0.0399	1.44	J	J		--	0.0400	1.37	J	J		--	0.0394	1.41	J	J		--	0.0390
cis-Chlordane	µg/kg	---	---	---	0.996	J	J		--	0.0399	1.17	J	J		--	0.0400	1.11	J	J		--	0.0394	1.11	J	J		--	0.0390
cis-Nonachlor	µg/kg	---	---	---	0.519	U	J	U	--	0.0490	0.529	U	J	U	--	0.0564	0.598	U	J	U	--	0.0663	0.558	U	J	U	--	0.0479
trans-Nonachlor	µg/kg	---	---	---	0.977	J	J		--	0.0399	0.977	J	J		--	0.0400	1.00	J	J		--	0.0394	0.932	J	J		--	0.0390
Oxychlordane	µg/kg	---	---	---	0.0743	U	U		--	0.0743	0.0920	U	U		--	0.0920	0.0870	U	U		--	0.0870	0.0627	U	U		--	0.0627
Total Chlordane[b]	µg/kg	2.8	37	---	3.16	J	J		--	--	3.59	J	J		--	--	3.48	J	J		--	--	3.45	J	J		--	--
Dieldrin	µg/kg	1.9	---	1,700	0.155	J	J		--	0.0998	0.192	U*	KJ	U	--	0.100	0.177	J	J		--	0.0984	0.120	J	J		--	0.0975
Heptachlor	µg/kg	1.5	---	270	0.0399	U	U			0.0399	0.0400	U	U			0.0400	0.0394	U	U			0.0394	0.0390	U	U		--	0.0390
Heptachlor epoxide	µg/kg	---	---	---	0.0998	U	U		--	0.0998	0.100	U	U		--	0.100	0.0984	U	U		--	0.0984	0.0975	U	U		--	0.0975
Endrin	µg/kg	---	---	---	0.0998	U	U		--	0.0998	0.100	U	U		--	0.100	0.0984	U	U		--	0.0984	0.0975	U	U		--	0.0975
Endrin aldehyde	µg/kg	---	---	---	0.134	U	U		--	0.134	0.100	U	U		--	0.100	0.0984	U	U		--	0.0984	0.0975	U	U		--	0.0975
Endrin ketone	µg/kg	---	---	---	0.0998	UJ	U	J		0.0998	0.100	UJ	U	J	--	0.100	0.0984	UJ	U	J	--	0.0984	0.0975	UJ	U	J	--	0.0975
alpha-Endosulfan	µg/kg	---	---	---	0.185	U*	KJ	U	--	0.0998	0.147	U*	KJ	U	--	0.1000	0.178	U*	KJ	U	--	0.0984	0.203	U*	KJ	U	--	0.0975
beta-Endosulfan	µg/kg	---	---	---	0.417	U*	KJ	U		0.114	0.355	U*	KJ	U		0.114	0.363	U*	KJ	U		0.0984	0.389	U*	KJ	U	--	0.0975
Endosulfan sulfate	µg/kg	---	---	---	0.0998	U	U			0.0998	0.100	U	U			0.100	0.0984	U	U			0.0984	0.0975	U	U		--	0.0975
Methoxychlor	µg/kg	---	---	---	0.200	U	U			0.200	0.200	U	U			0.200	0.197	U	U			0.197	0.195	U	U		--	0.195
Mirex	µg/kg	---	---	---	0.0399	U	U			0.0399	0.0400	U	U			0.0400	0.0394	U	U			0.0394	0.0390	U	U		--	0.0390

Notes:

Yellow shaded cells exceed SL
All results shown are on a dry weight basis.

--- = no criteria
-- = not analyzed
BT = bioaccumulation trigger
DMMP = Dredged Material Management Program
MDL = method detection limit
ML = maximum level
MRL = method reporting limit
NA = not available
SL = screening level
Val. = validation

J = estimated concentration
U = the target analyte was not detected at the reported concentration
K = Raised reporting limit due to interference This analyte is not detected above the reporting limit (RL) or if noted, not detected above the limit of detection (LOD).

K* = [HR-Pesticides] - Peak detected but did not meet all quantification criteria, result reported represents the estimated maximum possible concentration.

[a] Criteria from DMMP Table 8-3 (DMMP 2016).
[b] Sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane

Table 7. Sediment Conventional and Dioxin/Furan Results

Analyte	Units	Result	EBBT-Comp Qualifiers Final	Lab	Val.	MDL[a]	MRL
Grain Size							
Grain Size, Fines (Silt/Clay)	percent	50.1				0.1	0.1
Clay: 0 to 3.9 microns (calculated)	percent	21.2				--	--
Silt: 3.9 to 62.5 microns (calculated)	percent	28.9				--	--
Sand: 62.5 to 2,000 microns (calculated)	percent	46				--	--
Gravel: >2,000 microns (2 mm) (calculated)	percent	0				--	--
Conventionals							
N-ammonia	mg/kg	4.03				0.63	0.63
Preserved total solids	percent	50.74				0.04	0.04
Total organic carbon	percent	1.79				0.02	0.02
Total solids	percent	52.31				0.04	0.04
Total sulfides	mg/kg	314				1.93	1.93
Total volatile solids	percent	4.12				0.01	0.01
Dioxins/Furans							
2,3,7,8-TCDD	pg/g	0.587	*U*	*U*		0.587	0.499
1,2,3,7,8-PeCDD	pg/g	4.55	*J*	*J*		0.646	0.997
1,2,3,4,7,8-HxCDD	pg/g	2.04	*U*	*J,EMPC*	*U*	1.03	0.997
1,2,3,6,7,8-HxCDD	pg/g	8.43	*J*	*J*		0.908	0.997
1,2,3,7,8,9-HxCDD	pg/g	5.49	*J*	*J*		1.01	0.997
1,2,3,4,6,7,8-HpCDD	pg/g	211	*J*	*J*		1.16	1.25
OCDD	pg/g	1940	*J*	*B*	*J*	1.98	9.97
2,3,7,8-TCDF	pg/g	1.79	*J*	*J*		0.580	0.499
1,2,3,7,8-PeCDF	pg/g	0.813	*U*	*U*		0.813	0.997
2,3,4,7,8-PeCDF	pg/g	1.67	*J*	*J*		0.746	0.997
1,2,3,4,7,8-HxCDF	pg/g	3.31	*J*	*J*		0.467	0.997
1,2,3,6,7,8-HxCDF	pg/g	1.75	*U*	*J,EMPC*	*U*	0.471	0.997
1,2,3,7,8,9-HxCDF	pg/g	0.494	*U*	*U*		0.494	0.997
2,3,4,6,7,8-HxCDF	pg/g	2.61	*U*	*J,EMPC*	*U*	0.448	0.997
1,2,3,4,6,7,8-HpCDF	pg/g	35.5	*J*	*J*		0.703	0.997
1,2,3,4,7,8,9-HpCDF	pg/g	2.96	*J*	*J*		0.989	0.997
OCDF	pg/g	117	*J*	*J*		1.27	1.99
TEQ (ND=1/2 DL)	pg/g	10.72	*J*			1.03	1.30
TEQ (ND=0)	pg/g	10.06	*J*			0	0

Notes:

a - The EDL is provided for dioxin/furan results rather than the MDL
All results shown are on a dry weight basis.
EDL = estimated detection limit
MDL = method detection limit
MRL = method reporting limit
TEQ = toxicity equivalence
Val. = validation

Qualifiers:

B = analyte detected in an associated method blank at a concentration greater than one-half of ARI's reporting limit or 5 percent of the regulatory limit or 5 percent of the analyte concentration in the sample

EMPC = estimated maximum possible concentration defined in EPA Statement of Work DLM02.2 as a value "calculated for 2,3,7,8-substituted isomers for which the quantitation and/or confirmation ion(s) has signal to noise in excess of 2.5, but does not meet identification criteria" (dioxin/furan analysis only)

J = estimated concentration

U = the target analyte was not detected at the reported concentration

Table 8. Carr Inlet Reference Sediment Analytical Results

		16-6 - Bioaccumulation				16-7 - Bioaccumulation				16-8 - Bioaccumulation				CR23 - Bioassay			
			Qualifiers				Qualifiers				Qualifiers				Qualifiers		
Analyte	Units	Result	Final	MDL[a]	MRL	Result	Final	MDL[a]	MRL	Result	Final	MDL[a]	MRL	Result	Final	MDL	MRL
Grain Size																	
Particle/Grain Size, Fines (Silt/Clay)	percent	87.5		0.1	0.1	38.8		0.1	0.1	74.8		0.1	0.1	58.7		0.1	0.1
Percent fines (field measurement)	percent	50		--	--	56		--	--	60		--	--	52		--	--
Clay: 0 to 3.9 microns (calculated)	percent	41.4				18.2				35.3				6.9			
Silt: 3.9 to 62.5 microns (calculated)	percent	46				20.7				39.4				51.8			
Sand: 62.5 to 2,000 microns (calculated)	percent	12.5				59.8				25.1				41.2			
Gravel: >2,000 microns (2 mm) (calculated)	percent	0				1.4				0.2				0			
Conventionals																	
N-ammonia	mg/kg	15		0.88	0.88	8.6		0.73	0.73	13.1		0.81	0.81	1.93		0.6	0.6
Preserved total solids	percent	73.05		0.04	0.04	68.33		0.04	0.04	73.4		0.04	0.04	66.81		0.04	0.04
Total organic carbon	percent	2.00		0.02	0.02	0.81		0.02	0.02	1.44		0.02	0.02	0.49		0.02	0.02
Total solids	percent	39.81		0.04	0.04	53.65		0.04	0.04	41.9		0.04	0.04	66.77		0.04	0.04
Total sulfides	mg/kg	212		22.4	22.4	99.7		6.82	6.82	279		26.1	26.1	17.8		1.5	1.5
Total volatile solids	percent	6.65		0.01	0.01	3.53		0.01	0.01	5.99		0.01	0.01	2.22		0.01	0.01
Dioxins/Furans																	
2,3,7,8-TCDD	pg/g	0.372	U*	0.067	0.999	0.236	U*	0.073	0.998	0.392	U*	0.084	0.998	NA			
1,2,3,7,8-PeCDD	pg/g	1.81		0.099	0.999	0.774	J	0.083	0.998	1.64		0.093	0.998	NA			
1,2,3,4,7,8-HxCDD	pg/g	1.3		0.123	0.999	0.664	J	0.070	0.998	1.38		0.096	0.998	NA			
1,2,3,6,7,8-HxCDD	pg/g	6.88		0.115	0.999	2.93		0.069	0.998	6.19		0.090	0.998	NA			
1,2,3,7,8,9-HxCDD	pg/g	4.09		0.124	0.999	1.79		0.072	0.998	3.72		0.097	0.998	NA			
1,2,3,4,6,7,8-HpCDD	pg/g	100	J	0.218	2.5	40		0.154	2.49	90.1	J	0.253	2.5	NA			
OCDD	pg/g	735	J	0.277	9.99	282	B	0.212	9.98	632	J	0.262	9.98	NA			
2,3,7,8-TCDF	pg/g	2.51		0.068	0.999	1.08		0.089	0.998	2.24		0.060	0.998	NA			
1,2,3,7,8-PeCDF	pg/g	1.3		0.066	0.999	0.528	J	0.073	0.998	1.17		0.103	0.998	NA			
2,3,4,7,8-PeCDF	pg/g	1.38		0.059	0.999	0.55	U*	0.068	0.998	1.17	U*	0.091	0.998	NA			
1,2,3,4,7,8-HxCDF	pg/g	2.93		0.065	0.999	1.13		0.045	0.998	2.54		0.061	0.998	NA			
1,2,3,6,7,8-HxCDF	pg/g	1.17		0.066	0.999	0.49	J	0.045	0.998	1.08		0.063	0.998	NA			
1,2,3,7,8,9-HxCDF	pg/g	0.642	U*	0.062	0.999	0.308	U*	0.044	0.998	0.56	J	0.056	0.998	NA			
2,3,4,6,7,8-HxCDF	pg/g	1.58		0.063	0.999	0.802	J	0.044	0.998	1.59		0.062	0.998	NA			
1,2,3,4,6,7,8-HpCDF	pg/g	24.8		0.075	0.999	10.7		0.049	0.998	24.1		0.098	0.998	NA			
1,2,3,4,7,8,9-HpCDF	pg/g	1.46		0.098	0.999	0.642	J	0.065	0.998	1.44		0.128	0.998	NA			
OCDF	pg/g	59.5		0.186	2	21.4		0.14	2	54.6		0.198	2	NA			
TEQ	pg/g																
TEQ (ND=1/2 DL)	pg/g	6.03	J	0.258	3.18	2.50	J	0.229	3.17	5.34	J	0.271	3.17	NA			
TEQ (ND=0)	pg/g	5.81	J	0	0	2.28	J	0	0	4.97	J	0	0	NA			

All results shown are on a dry weight basis.

a - The EDL is provided for dioxin/furan results rather than the MDL

-- = no criteria
MDL = method detection limit
MRL = method reporting limit
Val. = validation
NA = not analyzed

EMPC = Estimated maximum possible concentration

J = estimated concentration
U = indicates the target analyte was not detected at the reported concentration
U* = EMPC values flagged as undetected
B = analyte detected in an associated Method Blank at a concentration greater than one-half of ARI's Reporting Limit or 5 percent of the regulatory limit or 5 percent of the analyte concentration in the sample

Table 9. Field grain size wet seiving data.

	Field grain size (% fines)
KEN01	54
KEN02	50
KEN03	42
KEN04	61
KEN05	51
KEN06	48
KEN07	47
KEN08	51
KEN09	52
CI-16-6	50
CI-16-7	56
CI-16-8	60
CR23	52

Table 10. Carr Inlet Sediment Sampling Summary

Sample ID	Latitude (NAD83)	Longitude (NAD83)	Northing (NAD83)	Easting (NAD83)	Depth (ft MLLW)	Estimated Tide Level	Approximate Mudline	Date	Time	Recovery (cm)
Carr Inlet Bioassay Reference										
CR23	47.3330	-122.6715	736642	1102008	42.5	12.2	30.3	03/13/19	1024	27
Carr Inlet Bioaccumulation Reference										
CI-16-6-G1	47.2486	-122.6519	705756	1106042	403	6.9	396	02/18/19	10:31:56	18, 18
CI-16-6-G2	47.2487	-122.6519	705767	1106023	408	7.6	400	02/18/19	11:07:41	18, 18
CI-16-6-G3	47.2486	-122.6518	705763	1106052	405	8.2	397	02/18/19	11:32:08	18, 18
CI-16-7-G1	47.2553	-122.6575	708224	1104702	408	8.9	399	02/18/19	11:55:17	18, 18
CI-16-7-G2	47.2553	-122.6575	708234	1104700	410	9.6	400	02/18/19	12:37:46	18, 18
CI-16-7-G3	47.2553	-122.6575	708229	1104714	413	10.3	403	02/18/19	12:58:26	18, 17
CI-16-8-G1	47.2464	-122.6494	704917	1106640	437	10.9	426	02/18/19	13:23:51	18, 18
CI-16-8-G2	47.2463	-122.6493	704907	1106651	436	11.6	424	02/18/19	13:51:45	18, 18
CI-16-8-G3	47.2464	-122.6493	704924	1106648	438	12.3	426	02/18/19	14:16:17	18, 18
Carr Inlet Bioaccumulation Reference Calculated Centroid Locations										
CI-16-6	47.2486	-122.6519	705762	1106039	--	--	398	02/18/19	10:31:56	--
CI-16-7	47.2553	-122.6575	708229	1104705	--	--	401	02/18/19	11:55:17	--
CI-16-8	47.2464	-122.6493	704916	1106646	--	--	425	02/18/19	13:23:51	--

Notes:
-- = not available
MLLW = mean lower low water

Table 11. Bioassay Results for Control, Reference, and Onsite Sediments

Sample	Grain Size (% fines)	Amphipod Test: Mortality (%)	Larval Test: Normalized Combined Mortality & Abnormality (%)	Juvenile Polychaete Test: Mean Growth Rate - AFDW (mg/ind/day)
Control	NA	0	83.2 ± 3.1	0.401 ± 0.11
CR-23	58.7	0	90.9 ± 5.9	0.361 ± 0.09
KEN02	70.5	4 ± 4.2	21.2 ± 12.9	0.350 ± 0.05
KEN07	59.3	9 ± 4.2	56.6 ± 6.2	0.337 ± 0.04

Notes:

CR-23 is the reference sample, collected from Carr Inlet, WA.
Reported results include the standard deviation (e.g., ± 2.2).

AFDW = ash-free dry weight
mg/ind/day = milligrams per individual per day
NA = not available
Test species:
amphipod: *Eohaustorius estuarius*
larvae: *Mytilus galloprovincialis*
polychaete: *Neanthes arenaceodentata*

Table 12. Bioassay Results Relative to Performance Standards and Interpretive Criteria

Test	Negative Control		Reference Sediment		Nondispersive Disposal Site Interpretation Guidelines					
	Performance Standard	Result	Performance Standard	CR-23 Result	1-Hit Rule	2-Hit-Rule	KEN02 Result	Result Summary	KEN07 Result	Result Summary
Amphipod Mortality	$M_C \leq 10\%$	0.0%	$M_R - M_C \leq 20\%$	0.0%	$M_T - M_C > 20\%$ and M_T vs. M_R SS (p=.05) and		4% Yes	Pass	9% Yes	Pass
					$M_T - M_R > 30\%$	NOCN	4%		9%	
Larval Development	$N_C/I \geq 0.70$	0.83	$N_R/N_C \geq 0.65$	0.91	$N_T/N_C < 0.80$ and N_T/N_C vs. N_R/N_C SS (p=.10) and		0.21 Yes	Fail	0.57 Yes	Fail
					$N_R/N_C - N_T/N_C > 0.30$	NOCN	0.7		0.346	
Juvenile Polychaete Growth (AFDW)	$M_C \leq 10\%$ and $MIG_C \geq 0.38$ [a]	0.0% 0.401	$M_R \leq 20\%$ and $MIG_R/MIG_C \geq 0.80$	0% 0.90	$MIG_T/MIG_C < 0.80$ and MIG_T vs. MIG_R SS (p=.05) and		0.87 No	Pass	0.84 No	Pass
					$MIG_T/MIG_R < 0.50$	$MIG_T/MIG_R < 0.70$	0.97		0.93	

Notes:
Performance standards are defined in the Dredged Material Evaluation and Disposal Procedures User Manual (DMMO 2013).
The reference sample (CR-24) was collected from Carr Inlet, Washington.

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

[a] Target MIGc is 0.72 mg/ind/day; the test is considered to be failed if MIGc is less than 0.38 mg/ind/day.

Table 13. Summary Statistics for Survival and Growth of Test Organisms

		Macoma nasuta								*Nephtys caecoides*							
Sample ID	Rep.	Survival (no. of individuals)	Survival (%)	Mean Survival (%)	Std. Dev.	Test Initiation Mean Tissue Weight (g/individual) [a]	Test Termination Tissue Weight (g)	Test Termination Mean Tissue Weight (g/individual)	Std. Dev.	Survival (no. of individuals)	Survival (%)	Mean Survival (%)	Std. Dev.	Test Initiation Mean Tissue Weight (g/individual) [a]	Test Termination Tissue Weight (g)	Test Termination Mean Tissue Weight (g/individual)	Std. Dev.
	1	13	86.7				43.7			98	93.3				16.2		
	2	13	86.7				37.0			97	92.4				18.3		
KEN01-Comp	3	15	100	94.7	7.3	3.58	42.1	3.04	0.2	101	96.2	94.7	2.0	0.158	18.1	0.179	0.01
	4	15	100				45.0			102	97.1				18.1		
	5	15	100				48.0			99	94.3				18.5		
	1	15	100				46.2			103	98.1				18.3		
	2	15	100				45.6			94	89.5				16.5		
Supercomposite	3	15	100	100.0	0.0	3.58	51.0	3.07	0.2	99	94.3	94.5	3.2	0.158	17.6	0.183	0.01
	4	15	100				43.4			101	96.2				19.9		
	5	15	100				44.0			99	94.3				18.4		
	1	14	93.3				49.3			97	92.4				18.3		
	2	15	100				45.1			97	92.4				17.0		
CI16-8 (Reference)	3	14	93.3	96.0	3.7	3.58	41.6	3.19	0.3	97	92.4	93.7	1.8	0.158	18.9	0.179	0.01
	4	14	93.3				49.9			100	95.2				17.9		
	5	15	100				43.2			101	96.2				16.1		
	1	15	100				45.2			101	96.2				20.0		
	2	14	93.3				44.7			101	96.2				18.4		
Control	3	15	100	98.7	3.0	3.58	54.8	3.15	0.3	104	99.0	97.7	1.7	0.158	18.8	0.188	0.01
	4	15	100				47.0			105	100				19.6		
	5	15	100				41.1			102	97.1				19.4		

Notes:

Rep. = replicate

[a] Tissue weights at test initiation are based on the mean weight of the pre-test organisms. The number of organisms used for each pre-test weight determination was based on the same number of organisms used for setting up the test sediments (15 for *M. nasuta* and 105 for *N. caedoides*)

Table 14. Bioaccumulation Exposure Tissue Data Summary, *Macoma nasuta*

Sample Name	Dioxin/Furan TEQ Mammal - Half DL (ng/kg ww)	Dioxin/Furan TEQ Mammal - ND=0 (ng/kg ww)	Lipid (% ww)
Pre-Test Tissue			
Mn Pretest Rep 1	0.146 U	0 U	0.80
Mn Pretest Rep 2	0.141 J	0.00162 J	0.84
Mn Pretest Rep 3	0.0913 U	0 U	0.92
Average Mn Pretest	*0.126 J*	*0.001 J*	*0.85*
Carr Inlet Reference Tissues			
Mn CI16-8 Rep 1	0.177 J	0.0150 J	0.72
Mn CI16-8 Rep 2	0.192 J	0.00451 J	0.60
Mn CI16-8 Rep 3	0.149 J	0.0150 J	0.64
Mn CI16-8 Rep 4	0.158 J	0.0171 J	0.68
Mn CI16-8 Rep 5	0.183 J	0.0104 J	0.56
Average Mn CI16-8	*0.172 J*	*0.0124 J*	*0.64*
Elliott Bay Tissue			
Mn EBBT-Comp Rep 1	0.184 J	0.0585 J	0.48
Mn EBBT-Comp Rep 2	0.232 J	0.0853 J	0.56
Mn EBBT-Comp Rep 3	0.215 J	0.0632 J	0.48
Mn EBBT-Comp Rep 4	0.155 J	0.0192 J	0.56
Mn EBBT-Comp Rep 5	0.257 J	0.124 J	0.64
Average Mn EBBT-Comp	*0.209 J*	*0.070 J*	*0.54*
Kenmore Tissues			
Mn KEN 01 Rep 1	0.201 J	0.0126 J	0.72
Mn KEN 01 Rep 2	0.313 J	0.0491 J	0.56
Mn KEN 01 Rep 3	0.375 J	0.0768 J	0.64
Mn KEN 01 Rep 4	0.239 J	0.0774 J	0.48
Mn KEN 01 Rep 5	0.221 J	0.0475 J	1.1
Average Mn KEN 01	*0.270 J*	*0.0527 J*	*0.70*
Mn Supercomp Rep 1	0.159 J	0.0544 J	0.54
Mn Supercomp Rep 2	0.148 J	0.0475 J	0.58
Mn Supercomp Rep 3	0.146 J	0.0170 J	0.64
Mn Supercomp Rep 4	0.150 J	0.0405 J	0.56
Mn Supercomp Rep 5	0.155 J	0.0476 J	0.56
Average Mn Supercomp	*0.151 J*	*0.0414 J*	*0.58*

Notes:
DL = detection limit
J = estimated concentration
TEQ = toxicity equivalence
U = the target analyte was not detected at the reported concentration

Table 15. Bioaccumulation Exposure Tissue Data Summary, *Nephtys caecoides*

Sample Name	Dioxin/Furan TEQ Mammal - Half DL (ng/kg ww)	Dioxin/Furan TEQ Mammal - ND=0 (ng/kg ww)	Lipid (% ww)
Pre-Test Tissue			
Nc Pretest Rep 1	0.169 U	0 U	0.64
Nc Pretest Rep 2	0.337 J	0.0951 J	0.36
Nc Pretest Rep 3	0.109 U	0 U	0.44
Average Nc Pretest	*0.205 J*	*0.032 J*	*0.48*
Carr Inlet Reference Tissues			
Nc CI16-8 Rep 1	0.0771 J	0.00740 J	0.54
Nc CI16-8 Rep 2	0.100 J	0.000720 J	0.44
Nc CI16-8 Rep 3	0.133 J	0.00515 J	0.46
Nc CI16-8 Rep 4	0.0650 J	0.00531 J	0.48
Nc CI16-8 Rep 5	0.0800 J	0.00935 J	0.46
Average Nc CI16-8	*0.0910 J*	*0.00559 J*	*0.48*
Elliott Bay Tissue			
Nc EBBT-Comp Rep 1	0.134 J	0.0330 J	0.46
Nc EBBT-Comp Rep 2	0.142 J	0.0306 J	0.46
Nc EBBT-Comp Rep 3	0.124 J	0.0359 J	0.42
Nc EBBT-Comp Rep 4	0.135 J	0.0353 J	0.42
Nc EBBT-Comp Rep 5	0.146 J	0.0217 J	0.58
Average Nc EBBT-Comp	*0.136 J*	*0.031 J*	*0.47*
Kenmore Tissues			
Nc KEN 01 Rep 1	0.106 J	0.0154 J	0.48
Nc KEN 01 Rep 2	0.126 J	0.00994 J	0.42
Nc KEN 01 Rep 3	0.104 J	0.0108 J	0.48
Nc KEN 01 Rep 4	0.164 J	0.0169 J	0.38
Nc KEN 01 Rep 5	0.0937 J	0.0000642 J	0.48
Average Nc KEN 01	*0.119 J*	*0.0106 J*	*0.45*
Nc Supercomp Rep 1	0.0783 J	0.00191 J	0.60
Nc Supercomp Rep 2	0.0831 J	0.00175 J	0.68
Nc Supercomp Rep 3	0.0875 J	0.00189 J	0.54
Nc Supercomp Rep 4	0.183 J	0.0439 J	0.64
Nc Supercomp Rep 5	0.111 J	0.000743 J	0.64
Average Nc Supercomp	*0.109 J*	*0.0100 J*	*0.62*

Notes:
DL = detection limit
J = estimated concentration

TEQ = toxicity equivalence
U = the target analyte was not detected at the reported concentration

Table 16. Statistical Comparison between Kenmore Site Samples and Reference (Carr Inlet) and Benchmark (Elliott Bay) Areas. Percent difference from the Carr Inlet reference area also shown.

			Comparison to Carr Inlet		Comparison to Elliott Bay
Organism	Test Sediment	Dioxin TEQ	% Difference from Reference	Gehan Test *p*-value	Gehan Test *p*-value
Macoma	KEN01	ND=1/2 DL	57.04	0.005	0.087
		ND=0	325.81	0.023	0.827
	Supercomposite	ND=1/2 DL	-11.76	0.962	0.989
		ND=0	235.48	0.006	0.963
Nephtys	KEN01	ND=1/2 DL	30.48	0.059	0.913
		ND=0	97.23	0.058	0.995
	Supercomp.	ND=1/2 DL	19.34	0.174	0.941
		ND=0	89.14	0.8	0.942

Notes:

All Below DL = All Kenmore samples are below the detection limit.

NaN = reference or benchmark samples are below the detection limit.

yellow highlight Kenmore samples with concentrations that are 20% greater than reference.

gray shading Kenmore samples statistically significantly different where Kenmore > reference or benchmark.

Table 17. Statistical Comparison using BioStat between Kenmore Site Samples, Carr Inlet Reference and Elliott Bay Benchmark.

		Comparison to Carr Inlet		Comparison to Elliott Bay	
Organism	Test Sediment	Statistic Used	*Statistically different?*	Stastic Used	*Statistically different?*
Macoma	KEN01	Approximate t-test	yes	Student's t-test	yes
	Supercomposite	Approximate t-test	no	Approximate t-test	no
Nephtys	KEN01	Mann-Whitney	yes	Approximate t-test	no
	Supercomposite	Mann-Whitney	no	Student's t-test	no

Notes:
gray shading Kenmore samples statistically significantly different where Kenmore > reference or benchmark.

Table 18. Tissue PQLs

Dioxins/Furans	TEF	PQL
2,3,7,8-TCDD	1	1
1,2,3,7,8-PeCDD	1	5
1,2,3,4,7,8-HxCDD	0.1	5
1,2,3,6,7,8-HxCDD	0.1	5
1,2,3,7,8,9-HxCDD	0.1	5
1,2,3,4,6,7,8-HpCDD	0.01	5
OCDD	0.0003	10
2,3,7,8-TCDF	0.1	1
1,2,3,7,8-PeCDF	0.03	5
2,3,4,7,8-PeCDF	0.3	5
1,2,3,4,7,8-HxCDF	0.1	5
1,2,3,6,7,8-HxCDF	0.1	5
1,2,3,7,8,9-HxCDF	0.1	5
2,3,4,6,7,8-HxCDF	0.1	5
1,2,3,4,6,7,8-HpCDF	0.01	5
1,2,3,4,7,8,9-HpCDF	0.01	5
OCDF	0.0003	10
Sum TEQ		11.406
Ecology Dioxin PQL		1

Table 20. Kenmore Navigation Channel Bioaccumulation Intrepretation Summary

		Bioaccumulation Interpretation						
Test Sediments	Organism	Statistically different from Carr Inlet Reference, a = 0.1, Biostat results	Greater than 20% above Carr Inlet Reference	Statistically different from Elliott Bay benchmark, a=0.1, Biostat results	Greater than 50% contribution to sum TEQs from non-detects	concentrations above Ecology tissue PQL?	Average concentration greater than *in situ* tissue concentrations?	Suitable for open-water disposal in Elliott Bay?
KEN01	*Macoma*	yes	yes	yes	yes	no	no	**YES**
	Nephtys	yes	yes	no	yes	no	no	
Supercomposite[c]	*Macoma*	no	no		yes	no	no	**YES**
	Nephtys	no	no		yes	no	no	

Table 21. Kenmore Navigation Channel Benthic Toxicity Evaluation Summary

	Chemistry Exceedances	Bioassay Results			Suitable for open-water disposal in Elliott Bay?
DMMU	SL	Amphipod	Neanthes growth	Larval	
KEN01	total chlordane		---	---	**NO**
KEN02	butylbenzyl phthalate, total chlordane	Pass	Pass	1-Hit failure	**NO**
KEN03	total chlordane		---	---	**NO**
KEN04	total chlordane		---	---	**NO**
KEN05	total chlordane, DDE		---	---	**NO**
KEN06	total chlordane		---	---	**NO**
KEN07	butylbenzyl phthalate, total chlordane	Pass	Pass	1-Hit failure	**NO**
KEN08	total chlordane		---	---	**NO**
KEN09	total chlordane		---	---	**NO**

indicates not suitable for open-water disposal
indicates suitable for open-water disposal